Electronic Monitoring Systems for Hand Hygiene in Hospitals: Relationship to Practice and Exploration of Clinical Perceptions

Electronic Monitoring Systems for Hand Hygiene in Hospitals: Relationship to Practice and Exploration of Clinical Perceptions

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Abstract

Appropriate hand hygiene at the five evidence-based moments proposed by the World Health Organization (WHO) during the delivery of patient care by healthcare workers (HCWs) is crucial in the prevention and control of healthcare associated infections. Audits of hand hygiene are required by health and social care regulators and organisations to provide assurance of practice. Compliance with hand hygiene is frequently low and electronic monitoring systems (EMSs) offer a potential way of generating data to inform improvement to practice which avoids some of the drawbacks of auditing via direct observation. It is important that these electronic systems generate data which is reflective of the reality of frontline practice in terms of the occurrence of opportunities for hand hygiene.

Therefore, this mixed methods research aimed to fill a key gap in this field by developing a denominator for hand hygiene based on the average number of opportunities on inpatient wards in England. This was achieved via observations of the provision of care by frontline HCWs on two wards. In addition, compliance data captured during observations of care was compared with data from an EMS running concurrently on the wards. Following this, the second phase of the research explored the findings from the observation phase through interviews with frontline HCWs. Interview topics included the practical application of the five moments for hand hygiene, the role of audit in driving practice, the potential role of EMSs, and the impact on hand hygiene behaviour of the COVID-19 pandemic.

This data can not only be used to inform a denominator for EMSs but also provides additional knowledge of the burden of hand hygiene for HCWs. Further to this, interviews revealed some of the key challenges and common issues which arise when applying hand hygiene in the dynamic hospital environment. It was found that during the COVID-19 pandemic the use of personal protective equipment (PPE) and motivation of self-protection created barriers to effective hand hygiene practice. This thesis provides insight into the perceived value and trustworthiness of data gathered during direct audit of practice, bringing its usefulness into debate. With triggers to audit, and greater staff engagement, often seen as a reactive response to an outbreak of infection rather than an ongoing process of embedded preventative practices. Of particular interest was how EMSs may be accepted as an adjunct to, not a replacement of, existing audit practice.

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List of Abbreviations

5MHH	My five moments for hand hygiene
ABHR	Alcohol-based hand rub
AMS	Antimicrobial stewardship
BBF	Blood or bodily fluids
BCW	Behaviour change wheel
COM-B	Capability, opportunity, motivation, and behaviour
COVID-19	Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
COW	Computer on wheels
EMS/s	Electronic monitoring system/s
GMS	Group monitoring system
ICU/s	Intensive care unit/s
IPC	Infection prevention and control
IPCN	Infection prevention and control nurse
IV	Intravenous
HCAI	Healthcare associated infections
HCW/s	Healthcare worker/s
HHO	Hand hygiene opportunity
HRA	Health Research Authority
M1/M2/M3/M4/M5	Moment 1, Moment 2, Moment 3, Moment 4, Moment 5
NA/s	Nursing assistant/s
NICE	The National Institute for Health and Care Excellence
PPE	Personal protective equipment
RN/s	Registered nurse/s
RTA	Reflexive thematic analysis
TDF	Theoretical domains framework
USA	United States of America
UK	United Kingdom
WOW	Workstation on wheels
WHO	World Health Organization

Overview of the thesis

This thesis explores the topic of hand hygiene in hospitals, a critical behaviour in the prevention and control of healthcare associated infections. Its particular focus is routine audit data which is used to provide assurance of practice and inform improvement interventions. The current 'gold standard' to collect audit data is via direct observation of care, this however has multiple drawbacks. To address this, EMSs are being developed and calibrated to ensure they reflect the reality of practice in terms of the occurrence of opportunities for, and therefore compliance to, hand hygiene. The provision of accurate audit data is imperative if it is to be used effectively to motivate practice and enact change.

The aim of this research was to gain an understanding of the average number of hand hygiene opportunities on hospital inpatient wards in the United Kingdom (UK) and explore how this related to an existing EMS. Following this, interviews with frontline HCWs were performed to gain insight into their perceptions and experiences of the application of hand hygiene in everyday practice. As well as their thoughts around audit as a driver for practice and change, the potential role of EMSs, and whether the COVID-19 pandemic had any impact upon hand hygiene behaviour.

To do this a mixed methods sequential explanatory study design, employing both quantitative and qualitative methods was used. This pragmatic approach to the research enabled both observation of frontline practice, and in-depth interviews with those providing patient care. This allowed for the provision of a wider picture of the burden of hand hygiene on frontline HCWs, the potential for EMSs in terms of its representation of the reality of practice, and how the way care provision itself is organised and the motivations of the individuals who provide it further add to the complexity of the application of hand hygiene.

A scoping review presented in this thesis found many studies exploring infection prevention and control practices are not underpinned by a behaviour change framework. This study employed the Theoretical Domains Framework (TDF) and Capability, Opportunity, Motivation and Behaviour (COM-B) models to design question schedules and explore the findings. The research raises questions around the accuracy and usefulness of audit data as collected via direct observation of care, with EMSs providing a more accurate measure of hand hygiene compliance. This in turn brings into debate the usefulness of audit itself in motivating practice and as a driver for change.

The doctoral researcher is not positioned as an infection prevention and control practitioner by background and does not work as a frontline HCW. They approached this topic with a

background in psychology, specifically health psychology, and with experience working on academic research projects related to infection prevention and control. This has allowed for an outsider perspective when observing real-world practice, retaining curiosity about the way in which care is delivered and how this impacted upon hand hygiene opportunities and compliance. During interviews, participants were recognised as the experts in their fields without researcher assumptions or personal experiences leading the topics or analysis.

An overview of the structure of the thesis is provided below.

Chapter 1 introduces the research area, setting the scene for the thesis. This chapter outlines the burden of healthcare associated infections in the UK, and the ways infections can be transmitted in healthcare settings. It also introduces infection prevention and control practices, including hand hygiene and the ways in which practice is standardised and applied via the five moments for hand hygiene.

Chapter 2 presents a focused review of the literature which explores use of EMSs for hand hygiene, including considerations for the configuration of these systems. It also presents some of the psychological and practical factors which may influence an individual HCWs performance of hand hygiene, and the role which audit and monitoring of practice plays in driving hand hygiene behaviour.

Chapter 3 presents a scoping review on the application of behaviour change theories to the area of infection prevention and control practices. This explores the extent of literature on theory-driven practice and how behaviour change theory has been used to establish potential factors underlying the performance of infection prevention and control behaviours. Behaviour change theories play a crucial role in informing the development of interventions to support improvement, or change, to practice. An edited version of this chapter was published in the Journal of Infection Prevention in 2022.

Chapter 4 presents the rationale and aims of this study, along with the methodology, theoretical perspective, and methods employed. As an explanatory mixed methods study the research was performed in two phases. The methods for each phase are described, including data collection and analysis.

Chapter 5 details the results of Phase 1 of the research, the quantitative element. This chapter presents the findings from observation of practice on two inpatient wards in the UK,

including an average number of hand hygiene opportunities for frontline HCWs. Data generated by an EMS installed on the wards is also presented and explored.

Chapter 6 details the results of Phase 2 of the research, the qualitative element. This chapter explores the findings of eight semi-structured interviews with HCWs, including infection prevention and control practitioners. This explored the application of the five moments for hand hygiene, experience of audits, perceptions of EMSs, and the impact of the COVID-19 pandemic upon hand hygiene behaviour.

Chapter 7 brings together the findings from Phase 1 and Phase 2 to provide a deeper understanding of hand hygiene audit and practice. With key findings explored under the elements of the COM-B model of behaviour and in relation to existing literature.

Chapter 8 presents a summary of the key findings and their implications for practice, reflections on completing the research and its challenges, limitations of the research, and potential future research directions.

Chapter 1 Introduction

1.1 Chapter overview

This chapter introduces the wider background and context to this research. It explores healthcare associated infections (HCAI) and the role that HCWs have in the potential spread of infections in healthcare settings. This is discussed alongside the evidence-based guidelines that underpin infection prevention and control (IPC) practice, in particular the five moments of hand hygiene framework which was developed to define points during patient care provision when hand hygiene is required to reduce the transmission of pathogens. The auditing of hand hygiene practice is discussed, along with current methods which are used to determine whether practice standards are achieved.

1.2 Background to the research

Hand hygiene, the cleansing of hands, is a crucial behaviour for HCWs during the provision of patient care as hands are the main route via which infections can occur and spread. The major impact of HCAI upon patients worldwide prompted researchers in the field of patient safety to develop evidence-based guidance for hand hygiene. The outcome being the World Health Organization's My 5 Moments for Hand Hygiene (5MHH). The 5MHH considers the protection of both the patient and the HCW from infection and offers a method to standardise hand hygiene requirements across the health and social care sector globally.

At the time of the publication of the 5MHH in 2009 performance of hand hygiene was often found to be suboptimal. Thus, the initiative was framed with an improvement science approach and as such included promotional materials such as posters and resources to support implementation of the 5MHH programme. Documentation was also provided to support monitoring and feedback of compliance with the 5MHH as they occur in practice. This not only focuses attention on the importance of tracking potential changes in compliance but can also fulfil requirements at a governmental or organisational level which require hand hygiene practice is in place as part of a hospital IPC programme.

From a regulatory standpoint in the UK, hand hygiene is part of IPC practices which are detailed in requirements set by the Department of Health and Social Care. These requirements are used by the Care Quality Commission, the national independent regulator, to assess whether the infection prevention systems and practices healthcare providers have in place are compliant to requirements. The regulations are part of a specific Code of Practice for the prevention and control of infections. This Code of Practice contains guidance as to how providers must meet criteria as set out by the Health and Social Care Act 2008 (Department of Health, 2015). This includes IPC practices focused on antimicrobial

resistance and preventing and controlling the spread of infection, including implementation of hand hygiene policy, training, and audit and feedback.

Auditing programmes operate as a key performance indicator within healthcare service providers to check whether practice is meeting set standards, and a way of measuring improvement interventions, or maintenance once standards are met. Hand hygiene audits are used to explore compliance with the 5MHH as applied by HCWs during the provision of patient care. This is usually done via direct observation of practice, though this method has downfalls which risks data being reported which is not an accurate representation of hand hygiene practice. As with many areas of healthcare innovation, digital solutions in the form of EMSs are a potential avenue to support accurate monitoring of practice. Electronic monitoring systems themselves require exploration and development to see whether they can measure practice which is representative of compliance with the 5MHH as they occur in real world practice.

The ultimate aim of hand hygiene is to mitigate the risk of the transfer of pathogens via the hands of the HCW. This includes transfer to the patient, between vulnerable sites on one patient, and from the patient to the HCW themselves or the healthcare environment and other patients within it. The potential negative impact of infections acquired within healthcare settings is serious, both in terms of patient outcomes and financial implications. As compliance with the 5MHH is often reported in the literature as low, hand hygiene is the focus of many service improvement initiatives at both national and local levels.

It is noted that the word ‘compliance’ in reference to hand hygiene practice is somewhat contentious as it potentially implies a lack of agency on the part of HCWs, perhaps also suggesting that a lack of compliance is a purposeful act. As compliance is still widely used in the literature surrounding hand hygiene practice and throughout the document published by the WHO which supports the 5MHH this word will be used throughout the thesis. Though it is recognised that this language in itself may require change to further engage frontline staff.

1.2.1 Healthcare-associated infections

Healthcare-associated infections, also known as nosocomial infections, are those which occur due to care received in a hospital, other healthcare facility, or from care provided to individuals in community settings. These infections can occur as a result of receiving medical or surgical treatment, or from simply interacting with a healthcare environment (NICE, 2011). Healthcare environments themselves are liable to contain pathogens with an enhanced capacity to spread due to their resistance to antibiotics (Avershina, Shapovalova and

Shipulin, 2021). Infections are caused by microorganisms called pathogens, these may cause one specific disease or be the root of many different types of infections depending on where it occurs in the body (Wilson, 2019). Patients can be particularly vulnerable to infection as they may have comorbidities or underlying diseases which can put them at greater risk.

Microorganisms exist both within the body and on the surface of the skin, these are referred to as flora. Infections can be transmitted via endogenous or exogenous routes (Van Saene, Silvestri and Cal, 2005). Endogenous infections originate from flora which are present within one's own body, these can cause infection when barriers between sterile and non-sterile tissues are broken causing microorganisms to be introduced to other parts of the body. Whereas exogenous infections enter from outside of the body, via medical devices or from the environment. For example, via an invasive procedure such as surgery which breaks the skin barrier, or an invasive device such as a urinary catheter which are inserted through openings in the body. These invasive treatments create a route for pathogens to enter and a critical source of pathogens can be via the hands of HCWs when in contact with the patient or their invasive device.

Our hands are colonised by resident flora, which are naturally present in our skin, these are of low pathogenicity and not likely to cause infection unless they are transferred into sterile body cavities, the eyes, or areas of broken skin (World Health Organization, 2009). Transient flora is acquired temporarily on hands by touching surfaces, including other people or the environment. Most transient flora are located on the surface of the skin, and they are not adapted to survive on the dry and acidic environment. They are therefore easily deposited onto the next surface with which the hands come into contact (Loveday et al., 2014a). For HCWs this means that this transient flora can be passed between surfaces and onto patients when providing care if hands are not decontaminated. The potential transmission of pathogens from the hands of HCWs to the healthcare environment or patients comprises five sequential steps demonstrating the crucial role of hands in the potential spread of infection (Table 1.1, overleaf).

Table 1.1 Five steps in the transmission of pathogens via the hands of HCWs (adapted from Pittet et al., 2006).

Step	Description
1	Organisms are present on the patient's skin or have been shed onto items in the patient's immediate environment (e.g., bedding, bedside table).
2	Organisms are transferred to HCWs hands through touch.
3	Organisms are capable of surviving on HCWs hands for several minutes.
4	Hand hygiene by the HCW may be inadequate, omitted completely, or the agent used for hand hygiene inappropriate.
5	The HCWs contaminated hands come into direct contact with another patient, with an item in direct contact with the patient, or with the healthcare environment. This creates cross-transmission.

Some common causes of infection include the pathogens *Escherichia coli* (E. coli), *Clostridioides difficile* (C. difficile), and Methicillin-resistant *Staphylococcus aureus* (MRSA) (National Audit Office, 2004). The most recent published data from a point prevalence survey of HCAI in acute hospital settings in England found a prevalence to be around 6.4% (Health Protection Agency, 2012). This survey found that six HCAI accounted for more than 80% of all infections, these were respiratory tract infections, urinary tract infections, surgical site infections, clinical sepsis, gastrointestinal infections, and bloodstream infections.

The potential impact of HCAI can be severe with the potential for additional treatment including antibiotic treatment, prolonged stay in hospital, long-term disability, and mortality (Jenkins, 2017). It is not only patients or those receiving medical care who are at risk of developing HCAI, with others including HCWs, carers, and visitors also susceptible either through contact with a patient or the healthcare environment (NICE, 2014). These individuals may then need medical treatment or hospital admission themselves. For those who are HCWs this could result in time absent from work, as a consequence this may require hospitals to hire agency staff to cover shifts.

An additional consideration is the cost of treatment, with occurrence of HCAI increasing the utilisation of hospital resources such as nursing care and laboratory tests, this in turn increases healthcare spending. Guest et al. (2020) explored the cost of HCAI occurring in adult patients and frontline HCWs to the National Health Service (NHS). They estimate that in 2016/2017 the NHS incurred £2.1 billion in costs related to HCAI, with 99.8% of costs related to the management of patients and the rest associated with treatment and staff cover for frontline HCWs who acquired HCAI. The cost is likely to be higher when accounting for specialised hospitals, and the wider socio-economic impact (Plowman et al., 2001; Guest et al., 2020). Ensuring IPC systems and practices, at both an individual and provider level, are

implemented appropriately and to the correct standard is key. It has been suggested that at least 20% of HCAI are preventable through improved practice (Harbarth, Sax and Gastmeier, 2003).

Commissioned by the Department of Health in 1998, the first evidence-based guidelines for the prevention of HCAI in hospitals were developed in 2001 (Pratt et al., 2001). These guidelines, known as 'the epic project', were further updated in 2007 and 2014 (Pratt et al., 2007; Loveday et al., 2014a). The guidelines were developed through a systematic review of evidence and provide principles of best practice which inform local hospital protocols. This process ensures that best practice is supported by research-based evidence which has been critically appraised. When implemented in clinical practice, local guidelines can be used to audit practice to ensure compliance and encourage quality of care.

An organisation's IPC programme is informed by the Health and Social Care Act 2008 code of practice on the prevention and control of infections, and related guidance (Department of Health, 2015). This specifies the need to provide safe care and treatment to service users, including healthcare providers delivery of mandatory staff training in IPC measures, surveillance of the occurrence of certain infectious diseases, provision of sufficient resources to ensure a clean environment, and an audit programme of IPC policies. The Care Quality Commission routinely inspects care providers to ensure they are providing care in line with the Health and Social Care Act 2008 (Care Quality Commission, 2021).

The importance of rigorous and embedded IPC practices has been highlighted recently with the emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, commonly known as COVID-19) which was declared a global pandemic by the WHO in March 2020. At the start of the pandemic knowledge surrounding the transmission routes of COVID-19 was scarce. This impacted the advice and guidance provided regarding the level of precautions required within healthcare settings to protect both patients and HCWs. Nosocomial infections of COVID-19 were a major concern. During the first wave of the pandemic in the UK (January to August 2020) across acute, residential, and long-term care settings research approximates 11.3% to 20.1% of patients acquired the virus whilst in hospital (Read et al., 2021; Knight et al., 2022).

Reflections on the occurrence of nosocomial COVID-19 have identified the importance of stringent IPC systems and practices to avoid the spread of infection (Rickman et al., 2020). Guidance released during the early stages of the pandemic promoted increased usage of PPE during patient care. This, along with additional demands placed on frontline staff caring

for an increased number of patients in intensive care units (ICUs), created difficulties with hand hygiene compliance and a lack of PPE changes between patients exacerbated by shortages in PPE stock. These factors contributed to increases in other HCAI during the pandemic (Patel et al., 2021; Sun Jin and Fisher, 2021).

Under normal circumstances care is delivered to all patients using standard IPC precautions. This involves application of hand hygiene and use of PPE when indicated, safe management of equipment (e.g., adhering to single use items by disposing after one use), a care environment which is routinely cleaned, management of linens to keep clean and used linen separate, management of spills and waste, and safe sharps disposal (Ritchie and McIntyre, 2015). These precautions apply to all patients to promote consistency of practice and control infection risks.

If a patient is suspected to have an infection which could be easily transmitted to others, or confirmed infection status, they will be treated under transmission-based precautions. The extent of these precautions will depend on the transmission route of the infectious organism, these being contact (direct contact with the patient, or indirect contact through the patient environment) and droplet or airborne (large and small particles from a patient's respiratory system). In the case of a patient with a suspected or confirmed infection, they will be admitted to a hospital side room to isolate them from others. Healthcare workers use precautions appropriate to the infection transmission route such as enhanced PPE (e.g., disposable apron, fluid resistant surgical mask, visor, gloves) alongside hand hygiene to reduce the risk of spreading the infection. For planned hospital admissions, patient screening for infection can be performed prior to admission. This is done with the aim of identifying, and treating, any existing infection to avoid an infected person entering the hospital.

1.2.2 The role of hands in the transmission of infection

The most important practice in the reduction of HCAI is the performance of hand hygiene by HCWs (World Health Organization, 2009). The potential role of hands in the spread of infection was first identified in the mid-19th century by Dr Ignaz Semmelweis in Vienna (Bjerke, 2004). Semmelweis noted high maternal mortality rates on a clinic run by medical students when compared to one run by midwives. Through observation of practice, he noticed that medical students attended the clinic after performing autopsies at the morgue. Although students washed their hands, they remained odorous and from this Semmelweis hypothesised that the contaminated hands of the students were spreading disease to women in the maternity clinic. He tested his theory by implementing compulsory hand

washing with soap and water followed by an antiseptic agent, this reduced patient mortality rates from 10% to 1%. Although these results were published at the time, the findings were not widely accepted within Semmelweis' lifetime. Various studies over many decades have now confirmed the role of contaminated hands in the spread of infection within healthcare settings (World Health Organization, 2009).

The patient themselves, and the items and surfaces in close contact with them, are recognised as areas where HCWs hands can become contaminated. Thus, pathogens can be transferred onto HCWs hands through direct contact with an infected or colonised patient, or through indirect contact with the contaminated environment by touching the items and surfaces within it. The longer HCWs are in contact with a patient, the patient's bed space, and healthcare environment, without cleaning their hands the greater their level of hand contamination (Pittet et al., 1999; Pittet et al., 2006). This can lead to the spread of pathogens, potentially causing infection (Foca et al., 2000; Halwani et al., 2006).

Provision of patient care involves tasks which can be characterised as 'clean' or 'dirty'. Performing clean activities includes non-invasive patient contact such as taking a patient's blood pressure or helping them to transfer from the bed to a chair. Whereas so-called dirty activities involve potential contact with blood or bodily fluids (BBF) such as wound care or changing a urinary catheter. Blood and bodily fluids are a source of various viruses and pathogens, these are acquired on the hands in great numbers as BBF are heavily contaminated (Wilson, 2019). Both clean and dirty activities result in hand contamination with microorganisms able to survive on hands for minutes, in addition the wearing of gloves does not protect the hands from becoming contaminated (Pittet et al., 2006).

When considering the healthcare environment, microorganisms can be transferred between surfaces through touch. Different microorganisms can survive for varying periods of time on surfaces, ranging from days to weeks. This is important as objects which can carry pathogens include commonly touched items during the provision of patient care, such as sink taps, digital thermometers, computer keyboards, call buttons, door handles, and cotton blankets (Bures et al., 2000; Boyce, 2007; Galvin et al., 2012). It has been found that when touched, these items can contaminate the hands of HCWs and contaminate patients via direct contact such as placing an oximeter on a patient's finger (Boyce, 2007; Suleyman, Alangaden and Bardossy, 2018).

As the patient, patient bed space, and healthcare environment are all potential sources of contamination for HCWs, proper cleaning of the hands during the provision of patient care is

essential. Hand decontamination is completed by washing hands with soap and water or using alcohol-based hand rub (ABHR). Both methods work by removing transient microorganisms from the hands. Handwashing suspends microorganisms and mechanically removes them in the stream of water, whereas ABHR is rubbed onto dry hands to kill any microorganisms (Widmer, 2000). Soap and water must be used if hands are visibly soiled, contaminated with BBF, or after caring for a patient with vomiting or diarrhoea. The technique for cleaning hands is similar, with soap and water cleaning expected to take around 40 to 60 seconds to complete and ABHR around 20 to 30 seconds (World Health Organization, 2009).

1.2.3 Hand hygiene guidelines

The first national guidelines for hand hygiene practice were published in the 1980s in the United States of America (USA) and have been developed over the decades since to become essential in the prevention and control of infection across the globe (World Health Organization, 2009). To provide standardised guidance regarding appropriate hand hygiene the World Health Organization (WHO) developed the 5MHH. These moments are underpinned by evidence-based recommendations as to when the transmission of pathogens may occur between donor and receptor surfaces as presented in a seminal paper by Sax et al. (2007). The authors emphasise that the 5MHH aim to provide a practical resource to encourage understanding, and as a basis for education and the monitoring of hand hygiene practice.

The 5MHH comprise: 1) before touching a patient, 2) before clean/aseptic procedures, 3) after body fluid exposure/risk of exposure, 4) after touching a patient, and 5) after touching patient surroundings (World Health Organization, 2009). The order and numbering of the moments reflect common workflow patterns when delivering patient care (Sax et al., 2007). The supporting documentation from the WHO includes an illustration of the 5MHH which serves as an educational and promotional tool (Figure 1.1, overleaf).

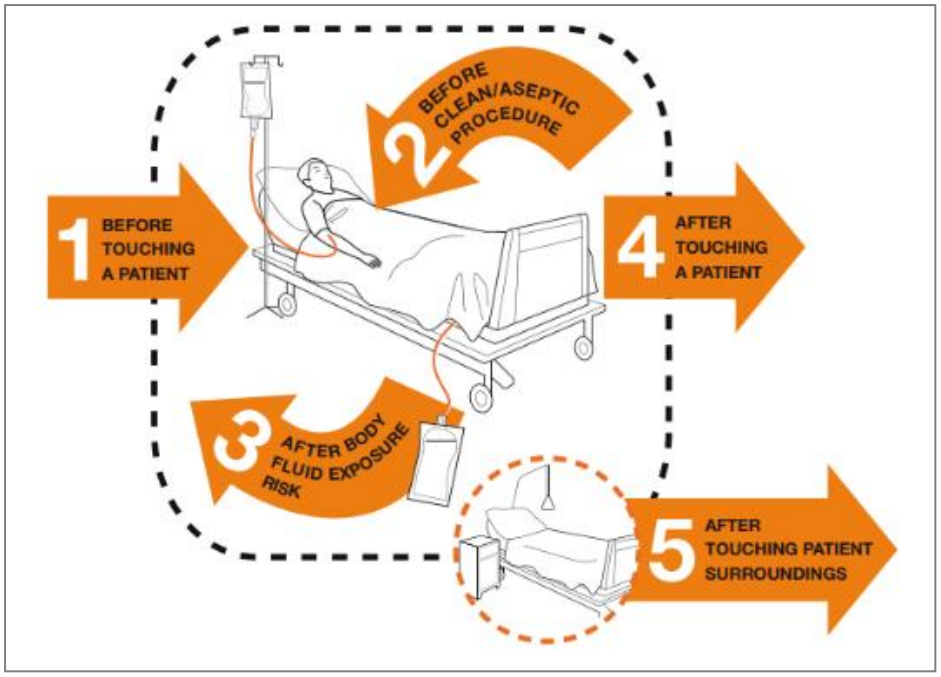

Figure 1.1 The World Health Organization's My Five Moments for Hand Hygiene (World Health Organization, 2009).

The illustration highlights potential clean sites and body fluid sites within the patient zone, showing an intravenous (IV) drip and catheter/drain attached to the patient and highlighted in orange. Clean sites include wounds or invasive medical devices, such as IV drips, which break the skin of the patient and therefore must be protected from microorganisms. Body fluid sites carry a risk of body fluid or blood-borne pathogen exposure for HCWs with the potential for HCWs contaminated hands to transmit these pathogens to another site on the same patient, or into the healthcare environment.

The 5MHH are also known as indications for hand hygiene, an indication is the evidenced-based reason as to why hand hygiene is required when that moment occurs in practice. There are times during the provision of care when two indications may occur in sequence, this creates two moments for hand hygiene which coincide. When this occurs, one hand hygiene action will fulfil both indications meaning there is just one opportunity for hand hygiene. For example, after touching one patient and moving directly into another patient zone and touching that patient results in moments 4 and 1 coinciding (Figure 1.2, overleaf). In this case one hand hygiene action, after moment 4 and before moment 1, would adhere to both indicated moments. Thus, from two indications for hand hygiene there is one hand hygiene opportunity for the HCW to comply with. The distinction between indications and opportunities for hand hygiene is particularly important when auditing adherence to the 5MHH in practice.

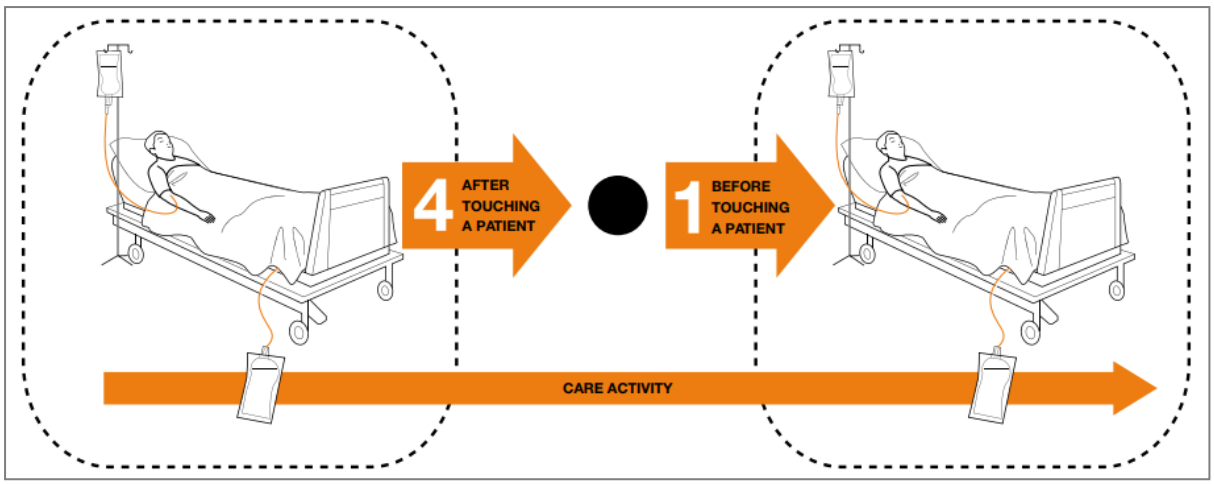

Figure 1.2 Coincidence of two hand hygiene indications, with the black dot representing one hand hygiene opportunity (World Health Organization, 2009b).

The illustrations in Figure 1.1 and Figure 1.2 include a dashed line which provides a visual separation of the patient zone and the healthcare zone. This is designed to help delineate the patient bed space, which we assume to be contaminated with the patient's own flora, and the healthcare environment which is likely to be contaminated from multiple sources. It is important to understand that the patient zone and healthcare zone is contaminated. Creamer et al. (2010) recovered MRSA more often on the fingertips of HCWs following their contact with the patient environment compared to clinical contact with the patient. Other studies have shown the role a contaminated environment can play in the spread of C. difficile, with HCWs presenting with increasing hand contamination correlated with greater environmental contamination (Weber et al., 2013).

Sax et al. (2007) provides a description of these two crucial zones (Table 1.2, overleaf). Items categorised as belonging in the patient zone are those which are dedicated to the patient until they are discharged, for example the overbed table and bed linen. The patient zone is cleaned in between patient admissions, with specialist cleaning required if a patient was known to have had an infection. This designation aims to help prevent the spread of pathogens both into the patient zone from the healthcare zone, and vice versa.

Table 1.2 Description of the patient zone and healthcare zone (adapted from Sax et al., 2007).

Area	Description
Patient zone *Contains the patient and their immediate surroundings*	• Typically includes the intact skin of the patient and all inanimate surfaces that are touched by or are in direct physical contact with the patient such as the bed rails, bedside table, bed linen, infusion tubing, and other medical equipment. • It further contains surfaces frequently touched by HCWs while caring for the patient such as monitors, knobs, and buttons, and other 'high frequency' touch surfaces within the patient zone.
Healthcare zone *Contains all surfaces outside the patient and patient zone*	• All other patients and their patient zones, and the healthcare facility environment.

The generation of hand hygiene opportunities (HHOs) most likely occurs in the patient zone where care tends to be delivered; this is considered the point-of-care. The point-of-care has been defined as where the HCW, patient, and care activity involving patient or patient zone contact occur (Kendall et al., 2012). For hand hygiene at the point-of-care to be achieved the necessary equipment is needed in a convenient location. Alcohol-based hand rub makes this easier to achieve, as most hospitals provide point-of-care ABHR dispensers in addition to wall mounted dispensers, these are normally bed-end dispensers which hook over the bed rail (Figure 1.3).

Figure 1.3 Point-of-care (left) and wall mounted (right) ABHR dispensers.

Bed-end dispensers enable access to ABHR in multi-bed bays where wall mounted dispensers may not be conveniently located for each patient bed space. A systematic review

of interventions to improve hand hygiene found moderate evidence from one study that point-of-care dispensers slightly improve hand hygiene compliance (Gould et al., 2017). This demonstrates that the provision of equipment is not always sufficient to foster consistent practice.

1.2.4 Measuring hand hygiene compliance

Systems of audit and feedback are used across the healthcare sector to ensure best practice by measurement against a defined standard. Regular auditing of hand hygiene is part of The National Institute for Health and Care Excellence (NICE) quality standard for IPC, along with the availability of facilities to perform hand hygiene, and training in hand decontamination (NICE, 2014). The development of the 5MHH provides a definable standard against which hand hygiene practice can be measured, meaning that healthcare settings can work to the same set of standards, reducing variation in practice (Sax et al., 2007). There are multiple purposes for performing hand hygiene audits including the assessment of compliance rates, provision of feedback to HCWs regarding their hand hygiene practice and technique, provision of data for improvement interventions, and investigations into outbreaks of infection (World Health Organization, 2009).

A standardised observation form for use in healthcare settings accompanies the 5MHH (Appendix 1). Hand hygiene compliance rates are usually reported as a percentage. This is calculated by dividing the numerator, which is the sum of all observed hand hygiene events (times when HCWs cleaned their hands when indicated by the 5MHH), by the denominator which is the number of opportunities for hand hygiene (as indicated by the 5MHH), this is multiplied by 100 to provide a percentage rate (Figure 1.4).

$$\text{Compliance (\%)} = \frac{\text{Number of hand hygiene events}}{\text{Number of hand hygiene opportunities}} \times 100$$

Figure 1.4 Hand hygiene compliance rate calculation.

Frequently, a target compliance rate is used for which to measure audit results against. This is often set locally within individual healthcare organisations and is commonly 90% or above (Mahida, 2016). There is debate surrounding whether this target is realistic or achievable in practice (Bradley, Holden and Garvey, 2017). A specific compliance rate is not recommended by WHO due to the importance of local contexts across the globe which impact the availability of resources for consistent hand hygiene practice. They do however discuss more generally that any audited practice where compliance with the defined

standard is >90% suggests that practice is established and reliably performed, whereas practice which occurs on <90% of occasions may be inconsistent (World Health Organization, 2009). This implies that targets of >90% would be preferable in ensuring hand hygiene is embedded into practice.

Data on hand hygiene compliance is normally collected via audits involving direct observation of patient care provision. This can be ward-led where the audit is completed by an internal team member from the clinical area, this may be an IPC link practitioner who has attended IPC training, or someone untrained in IPC. Audits may also be independently led by someone external to the clinical area, this could be a member of the organisation's IPC team or a peer monitor, for example, a staff member from another ward. Hand hygiene audits tend to be a regular reporting requirement, often performed for monthly submission.

Auditing via direct observation involves an auditor being present in a clinical area and observing HCWs delivery of patient care as it happens in real-time. The auditor identifies an opportunity for hand hygiene in the care episode, according to the 5MHH, and categorises the moment as complied with (hand hygiene took place) or missed (hand hygiene did not take place). Further detail such as job role of the individual being observed, use of correct hand hygiene technique, type of moment observed, and whether gloves were worn are also usually noted. This provides the clinical area with further detail surrounding their compliance and can highlight specific issues, for example if glove use appears to impact hand hygiene.

Different organisations have differing requirements as to how many HHOs they observe before calculating an overall compliance rate. Alongside a compliance rate the information collected via audit is used to provide feedback to HCWs regarding quality of hand hygiene practice and technique and highlight areas for improvement. Regular provision of a compliance rate can help to identify over time whether organisations, individual wards or clinical specialisations, or certain roles of HCWs (e.g., doctors, nurses, nursing assistants) have persistent low, high, or variable compliance with hand hygiene. This may indicate that further exploration or interventions are needed into specific workplace culture, or systems of care provision which in turn may be impacting hand hygiene performance.

Although audit via direct observation allows for measurement of the appropriate timing of hand hygiene and assessment of technique, it has disadvantages. The main criticism of direct observation being that the overt presence of an auditor risks HCWs becoming aware of being the subject of observation, this can lead to modification or improvement in their behaviour; known as the Hawthorne effect (Srigley et al., 2014). The Hawthorne effect has

been demonstrated within audits using direct observation, with literature finding covert observations by unknown auditors capturing lower hand hygiene compliance rates than overt observations by familiar auditors (El-Saed et al., 2018). Therefore, data captured via direct observational audit by known auditors is likely to overestimate compliance as HCWs alter their behaviour by increasing their adherence to the 5MHH when they realise their practice is under observation.

As direct observational audits are unlikely to be performed for long periods of time, the compliance rates they generate are based on a small proportion of total hand hygiene activity. In addition, audits are time consuming both in terms of training staff to perform them, and the time required to complete regular audits across large settings (Gould, Drey and Creedon, 2011). There may also be inconsistency in the level of training undertaken by auditors and variation in how audits are performed (Jeanes et al., 2015). Research has also reported a sampling bias in direct audits, with those audited more likely to be staff working on a weekday, during the day shift (Haas and Larson, 2007) and on critical care units (Jeanes et al., 2019). Again, this results in a small and specific proportion of total hand hygiene activity being captured during these audits.

1.2.5 Electronic monitoring systems for hand hygiene audits

In order to address the issues surrounding direct observational audit, other ways of measuring hand hygiene compliance have been developed such as EMSs. This includes technology such as remote video monitoring, electronic dispenser counters, and monitoring networks involving sensors in the environment and/or attached to HCWs (Ward et al., 2014) (Table 1.3, overleaf). The main function of these EMSs is to collect and generate compliance data by electronic means which can be fed back by way of individualised or anonymised performance reports, daily compliance rates, and organisational, ward level, and individual compliance reports.

Table 1.3 Description of available types of EMSs.

Types of EMSs	Description
Remote video monitoring	• Videos capture care delivery and can be remotely viewed to audit compliance with the 5MHH. • Can be replayed to provide accurate data, though this increases the time between occurrence of practice and audit completion. • Potential issues around patient privacy.
Electronic dispenser counters	• Counters are located within ABHR and soap dispensers which captures when the dispenser is used, this provides a numerator of hand hygiene events. Data is collected via a centralised computer system. • Compliance cannot be categorised by the individual moments of the 5MHH. Adherence is focused on overall team compliance, not individual HCW performance.
Monitoring networks	• Networks have different levels of sophistication. Generally, HCWs wear sensors which detect their proximity to an ABHR or soap dispenser and assume usage based on a set period of time or sensor activation. • Some networks detect HCW location and movement within the patient zone and from this assume occurrence of specific moments of the 5MHH. • May incorporate hand hygiene reminder technology for the wearer (e.g., sound or light feedback). • Some networks only account for hand hygiene compliance upon entry/exit to individual patient rooms. • Can generate individual compliance rates for HCWs as well at ward level compliance.

With most EMSs a compliance rate is generated by tracking usage of ABHR and soap dispensers via counters, sensors, or proximity to a dispenser suggesting usage. This dispenser activity constitutes a numerator and is divided by a denominator of expected opportunities for hand hygiene; these numbers can then be used to calculate a percentage compliance rate. Some monitoring networks develop their denominator based on the movements of HCWs around the ward, including their proximity to the patient and the patient zone. From the time spent within the zones it deduces that a HHO is likely, or unlikely, to have occurred and this becomes the denominator (Gould et al., 2020). Others use a denominator based on research which explores expected practice for that setting, this normally accounts for the type of ward specialty, number of staff on shift, and number of patients admitted on the ward.

The Hawthorne effect

Another benefit of continuous monitoring is that the data captured is less susceptible to the Hawthorne effect when compared to direct observational audit where an auditor is visible. Studies which have involved the installation of EMSs have been able to demonstrate the impact direct observation has on staff hand hygiene behaviour by comparing direct observation compliance rates to compliance rates generated by EMSs. McLaws and Kwok (2018) compared the compliance rates generated by an EMS to those collected through daily direct observation audits of 20 minutes which took place over 18 months on two hospital wards. On a medical ward they found hand hygiene activity during times of direct observational audit was three times higher than the EMS rate, and on a surgical ward 1.6 times higher than the EMS rate.

Similarly, Gould et al. (2020) compared compliance rates on a medical ward as captured via an EMS to 21 hours of direct observation by an auditor unknown to the HCWs on the ward. For the three hours before the unknown auditor began their audit the EMS generated compliance was 10.3%. The compliance rate calculated via direct observation began at 24% during the first session and increased threefold across successive sessions to 76% in the fifth session. This suggests that the HCWs became familiar with the auditor and aware that they were being audited on their hand hygiene practice, they therefore increased their hand hygiene behaviour when the auditor was present.

Capturing hand hygiene practice accurately

Technologies such as electronic dispenser counters and monitoring networks can capture hand hygiene activity 24-hours a day, seven days a week. Direct observational audits focus on hand hygiene during care provision over short periods of time where staff are actively providing care, this is likely to overestimate hand hygiene activity. Care activity during a typical shift will fluctuate as other tasks which do not involve direct patient care are completed, such as writing in patient notes and organisation of stock. As EMSs operate constantly in the background it can capture this fluctuation in activity to give a more realistic overview of hand hygiene activity and compliance.

Constant monitoring of practice also provides an advantage in that the systems reflect changes or trends in hand hygiene over time. This is key when changes to practice are introduced such as those arising from periods of improvement activity (Morgan et al., 2012). Tracking the overall impact of interventions on compliance before, during, and after implementation provides data demonstrating whether there are changes in practice over the short and long-term. Systems vary in specificity of feedback, with some operating at a ward-

level focusing on the whole team and others able to identify individual performance. Most systems can focus on performance according to shift type, or particular times of the day which could help to direct the focus of any further need for improvement to practice at specific times. A more detailed discussion of EMSs is presented in more detail in Chapter 2.

1.3 Chapter summary

This chapter presented the contextual background to this research. The prevention of HCAI is required by government regulations and is an important part of delivering safe and effective care for patients. Avoidance of HCAI can help to not only prevent additional treatment and avoid serious illness for patients, but also reduce associated healthcare spending. There are multiple ways in which infections can be transmitted in the healthcare environment, with one of the main routes being on the hands of HCWs during the provision of patient care. The COVID-19 pandemic heightened focus on IPC practices and messaging that appropriate hand hygiene is a crucial practice in preventing the spread of infection to both patients and HCWs themselves.

The 5MHH provide evidence-based guidelines to promote and support, as well as standardise, expected practice across different healthcare settings and countries. Hand hygiene practice is traditionally audited via direct observation, though in more recent years the development of EMSs for hand hygiene aims to avoid some of the pitfalls of direct observation. There are different types of EMSs and different ways in which data can be utilised and fed back to HCWs, often with the aim of encouraging and optimising practice. A crucial aspect of EMSs is the denominator within systems which is used to calculate the compliance rate to ensure data presented to frontline staff are accurate.

The next chapter focuses more specifically on literature around EMSs, use of these systems in practice, and research informing their configuration in terms of denominators based on real-world practice. It also explores the application of the 5MHH by HCWs including psychological factors which can influence performance, along with the potential impact of PPE, commonly used equipment, and the ward environment on hand hygiene practice.

Chapter 2 Literature review

2.1 Chapter overview

This chapter aims to focus on literature which is pertinent to the specific area of research. This includes exploration of EMSs which use counters to generate compliance rates for hand hygiene, and what needs to be considered when implementing an EMS. In particular, the potential acceptability of these types of systems by frontline staff and their potential to influence behaviour change. The 5MHH themselves are explored with relation to their practicality, and their understanding and application by HCWs in everyday practice. Potential individual influences on the performance of hand hygiene behaviour are also discussed.

2.2 Literature review

2.2.1 Methods

To explore key areas of literature related to the research question and topic area, a series of systematic searches were conducted. The aim was to present a comprehensive overview of evidence across a broad range of discreet topics relevant to the research question. Search topics included: denominators for a counter-based EMS; HCWs experiences of EMSs; the potential impact on hand hygiene of the clinical environment and items within it; and psychological factors which play a role in hand hygiene practice. This chapter provides a narrative summary of this evidence and identifies gaps in the research.

Inclusion and exclusion criteria

Studies were included if they addressed one or more of the defined topic areas and were primary research or systematic evidence reviews published in academic journals with an abstract available. Studies were excluded if they were not published in the English language or were published outside of pre-determined search limits specified for each search (Appendix 2).

Search strategy

Searches were developed using a combination of key terms from previously published literature and knowledge of the research area. Due to the complex nature of the multiple searches the search results are presented in table form (Appendix 2). Databases searched were MEDLINE, Academic Search Complete, CINAHL complete, and PsycInfo. In addition, a snowballing method was used for literature found in the systematic search. This included searching references within the included studies to seek other relevant papers and reviewing papers which had cited included studies.

2.2.2 Results

Searches identified a total of 236 studies, following abstract sifting a total of 50 studies were identified for inclusion. A further 47 studies were identified via reference and citation searching.

Configuration of electronic monitoring systems

Electronic dispensers with counters are a simple way of measuring hand hygiene compliance. These take the form of ordinary ABHR and soap dispensers, with the addition of counters which record a hand hygiene event each time it is used. This means no change to working practices are required when a system is installed, potentially avoiding the challenges associated with staff adoption of systems which impact their existing workflows (Conway, 2016). Counter systems also avoid the need for additional wearable technology such as sensors integrated into badges or bracelets which can be seen as inconvenient by HCWs and a barrier to acceptance of EMSs (Levin et al., 2019). Configuration of counter systems can be complex as in order for systems to provide reliable compliance data the denominator of expected HHOs needs to be accurate (Ward et al., 2014).

Comparison of expected HHOs can be challenging as the number depends on the method used for measuring opportunities. This could be as simple as counting a HHO on entry and exit of the patient zone (World Health Organization, 2009). Though this method omits the crucial moments from the 5MHH which occur at the patient's bedside. Research in the USA has explored development of a denominator for EMSs which incorporates the occurrence of the 5MHH in practice (Steed et al., 2011). This was done using the WHO method for observational audit of the 5MHH within two hospitals, one large and one community, covering 24-hours of the day and 7 days of the week across three clinical areas. Adjustments were made to account for number of staff on shift, patient to nurse ratio, as well as corrections for overestimation of hand hygiene moments due to the Hawthorne effect and sampling bias. The authors found that the expected numbers of HHOs differed depending on hospital type, clinical area, and whether it was day shift or night shift.

The data proposed by Steed et al. (2011) was verified by further studies comparing the denominator of expected HHOs to actual observed HHOs by installing and analysing 24-hour video surveillance of patients on a medical ward in the USA (Diller et al., 2014). The authors found, when compared to the large hospital, a similar proportional occurrence of each of the 5MHH and no significant difference in the average number of HHOs per patient per day, this being 71.6 (Steed et al., 2011) and 73.9 (Diller et al., 2014). These studies indicate that a formula which accounts for fluctuations in staff and patient numbers as well as sampling bias and the Hawthorne effect may provide accurate estimates of denominator

data for EMSs. In these studies, HHOs are presented as a number per patient per day as this provides a benchmark which can be increased or decreased depending on the number of patients present on a hospital ward.

A further study in Australia explored differences between HHOs for nurses and physicians on surgical and medical wards by observing practice 24-hours a day for a week (Azim, Juergens and McLaws, 2016). It was found that nurses had a greater burden of HHOs, experiencing around two-thirds (63-68%) of all HHOs across the week. At a daily individual level nurses experienced 43 HHOs per nurse (medical ward) and 66 HHOs per nurse (surgical ward), compared to physicians who had 15 HHOs per physician (medical ward) and 16 HHOs per physician (surgical ward). The average number of HHOs per ward across the day on the medical ward was 1594 (day shift average: 910, night shift average: 561), and the average on the surgical ward was 1471 (day shift average: 863, night shift average: 415). In an additional study the authors explored their data using the Steed et al. (2011) adjustment based on staffing ratios and found a similar number of HHOs across a 24-hour period, this resulted in 76 per patient per day which was similar to the 72 per patient per day reported by Steed et al. (2011). Data from these studies are presented in Table 2.1.

Table 2.1 Number of HHOs in the literature informing development of denominator for EMSs.

	Steed et al. (2011) Large hospital	**Steed et al. (2011) Community hospital**	**Diller et al. (2014)**	**Azim, Juergens, and McLaws (2016)**
Medical ward				
Dayshift (7am-7pm)	33.3 per patient-day	16.6 per patient-day	46.7 per patient-day	38 per patient-day
Nightshift (7pm – 7am)	40.7 per patient-day	12.7 per patient-day	28.0 per patient-day	24 per patient-day
24-hour period	71.6 per patient-day	30.3 per patient-day	73.9 per patient-day	67 per patient-day
Average total 24-hour period	-	-	-	1594
Surgical ward (ICUs)				
Dayshift (7am-7pm)	87.1 per patient-day	39.1 per patient-day	-	43 per patient-day
Nightshift (7pm – 7am)	93.5 per patient-day	29.2 per patient-day	-	21 per patient-day
24-hour period	178.8 per patient-day	70.9 per patient-day	-	73 per patient-day
Average total 24-hour period	-	-	-	1471

The surgical wards included in the studies were ICUs. There are differences in care that is provided on an ICU when compared to a standard medical or surgical ward. The ratio of HCWs to patients is usually higher, normally with a ratio of 1:1. Movement patterns of HCWs have been found to differ between ICUs and medical wards, with more frequent direct movement between different patients and patient bed spaces on medical wards (FitzGerald, Moore and Wilson, 2013). As the number of opportunities has been found to differ between staff type and ward type this suggests that staffing levels, skill-mix, and the type of ward need to be accounted for when configuring electronic monitoring equipment. Therefore, defining the frequency of HHOs across different healthcare settings is important in the development of effective EMSs.

A study exploring average numbers of HHOs on a typical ward has not been performed in the UK. There are some key differences between the care provision in the USA and Australia when compared to that in the UK as the UK operates a publicly funded national health service, free at the point of use. The most common type of ward layout in UK hospitals are multi-bedded bays with four to six patients per bay, rather than single rooms for individual patients which are more commonly found in the USA. Literature reports that in 2002 to 2003 around 23% of UK hospital beds were single rooms, rising to 33% in 2009 to 2010 (Maben et al., 2015). This slow rise may further increase in the coming years as Department of Health policy states that newly built hospitals should comprise a minimum of 50% single rooms (Department of Health, 2013). Existing hospitals will remain constrained by their current buildings in terms of space and layout as to the potential for the addition of single rooms.

Single rooms for individual patients create a distinct moment of entrance and exit to the patient zone whereas an open bay allows for the free movement of HCWs between the healthcare zone and the patient zone, and directly between different patient zones. This has the potential to impact the number of HHOs generated, and compliance with those moments, as it is easier to move between patient zones without going through a defined entry or exit point. Passing through clear entry and exit points provides an environmental boundary to prompt performance of hand hygiene (Hor et al., 2016).

Electronic monitoring systems in practice

The purpose of EMSs is to provide accurate compliance data for hand hygiene practice, this data can be utilised to improve compliance with the ultimate aim of decreasing occurrence of HCAI. In a survey of 29 available EMSs Cawthorne and Cooke (2021) found nine had supporting published evidence demonstrating their usage resulted in a reduction in HCAI,

though only one of these was of high-quality. Interestingly, the high-quality study implemented a counter-based EMS as part of a wider program focused on improvement which included huddles, improvement methodology webinar training, weekly email compliance reports, and reminders in the environment (Leis et al, 2020). This demonstrates that data from EMSs are likely suited to be part of a wider multi-modal approach to change.

Application of an electronic system in one hospital based in the USA found an increase in hand hygiene compliance and a significant reduction of MRSA (Kelly et al., 2016). The EMS used generated real-time data, which was unit specific. Unit leaders shared this with their teams which provided ongoing compliance feedback and the unit leaders engaged staff to generate ideas for improving hand hygiene practices. The authors report that 91% (21/23) of the units which took part saw an increase in hand hygiene compliance. This increase was associated with a significant decrease in occurrence of MRSA cases. This study again demonstrates that an electronic system on its own is unlikely to impact practice, it requires utilisation of the data it captures in order to engage frontline staff and enact change.

The integration of EMSs into clinical teams was further explored by Kwok et al. (2017) who installed an EMS on two wards. Both wards were asked to review compliance rates from the EMS daily, set performance goals, and 'nudge' each other to perform hand hygiene. They found that compliance was higher on the ward where there was a sense of social cohesion in the ward team. The staff on the socially cohesive team reported feeling comfortable providing, and receiving, verbal reminders to perform hand hygiene by others on the team. The staff also had a nurse manager who acted as a role model, and staff who engaged socially and comfortably with one another. This demonstrates that alongside the provision of compliance data is the key element of ward culture and team cohesion in accepting feedback and working towards common goals.

Acceptance of electronic monitoring systems

Staff experience and perceptions of working with EMSs in practice is an important aspect of the design and introduction of new technologies. Some studies have explored staff perceptions of the use of EMSs, including its potential impact on their hand hygiene practice as well as its acceptability. In a rapid review Meng et al. (2019) found themes in the literature surrounding staff acceptance of EMSs, these related to: the importance of systems being transparent and confidential; the user's own attitude towards the concept of monitoring itself; and the perceived accuracy and usability of the system.

Although EMSs may be utilised to help improve hand hygiene compliance, systems are unable to capture detailed data regarding quality of hand hygiene technique, and the specific occurrence and adherence to each of the 5MHH. This potential lack of nuance and recognition of the context in which care occurs is a concern which has been raised by staff. Research involving HCWs has found concerns surrounding its inability to account for times when entering and exiting a patient zone without generating an indication for hand hygiene and capturing the complexity of hand hygiene in the ward environment (Boscart et al., 2008; Ellingson et al., 2011; Tarantini et al., 2019).

Other issues surrounding acceptability include studies with HCWs stating that the use of EMSs can lead to feelings of unease due to a sense of being 'watched', along with concerns about data security and the potential for data to be used for punitive measures against individual staff members (Ellingson et al., 2011; Dyson and Madeo, 2017; Benudis et al., 2019; Tarantini et al., 2019). These concerns can contribute to a mistrust of the data generated by EMSs. Achieving staff confidence in the data provided by EMSs is crucial. Ellingson et al. (2011) found staff placed importance on hospital leaders possessing an understanding of how EMSs generate compliance data by familiarisation with research studies demonstrating their accuracy. This was key to them feeling comfortable with the potential adoption of EMSs.

Systems may be better accepted if they can demonstrate they have undergone evaluation in real-world settings (McGuckin and Govednik, 2015). Ensuring accuracy could require a period of trial and calibration based on observed practice in the local setting (Gould et al., 2020). Both of these approaches would be beneficial in demonstrating to frontline staff the accuracy of the system to be implemented and its relevance to their specific practice. Levin et al. (2019) present the idea that EMSs could still be used to focus staff on improvements to hand hygiene compliance, even if they are slightly inaccurate. However, the authors acknowledge that this would likely be unacceptable to staff who expect accurate data on their performance and provision of inaccurate data could lead to frustration with the system.

Hand hygiene in practice

Despite the potentially severe consequences of HCAI for patients, and potential risk of infection to HCWs themselves, compliance with the 5MHH is often low in practice (Allegranzi and Pittet, 2009). As discussed in Chapter 1, the target for hand hygiene compliance in hospital settings tends to be set at >90%. The WHO report studies which have found variable compliance levels to hand hygiene, with average adherence being 38.7% (World Health Organization, 2009). In a systematic review of 96 studies Erasmus et al. (2010) found

a median compliance rate of 40%, with compliance rates varying according to staff role and ward setting. Nurses tend to have higher levels of compliance when compared to nursing assistants and doctors (Pittet, 2000). It is not necessarily the burden of a high number of indications for hand hygiene which makes it more difficult to achieve compliance with Azim, Juergens and McLaws (2016) finding that although nurses had a greater number of HHOs than physicians, their compliance with these moments was also higher.

Psychological factors in hand hygiene behaviour

What could be seen as a simple behaviour, the cleansing of hands, is evidently complex and there are many psychological factors which can influence the performance of hand hygiene behaviour. Exploration into barriers which influence adherence to hand hygiene have revealed a variety of factors which impact behaviour including individual beliefs, environmental, and organisational influences. Literature reports a wide range of barriers such as workload and time pressures, glove use, organisational culture, dermatological issues from use of ABHR, poor access to hand hygiene resources, lack of knowledge, and forgetfulness (World Health Organization, 2009; Alsubaie et al., 2013; Smiddy, O'Connell and Creedon, 2015; Jimmieson et al., 2016; Scheithauer et al., 2017). Research has also reported facilitators to hand hygiene such as HCWs perceiving it as effective, peer support, ease of performance, climate of safety integrated into hospital culture and self-protection (Sax et al., 2007; Hanna, Davies and Dempster, 2009; Handiyani et al., 2019; Ibrahim et al, 2018; Sands and Aunger, 2020).

The drive to cleanse our hands is something which is established during childhood. Whitby, McLaws and Ross (2006) discuss two drives which influence the performance of hand hygiene, inherent and elective. An inherent drive to cleanse hands when they are felt to be dirty, either visibly soiled or sticky, is learnt when we are young. For HCWs this can be seen to extend to tasks which are felt to be ‘dirty’ such as delivering patient care which involves touching an area such as the groin or armpits, or a caring for a patient perceived as dirty due to age or appearance.

Borg et al. (2009) found self-reported compliance to hand hygiene to be higher following direct patient contact, or when hands were visibly dirty. The sense that a patient was unclean due to having open wounds or body odour has also been found to be a prompt for hand cleansing, with this feeling extending to patient unfriendliness or erratic behaviour (Lohiniva et al, 2015). The inherent need to clean one’s hands drives the majority of hand hygiene behaviour and stems from the emotion of disgust and feelings of self-protection (Curtis and Biran, 2001; World Health Organization, 2009).

Moments where hand cleansing is necessary but not driven by inherent motivation requires elective behaviour. This involves an active decision to cleanse hands following more common care activities such as touching items in a patient environment or social interactions such as handshakes. These activities would be less likely to be categorised as dirty, however though not visibly dirty these tasks still result in the contamination of hands. When interviewing nurses, Whitby, McLaws and Ross (2006) found that the drive for the performance of elective hand hygiene was influenced by their categorisations of individual tasks and patients as having perceived levels of 'cleanliness' or 'dirtiness'. Therefore, how an individual HCW views the potential risk of each patient interaction is likely to influence their performance of hand hygiene. One study which used an EMS to track dispenser usage found higher usage near the toilets and sluice, suggesting hand cleansing linked to overtly dirty tasks (Iversen et al., 2020).

The presence of infectious outbreaks on hospital wards can also be a driver for hand hygiene. Outbreaks are defined as the occurrence of two or more persons linked via time, place, or association, who have the same infection. An outbreak typically triggers practical measures such as increased infection control precautions, isolating or cohorting of infected patients to specific areas or side rooms, nurse cohorting, and use of dedicated equipment for infected patients. Alongside this, the presence of infection may cause HCWs to experience greater motivation to perform hand hygiene to ensure the infection ceases to spread. In an exploration of hospital outbreaks Kovacs-Litman et al. (2020) found that wards with outbreaks which included both infected patients and staff had higher hand hygiene compliance than those with only infected patients. This demonstrates the role of self-protection in motivating hand hygiene as staff try to avoid becoming infected themselves.

In a review of qualitative literature Smiddy, O'Connell and Creedon (2015) found staff were motivated to perform hand hygiene by self-protection, and that assessment of the potential risk of patient care tasks varied between individuals. A similar finding was presented by White et al. (2015) who explored nurse's perceptions of the 5MHH and found an array of differing beliefs about the relative importance of consistently performing hand hygiene at each of the five moments.

The influence of self-protection is also seen in the literature surrounding motivations for glove use when providing patient care (Jang et al., 2010; Loveday et al., 2014b; Jain, Clezy and McLaws, 2019). These studies show how individual beliefs and emotional judgements are integrated, either consciously or unconsciously, into decision making when it comes to

the performance of hand hygiene. These individual perceptions, based on emotion rather than evidence-based guidelines, make consistent performance of hand hygiene difficult to achieve.

Contextualisation of hand hygiene and the ward environment

Performance of hand hygiene is also influenced by environmental factors and established ways of working. The WHO report that staff may experience a lack of recognition of HHOs during patient care (World Health Organization, 2009). When considering the illustration of the 5MHH, the simplified image of the patient fails to contextualise the active ward environment in which patient care is delivered (Figure 1.1, page 23). The incorporation of the 5MHH into this environment is more complex than the illustration conveys when accounting for items and equipment and fluctuations in the pace of ward activity. When observing the reality of care provision on hospital wards Gould (2004) reported that rather than care being a series of discreet individual events with a clear beginning and end, it was a chain of fragmented activities. This can make it more difficult to assign the moments of hand hygiene in real-time, especially when unexpected activities arise.

Clack et al. (2014) explored the idea of infectious risk moments, points in the workflow when there is a risk of patient infection or colonization, including those indicated by the 5MHH. The risk of transmission of pathogens increases with successive indications which are not acted upon as the contaminated hands of HCWs continue to move around the environment touching patients and surfaces. The 5MHH act as interruptions in the workflow where performing hand hygiene reduces the potential spread of pathogens. Key to effective hand hygiene is adherence to each of the 5MHH in the sequence in which they occur, with partial compliance unlikely to protect patients (Haas and Larson, 2007).

Studies have explored how HCWs interact with patients and the environment when providing care. In an analysis of care provision on an ICU with nurses and doctors, Clack et al. (2017) tracked hand to surface movements using head-mounted cameras to establish potential routes of transmission. Surfaces included those inside and outside of the patient zone, and the patient themselves. The analysis of nearly five hours of footage revealed HCWs touched a surface every 4.2 seconds. They found in 7% (291/4222) of the events hands moved from outside to inside the patient zone, and in 5% (217/4222) hands moved from a surface to a critical patient site. Hand hygiene compliance at these key moments during care was low, at 3.4% (17/508). This novel method of exploring how HCWs move and interact with their patients and the healthcare environment enabled data to be collected which reflected the reality of care provision in a clinical setting.

The use of gloves in patient care

The use of PPE, in particular gloves, can impact compliance with hand hygiene. Gloves are indicated for use for certain care activities where there is likely to be contamination with BBF. Though research has found that gloves are often donned by HCWs even during low-risk patient care tasks where they are not indicated for use (Loveday et al., 2014b; Wilson et al., 2015). Gloves can be perceived as a 'second skin' by HCWs to prevent direct exposure to BBF, though crucially they are not a substitute for hand hygiene (Sax et al., 2007). This perception of gloves as a 'second skin' for HCWs is likely related to perceptions of 'dirty' tasks, and innate feelings of disgust, with gloves defusing these strong emotions (Wilson, Bak and Loveday, 2017). Gloves can, however, carry pathogens in the same way as hands. When an indication for hand hygiene occurs gloves should be removed, hand hygiene performed, and a new pair donned if required.

As gloves themselves are not impervious to developing miniscule holes this means that appropriate hand hygiene during and after care episodes is key. Glove dispensers themselves have been found to be contaminated (Moran and Heuertz, 2017). As the hands of HCWs can become contaminated during the donning and doffing of gloves this means hand hygiene is key before putting gloves on, and after taking them off. The timing of glove donning is crucial as gloves are often put on too early before a patient care task which risks cross-contamination between the touching of objects in the healthcare zone with gloved hands and the subsequent touching of the patient (Loveday et al., 2014b). Evidence also suggests that gloves are often kept on during entire patient care episodes which increases the risk of the potential for the transmission of microorganisms to the patient and between sites on one patient as appropriate hand hygiene is not performed (Loveday et al., 2014b).

The potential role of equipment in cross-transmission

Healthcare workers touch a variety of surfaces and equipment during care provision. These include equipment trolleys, computers, doors, bed frames, patient notes, notes trolleys, IV drips, blood pressure monitors, and telephones (Smith et al., 2012; FitzGerald, Moore and Wilson, 2013). Smith et al. (2012) note that although environmental cleaning is important, particularly targeting high-touch surfaces, it cannot remove risk. As soon as something is cleaned it can become contaminated again the next time it is touched, thus the emphasis on hand hygiene remains key as it should be performed directly before a care task begins or ends.

During the provision of direct care HCWs use different kinds of medical equipment, some of which is patient-shared equipment. Common patient-shared equipment on inpatient wards are thermometers, stethoscopes, blood pressure cuffs, and pulse oximeters. These can come into direct contact with patient, for instance a blood pressure cuff being put around a patient's arm, or indirect contact where the HCW touches the item and then touches the patient (Suwantarat et al., 2017). If not decontaminated after use these items risk becoming a source of transmission of infection.

Research which tested cleanliness of surfaces on blood pressure units which included pulse oximeter, blood pressure cuff, and monitor buttons found cleaning was insufficient (Havill et al., 2011). This is despite estimates of cleaning times for these kinds of items being fairly short, with a blood pressure cuff taking 29 seconds on average (Scott, Kane and Rankin, 2017). Insufficient cleaning of stethoscopes has also been found to be common (Boulée et al., 2019), resulting in contamination with greater levels of contamination where HCWs did not perform hand hygiene following patient examination (Uneke et al., 2010).

Some of the items commonly used during patient care are portable medical equipment such as IV drips and computer on wheels (COW) or workstation on wheels (WOW). The COW and WOW usually consists of a laptop computer on a small table on wheels at chest-height which can be pushed easily around the ward. They are often taken to the patient bedside during doctor's rounds, observation rounds, and medication rounds as these are times when HCWs may need to double check patient information or enter documentation about the care provided onto computerised patient records.

An analysis involving observations on six hospital units found that COW and IV drips were frequently touched when providing patient care (Jinadatha et al., 2017). The authors found that HCWs moved their hands back and forth between the COW and the patient without performing hand hygiene, providing the potential for cross-contamination. As COW are moved around the environment and tend to be used during successive care activities, they become a potential source of transmission of pathogens if not cleaned appropriately. Research exploring frequency of cleaning commonly used items on wards found that COW keyboards are not always cleaned daily meaning contamination is likely (Po et al., 2009).

Patient privacy curtains

Another potential source of infection from the ward environment to the patient are patient privacy curtains which are closed during care to preserve patient dignity (Brown et al., 2020).

This becomes important when considering the multi-bedded patient bays found in UK hospitals in which patient zones are defined by these curtains. Patient privacy curtains are not routinely cleaned and tend to be replaced or cleaned only when visibly soiled or upon discharge of an infectious patient from the bed space.

Patient privacy curtains are categorised by the WHO as part of the healthcare zone (World Health Organization, 2010). The implication of this being that HCWs should not touch the curtains upon entering or leaving the patient zone if patient contact occurs without decontaminating their hands after entering or before leaving. Despite this categorisation IPC experts themselves have mixed views on whether they would categorise curtains as belonging to the healthcare zone or patient zone (Bogdanovic et al., 2019). Although they are potentially overlooked by HCWs as a contaminated item, studies have found contaminated curtains can play a role in outbreaks of infection in hospital settings (Das et al., 2002; Mahida et al., 2014).

Studies have found ward curtains to be contaminated with MRSA (Klakus, Vaughan and Boswell, 2007; Vickery et al., 2012). For curtains which are contaminated, pathogens are able to transfer to gloved hands after handling (Trillis et al., 2008). Larocque et al. (2016) found touching of the curtains upon entering and leaving an empty patient bedspace transferred new bacteria to the hands of HCWs. As studies indicate that curtains tend to be touched by HCWs both before and after patient examination, this highlights the importance of hand hygiene at the point-of-care (Ohl et al., 2012). Gloves are often stored outside of the patient zone; this is an additional consideration in that gloves should be donned within the patient zone after decontamination of the hands.

Understanding the patient zone and healthcare zone

The concept of zoning in clinical settings distinguishes pathogens from inside the patient zone, originating from the patient themselves, and those from the healthcare environment outside of the patient zone. Though this distinction is more complex in overcrowded settings where patients are in close proximity, potentially sharing a bedspace (Salmon et al, 2015; Salmon and McLaws, 2015). The patient zone must be considered contaminated, with research finding the hands of patients and their rooms to be harbouring pathogens (Mody et al., 2019). As patients and HCWs come into contact with many items which they mutually touch in the patient zone such as the bed rail, bedside table, linen, and patient lockers it is essential to consider these items as potentially contaminated (Cheng et al., 2015).

Although a simplified concept, the way in which HCWs conceive these zones is likely to impact their hand hygiene practice and could lead to missed moments of hand hygiene. Understanding what items belong to the patient zone and the healthcare zone has been explored by Bogdanovic et al. (2019) who asked ten HCWs to assign 32 items in reference to whether they are allocated inside or outside the patient zone. They found accuracy of 68% (204/300) with most errors relating to items from the healthcare zone being categorised as belonging within the patient zone. This demonstrates a potential risk to patients if practice is incorrectly applied due to interpretations of the zones and the items within them.

Sax and Clack (2015) propose that conceptualisations of the patient and healthcare zones are a kind of mental model; these are unconscious understandings of the world built on past experiences. Mental models allow for individuals to interpret and interact with their environment quickly. They found HCWs held different perceptions of the patient zone and healthcare zone from one another. One example they provide is that of a computer terminal which although resides close to a patient's bed space, is categorised as belonging to the healthcare zone. They found some HCWs viewed the computer as part of the patient zone, and some as part of the healthcare zone. This impacted their hand hygiene practice and risked cross-contamination. This demonstrates that although HCWs may be aware of the delineation between the patient zone and the healthcare zone individuals build their own working mental models, which may not be aligned with guidelines and lead to inconsistent practice.

In the case of Sax and Clack (2015), the authors installed a line on the floor around the patient zone which excluded the computer terminal in order to challenge existing mental models held by the HCWs in order to influence hand hygiene practice. A similar project was undertaken by Yin, Lim and Chan (2019) who installed lines around the patient zones in a children's ICU. This intervention resulted in improved hand hygiene compliance and staff reported an increased awareness of infection risks when inside the patient zone. The authors proposed this design intervention simplified the application of the 5MHH for staff by prompting action with a visual distinction of the zones. These examples of inconsistent conceptualisations of the patient and healthcare zone, and items belonging to both, show how this could result in the potential for incorrect application of the 5MHH in everyday practice.

Practical application of the 5MHH

The context in which hand hygiene occurs is complex. The suitability of the 5MHH in their present form and requirement for targets of >90% compliance may be unobtainable. Gould et al. (2021) turn their attention to the ease of application of the 5MHH in everyday practice. The authors raise potential issues around how adaptable the 5MHH are for consistent compliance, for instance with acutely ill patients and in diverse settings. In addition, they question the clarity of the patient and healthcare zones, suggesting there can be difficulties determining when hand hygiene is required whilst actively providing care, and that the role of the environment and equipment in cross-transmission is sometimes overlooked.

They suggest an increased focus on hand hygiene at the patient bedside, and the addition of thorough hand hygiene at certain intervals during a shift. It is difficult to know how additional hand hygiene requirements would be accepted as an adjunct to the existing 5MHH, even in an updated form. The clarity of the 5MHH and its promotion in healthcare may be difficult to challenge. However, this is not to say that this is not an important route for research to explore. Due to the literature demonstrating low compliance rates for many years there is clearly innovation needed in this field to guide care that is both safe and achievable.

Feedback from hand hygiene audit

Monitoring of hand hygiene is part of a wider approach to IPC practice which includes training and education, provision of audit feedback, and a culture of safety (Pires and Pittet, 2017). Objective measures of performance are required as it is often hard for medical staff to accurately assess their own practice, leaving them unaware of any insufficiencies (Evans, McKenna and Oliver, 2002). Exploration of self-assessment of hand hygiene performance by HCWs has found overestimates of self-reported compliance when compared to observed practice (O'Boyle, Henly and Larson, 2001; Lamping et al., 2022). This could be an example of the theory proposed by Kruger and Dunning (1999), where those who lack adequate skills and knowledge cannot recognise their own incompetence meaning they overestimate their skills. Thus, individuals can be unskilled and yet remain unaware of this. As individual self-assessments of performance are likely to be flawed, the audit and feedback process can provide HCWs with an awareness of their practice and its consequences, encourage confidence in one’s abilities, and help to inform goal setting for improving practice (Ivers et al., 2012).

Many multi-faceted hand hygiene improvement interventions incorporate some form of audit and feedback (Srigley, Furness and Gardam, 2016; Stewardson et al., 2016; Hoffman et al., 2019). This includes the WHO strategy for implementing the 5MHH (Allegranzi et al., 2013) and the NHS ‘Cleanyourhands’ national campaign in England and Wales (Stone et al.,

2012). A systematic review of 140 studies focusing on the effectiveness of audit and feedback for various healthcare practices found varying success (Ivers et al., 2012). The process was more likely to be effective when: there was low compliance of the practice to begin with; audit and feedback were completed by a supervisor or colleague; feedback was ongoing; feedback was provided in verbal and written form; and a target and action plan were developed.

The form and content of feedback is an important factor in engendering change. Donati et al. (2020) found use of IPC link nurses feeding back data from systematic hand hygiene audits to their own clinical ward every three months increased compliance over a year. This suggests individuals who audit practice could be part of the ward team itself. Feedback can also be targeted at specific groups of workers to provide more individualised feedback and education relevant to their specific practice (Smiddy et al., 2019). Importantly, Larson et al. (2013) found for hand hygiene feedback to resonate with HCWs it needed to be meaningful and relevant to their practice in order for them to enact change. It is therefore perhaps the content of the feedback itself which is critical rather than the individual delivering it.

Key to assessing practice is that a specific benchmark or criteria is set, against which practice is measured (Evans, McKenna and Oliver, 2002). A benchmark can help to align variation in practice. Improving low compliance levels to reach required targets may be more acceptable if the process is designed to be slow and incremental to create realistic and achievable goals (World Health Organization, 2010). Though compliance targets are often used to drive practice, Kurtz (2016) reiterates that the ultimate goal of hand hygiene is to prevent the transmission of infection, something which has perhaps become overlooked by a focus on adherence to targets. This reframing of hand hygiene practice as driven by the need to protect the patient, and the HCW themselves, from infection has the potential to motivate HCWs and drive change with a tangible focus.

Measurement as a driver for improvement

The collection of data via routine audits provides a useful data set for which to feedback to HCWs and to compare current compliance with previous periods to drive and monitor change. During periods of quality improvement initiatives where changes to practice are introduced, it can be particularly helpful to compare data over time (Bradley et al., 2004). Direct observational audits carried out periodically provide a snapshot of hand hygiene compliance, whereas EMSs can monitor compliance 24/7 to provide a much larger and more detailed data set. Due to this, electronic systems are likely to be more sensitive in detecting changes in practice following improvement activity (Morgan et al., 2012).

With direct observation there is potential for delay in providing feedback to staff as data must first be compiled and analysed before it can be shared. A potential benefit of some EMSs is their capability to provide real-time, or daily, feedback of compliance rates. This sort of localised specific feedback can be used to engage staff and create ongoing dialogue during improvement work (Kelly et al., 2016). Electronic monitoring also requires minimal use of staff time to generate data, which potentially frees up time to focus on education and supporting improvements to practice.

While audit data from EMSs can track hand hygiene compliance over time, it does not provide information about hand hygiene technique and whether hand hygiene activity was indicated by the 5MHH. Following exploration of different hand hygiene audit methods Magnus et al. (2015) recommended that employing two measures may provide a more accurate assessment of hand hygiene practice. For example, using electronic counters to provide a compliance rate alongside periods of direct observational audit to measure quality of technique and correct timing. This recognises the benefit of direct audit, as although they provide exaggerated levels of achieved compliance, which in turn fosters unrealistic perceptions of what can be achieved, they do offer moments in which education can be provided to HCWs regarding the quality of their practice (Kwok, Juergens and McLaws, 2016).

Whether audit results and feedback are seen by all staff, or lead to improvements to practice, is debateable (Livorsi et al., 2018; Scherer et al., 2019). It is somewhat unlikely for the provision of data itself to drive change without planned systems of support and leadership to utilise the data generated. Boyce et al. (2019) trialled an EMS on four units within a hospital in the USA with the later addition of supplementary hand hygiene promoting activities such as reminders, daily reporting of compliance at shift handover, and coaching upon any decrease in compliance. The authors found no sustained improvement in compliance during the initial period where the system was installed until the interventions were also implemented. Thus, for EMSs to impact compliance rates the data it captures needs to be utilised and fed back appropriately.

How HCWs accept and utilise the data provided by EMSs to inform and potentially change their hand hygiene behaviour is key. Kelly et al. (2021) tested an EMS where most staff opted to receive a personalised report to their own computer device, alongside anonymised reports at ward level. These reports prompted different responses from participants. Some stated they ignored personal reports of poor practice, others felt it made them more

accountable for their own practice, whereas some admitted to not paying attention to, or engaging with, the data. In another study, Fish et al. (2021) found privately received feedback with compliance data from an EMS was less effective in improving compliance rates than public feedback displayed on the unit.

Variation has been found in HCWs preferences surrounding the frequency of feedback and its presentation from EMSs. Differences include choices such as whether feedback is individual and confidential, provided at a unit-level, includes comparison of performance to peers, and the regularity of feedback (Boscart et al., 2008). As EMSs can generate compliance data on a more frequent and consistent basis than direct observation this can result in a large volume of data for staff to absorb and action. In a qualitative study exploring staff opinion of EMSs including managers, mid-level, and frontline staff, Ellingson et al. (2011) found more managers and mid-level staff expressed a preference for real-time feedback compared to frontline staff. There was an overall preference across all groups for periodic feedback with frontline staff feeling real-time feedback would be irritating and overwhelming. As ultimately frontline staff will be the subject of measurement these aspects of experience require further exploration.

2.3 Chapter summary

This chapter outlined the ways in which hand hygiene is audited and monitored in clinical settings. Literature repeatedly reports compliance with the 5MHH is below targets. To generate these compliance rates by direct observation is time-consuming and unlikely to represent typical hand hygiene practice. The development of EMSs to monitor hand hygiene compliance requires a denominator that is based on the reality of practice on UK hospital wards, which has not previously been explored.

The literature also demonstrates the complex nature of hand hygiene for HCWs. How hand hygiene is perceived and understood as part of their ways of working is key. Important within this is how HCWs interpret the 5MHH in the ward environment, including the demarcation of the patient zone and healthcare zone, and the items belonging to these zones. This needs to be taken account of as new technologies and digital equipment are introduced into the clinical environment.

Feedback is an important indicator for HCWs to assess and adjust their performance. The systems of direct audit and potential for EMSs to generate compliance data could lead to a more efficient method of monitoring adherence to hand hygiene guidelines. As frontline staff will be the subject of EMSs these aspects of experience require further exploration. In

addition, the COVID-19 pandemic may have impacted hand hygiene behaviour in clinical settings due to changes in PPE usage when providing patient care, as well as its potential emotional impact on those delivering care. Whether a pandemic leads to change in the performance, or perceptions of, hand hygiene and whether this is temporary or long-lasting is of interest.

This thesis aims to develop a denominator for an electronic monitoring counter system for hand hygiene which is based on the reality of care delivery in the ward environment. Another important consideration is how HCWs themselves understand and apply the 5MHH as this has the potential to impact the number of opportunities generated for hand hygiene and, in turn, compliance rates.

As the monitoring of hand hygiene behaviour in isolation is unlikely to improve compliance it is often combined as part of larger behaviour change interventions. This chapter touched upon literature which aimed to improve compliance to hand hygiene. A crucial aspect of changing behaviour is to focus on key factors which influence behaviour itself. Thus, it is important to explore these factors and develop interventions to address them using behaviour change theory. The extent to which behaviour change theories have been applied in relation to IPC practice requires further exploration. Chapter 3 presents a scoping review which was performed to establish the extent of existing research in this area.

Chapter 3 Scoping review

3.1 Chapter overview

A scoping review was conducted to explore the use of behaviour change theories in IPC practices. As the literature in Chapter 2 highlighted, the monitoring of IPC practices alone is unlikely to change behaviour and there are numerous factors which impact the performance of individual behaviour. Some of the studies included in Chapter 2 were supported by behaviour change theory in order to explore healthcare professionals' behaviour in clinical settings and to implement behaviour change interventions.

The aim of the scoping review was to allow for exploration of how widely theoretical frameworks of behaviour change have been applied to the area of IPC practices to explore factors underlying performance of IPC behaviour and the potential development of interventions to support or improve IPC practice. To capture a comprehensive picture of the use of theory within the IPC specialty the search included all IPC practices and not solely hand hygiene. It also included practice in all healthcare settings, including nursing care homes. This allowed for the exploration of common themes across different health care environments IPC practices.

This scoping review has been published in the Journal of Infection Prevention (Greene and Wilson, 2022) (Appendix 3). The scoping review in Section 3.2 is a slightly longer version than the published version.

3.2 The use of behaviour change theory for infection prevention and control practices in healthcare settings: a scoping review

3.2.1 Background

Infection prevention and control practices

Healthcare associated infections are those which are acquired as a result of receiving treatment in, or visiting, a healthcare setting. Within care settings there are a variety of IPC practices which aim to reduce the occurrence and spread of infection. This includes activities such as hand hygiene, use of PPE, screening patients for infection, decontamination of equipment, and antimicrobial stewardship. The performance of these practices is supported by a base of research evidence.

Evidence-based guidelines for the prevention of HCAI in acute settings were produced for the NHS in 2001 (Pratt et al., 2001), and further updated in 2007 and 2014 (Pratt et al., 2007; Loveday et al., 2014a). These guidelines were developed through a systematic review of evidence and provide principles of best practice which can be used to inform local

procedures in healthcare facilities. The guidelines also provide a standard of practice which can be audited against in order to measure organisational adherence and quality of practice.

Despite many IPC activities being supported by evidence-based guidelines, they are not always complied with by staff. If not implemented effectively then IPC practices risk having little impact. Where practice is poor there may need to be a specific drive on optimising the performance of the IPC behaviour by working with staff to improve practice. Facilitating behaviour change to ensure application of best practice is one of the central roles of the IPC practitioner. Targeting areas thought central to eliciting the performance of a particular behaviour is key. Using behaviour change theory to explore application of evidence-based practices, especially where there may be issues with poor staff performance, allows for the identification of key determinants of behaviour which can be targeted with specific interventions.

Poor practice could be a result of environmental barriers, such as availability and accessibility of equipment. Behaviour can also be influenced by individual barriers which include the individual motivations and beliefs which drive one's behaviour. A variety of behaviour change frameworks and theories have been developed which map the key factors and processes thought to influence behaviour. These tend to incorporate environmental and individual factors as well as complex interactions between individuals and the social and physical contexts they operate within.

Behaviour change theory

There are many different theories of behaviour change, some of which synthesise components of multiple theories into a single framework. These aim to offer themselves as a practical tool, covering a wide scope of factors thought key to behaviour change, which can be utilised by researchers and professionals to identify relevant influences on the behaviour of interest. Some also identify relevant functions which may bring about change, these can be included in the development of behavioural interventions once the key behavioural influences have been identified.

The Behaviour Change Wheel (BCW) was developed in 2011 to help practitioners from across disciplines to identify appropriate interventions or policies when trying to encourage adoption of a particular behaviour (Michie, van Stralen and West, 2011). The BCW incorporates concepts from 19 existing behaviour change theories and contains the COM-B model at its centre (Ojo et al., 2019) (Figure 3.1, overleaf). Capability refers to possessing the psychological or physical capability to perform a behaviour; that is having the knowledge

and skills. Opportunity encompasses how the environment, both physical and social, around the individual can prompt behaviour. The motivation to perform behaviour can differ between individuals, this is impacted by both automatic habitual processes and reflective decision-making processes. The COM-B model reflects the interaction between these factors influences the performance of behaviour.

With the COM-B model at its centre the two outer circles of the BCW includes the potential functions by which interventions can be delivered, such as education or incentivisation. The outermost circle contains policy categories, such as governmental regulations and environmental planning, which can be used to drive behaviour change.

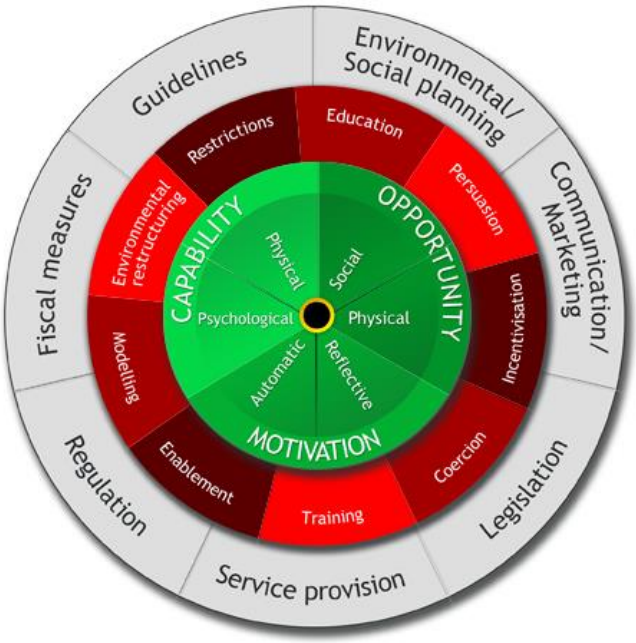

Figure 3.1 Behaviour Change Wheel. Image source: (Michie, Atkins and West, 2014).

Each of the COM-B components also map across the TDF (Table 3.1, overleaf). Like COM-B the TDF combines aspects of multiple theories, it was developed to support the implementation of evidence-based practice with a focus on changing the behaviour of health professionals (Michie et al., 2005). Through consensus from a group of health psychologists and researchers one hundred constructs derived from 33 behaviour change theories were reduced into a framework of 12 domains.

Each domain contains key constructs thought to play a role in behaviour change, with a focus on clinical practice. The TDF was later validated for use in implementation research, at this time two domains were added giving a total of 14 domains in the framework (Cane,

O'Connor and Michie, 2012). As COM-B and TDF share similar constructs they can be used in conjunction. For instance, Michie, Atkins and West (2014) suggest the COM-B can be used to identify relevant components to the behaviour of interest, from these the relevant TDF domains can be identified and used to further explore and interrogate these factors more deeply.

Table 3.1 Overview and definition of domains from COM-B and TDF (Adapted from Cane, O'Connor and Michie, 2012; Michie, Atkins and West, 2014).

COM-B component	TDF domain	Definition
Capability (psychological or physical)	Behavioural Regulation	Anything aimed at managing or changing objectively observed or measured actions
	Knowledge	An awareness of the existence of something
	Memory, Attention and Decision Processes	The ability to retain information, focus selectively on aspects of the environment, and choose between 2 or more alternatives
	Skills	An ability or proficiency acquired through practice
Opportunity (social or physical)	Environmental Context and Resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour
	Social Influences	Interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours
Motivation (automatic or reflective)	Beliefs about Capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use
	Beliefs about Consequences	Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation
	Emotions	A complex reaction pattern involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event
	Goals	Mental representations of outcomes or end states that an individual wants to achieve
	Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way
	Optimism	The confidence that things will happen for the best or that desired goals will be attained
	Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus
	Social/Professional Role and Identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting

The BCW and TDF combine and simplify several different behaviour change theories in order to create a tool or framework which can be used by practitioners across various disciplines to enact change (Cane, O'Connor and Michie, 2012). Utilisation of theoretical frameworks in healthcare settings to develop interventions provides a sound theoretical base which may have an important impact on outcomes. There is some evidence that interventions which are underpinned by theory are more likely to be effective (Michie and Johnston, 2012).

The purpose of this review is to explore how behaviour change theories have been applied to IPC practices in healthcare settings, to identify common themes and consider any implications for practice. Due to their focus on clinical practice the theories of interest are the BCW, COM-B, and TDF.

3.2.2 Methods

In order to explore the existing literature a scoping review was conducted. Scoping reviews are a way of systematically mapping an area of research evidence and generate a descriptive overview exploring the extent, range, and characteristics of published evidence for a particular topic (Pham et al., 2014). This highlights the types of evidence available and gaps in the existing literature. The objective of this scoping review was to explore how behaviour change theories have been applied to IPC practices in healthcare settings. The review followed the Joanna Briggs Institute methodology for conducting scoping reviews. The main review question was: How have behaviour change theories been applied to IPC practices in healthcare settings?

Inclusion and exclusion criteria

Evidence from primary research, both quantitative and qualitative, was included to ensure a broad range of studies were located. This kept the scope wide and ensured the map of the literature was thorough. Grey literature was not searched. Relevant theories were TDF, BCW, or COM-B and any type of IPC practice was included. The review focused on literature relating to healthcare settings, including care homes. Only studies published in the English language and published since the year 2000 were included as the relevant behaviour change theories were developed following this date. Text, review, opinion papers and letters were excluded.

Search strategy

A three-step strategy as recommended by Joanna Briggs Institute was undertaken. This comprised 1) an initial search undertaken to identify relevant keywords and search terms.

This informed 2) an individual search strategy developed for each database including mapping to relevant subject headings (Appendix 4). Databases searched were CINAHL Complete, EMBASE and MEDLINE. Lastly, 3) the reference lists of relevant papers were screened to identify any additional studies. Limits applied to the search were: papers published in the English language, published after the year 2000, and with an abstract available.

Two reviewers assessed all titles for relevance. Relevant papers were retrieved and resifted by both reviewers. Disagreements were resolved through discussion. Information on authors, country of origin, publication year, type of theory used, methods, and key findings were extracted into a charting table, a brief charting table is included, and the findings incorporated into a narrative summary.

3.2.3 Results

The scoping review identified 1516 papers after removal of duplicates. Of these, 11 were relevant to the research question and included in the review (Figure 3.2, overleaf). The most common reason for exclusion was that the theoretical approach used by the authors was not relevant to the research question.

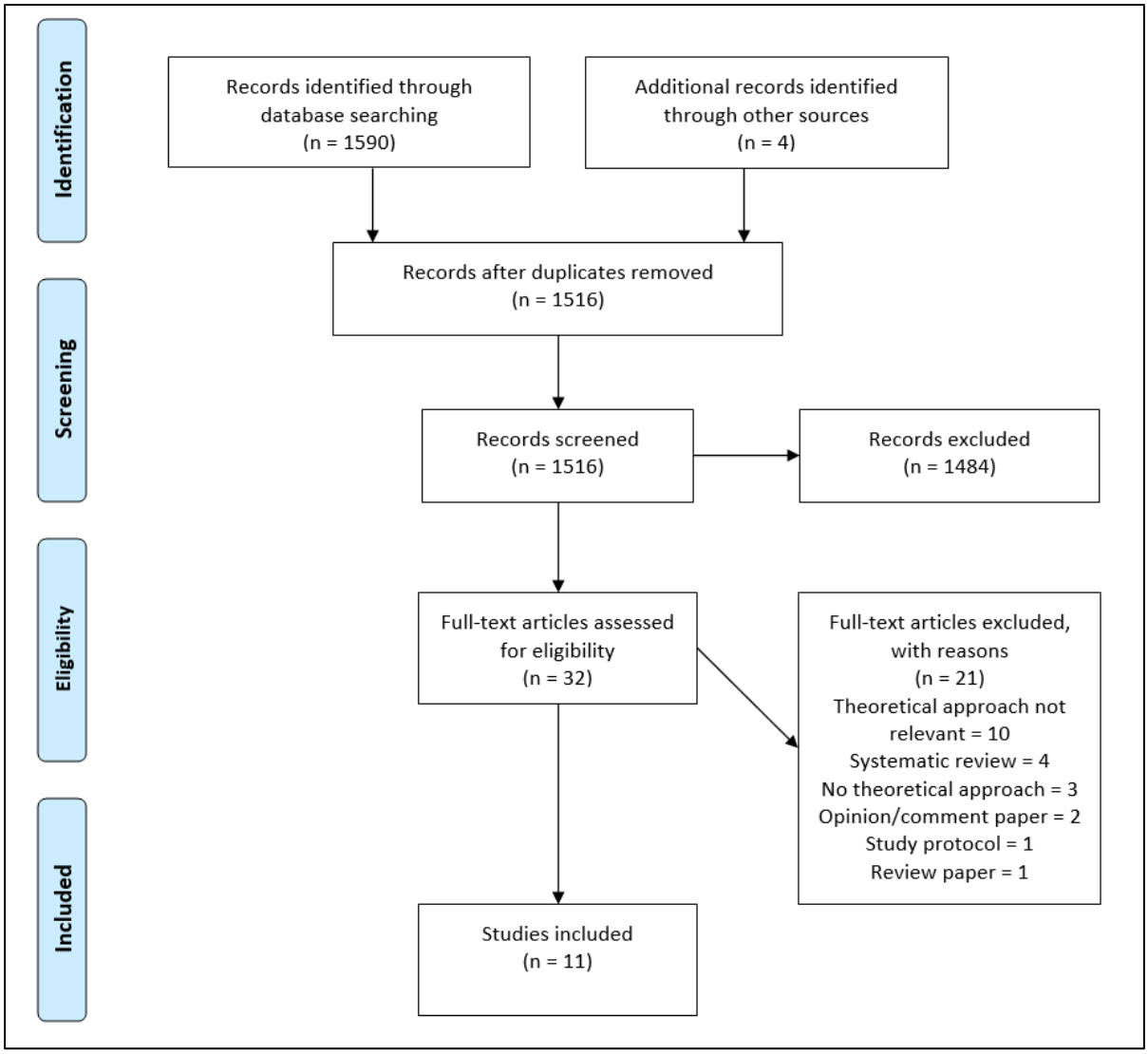

Figure 3.2 PRISMA Flow Diagram for the scoping review process.

As shown in Table 3.2 (overleaf) the included papers were published between the years 2011 and 2019 and were from two countries: UK (n=6) and Canada (n=5). Results are organised by the type of IPC practice the study focused upon. Of the 11 included studies seven focused on hand hygiene, three on antimicrobial stewardship, and one on methicillin-resistant Staphylococcus aureus (MRSA) screening.

Table 3.2 Brief charting table of reviewed papers.

Authors and country of publication	Relevant theory	Overview of study
Hand Hygiene		
1) Boscart et al. (2012) Canada	TDF	Identified nurses and administrators perceived barriers and facilitators to hand hygiene practices and introduction of an EMS for hand hygiene.
2) Dyson et al. (2011) UK	TDF	Exploration of a theory-informed and non-theory-informed question schedule to assess barriers and levers to hand hygiene.
3) Dyson et al. (2013) UK	TDF	Development of an instrument to measure barriers and levers to hand hygiene.
4) Fuller et al. (2014) UK	TDF	An exploration of real-time explanations of hand hygiene non-compliance.
5) McAteer et al. (2014) UK	TDF	Exploration of barriers and facilitators to implementation of hand hygiene intervention by those who delivered it.
6) Smith et al. (2019) Canada	TDF	Exploration of barriers and facilitators to hand hygiene in long-term care facilities through development of a theory informed questionnaire.
7) Squires et al. (2014) Canada	TDF	Exploration of the barriers and facilitators to physician hand hygiene compliance.
Antimicrobial Stewardship (AMS)		
8) Chambers et al. (2019) Canada	TDF	Exploration of barriers and facilitators that contribute to overuse of antibiotics for urinary tract infection (UTI) in long-term care. Developed a theory informed AMS programme.
9) Fisher et al. (2018) Canada	TDF and COM-B	Determination of the barriers and facilitators to promotion of intravenous to oral antimicrobial step-down by nurses.
10) Jones et al. (2018) UK	TDF and COM-B	Investigation of the attitudes towards and experiences of AMS for community pharmacies in order to explore barriers and opportunities to AMS.
MRSA Screening		
11) Currie et al. (2019) UK	TDF	Identification of factors which influenced staff compliance with MRSA screening policies.

Hand hygiene

Hand hygiene is a key behaviour in the interruption of the spread of pathogens during patient care. Performance of hand hygiene by HCWs at specific moments during care provision aims to reduce the spread of infection between sites on one patient, between different patients, and around the healthcare environment. Seven papers were identified which had used the relevant theories to explore staff performance of hand hygiene in healthcare environments. The studies focused on three different aspects of hand hygiene: barriers and facilitators, decision making, and intervention success.

Barriers and facilitators to hand hygiene

Five studies explored the barriers and facilitators to appropriate hand hygiene behaviour. Settings included long-term care (Smith et al., 2019) and hospital (Dyson et al., 2011; Dyson et al., 2013; Boscart et al., 2012; Squires et al., 2014). All five studies included interviews or questionnaires about the performance of hand hygiene with frontline staff as participants. All used the TDF to inform the development of question schedules and the analysis and interpretation of data.

Smith et al. (2019) aimed to identify key attitudes and barriers and facilitators to hand hygiene in the care home setting by designing a staff survey. An initial survey of 85 care workers narrowed the questions, which were based on existing surveys and literature and mapped on to the TDF domains. From this a second survey was developed which contained 47 closed-ended questions. Analysis of the second survey focused on 342 staff whose role included providing direct care. This survey identified four main themes which mapped on to three TDF domains. The barriers to hand hygiene were related to the domain of environmental context and resources, this included time pressure, workload, and environmental controls. Hand hygiene was facilitated by two domains, that of social/professional role and identity, and beliefs about consequences to self and others. This encompassed performance of hand hygiene feeling like part of their professional duty, and its potential impact on themselves, co-workers, and patients. The authors noted that the barriers they identified were similar to those seen in hospitals. Smith et al. (2019) saw the resulting questionnaire as a useful tool for defining key factors which may restrict or encourage hand hygiene behaviour in an organisation which can then inform selection of appropriate interventions specific to that setting.

As compliance with hand hygiene may differ depending on job role, theories can support the exploration of potential determinates of behaviour for these different groups. Looking at specific job roles, Squires et al. (2014) interviewed 42 physicians, both staff and residents from surgical and medical wards, using a question schedule informed by the TDF. Nine of the 14 domains from the TDF were identified as relevant to hand hygiene practice: i) knowledge, ii) skills, iii) beliefs about capabilities, iv) beliefs about consequences, v) goals, vi) memory, attention, and decision processes, vii) environmental context and resources, viii) social professional role and identity, and ix) social influences. The authors found that physicians reported a knowledge and skills gap related to guidelines and performance of hand hygiene. This was surprising given it would be expected these areas would be covered during training. The influence of just one domain, social influences, differed between the

specialties with more surgical staff reporting their team influenced their performance of hand hygiene than the medical staff. It was noted that nearly all participants thought performance of hand hygiene was a conscious process, and thus may benefit from reminders in the environment.

Dyson et al. (2011) explored barriers and facilitators to hand hygiene whilst comparing data elicited from two types of questionnaire. One questionnaire was developed using the TDF, with questions covering 12 domains. The other questionnaire was based on existing literature and probed existing factors which have been found to influence hand hygiene including social and organisational, individual differences, and knowledge. Questions were delivered via focus groups, interviews, and paper questionnaires with a total of 70 HCWs. The authors found that the theory-based questions prompted significantly more discussion of three domains in particular: emotion, habit/routine, and incentives. The authors suggest that these domains may have an unconscious influence upon behaviour, thus by asking participants about them outright their influence is considered and discussed.

The TDF has also been used to underpin the design of an instrument to explore barriers and facilitators to hand hygiene which can be administered to large groups. Through use of Delphi survey and pilot testing Dyson et al. (2013) developed an instrument which consisted of 33 questions spanning ten TDF domains. Testing with HCWs showed that those who reported higher numbers of barriers had lower self-reported compliance with hand hygiene. The authors propose that development of such instruments allows for large scale assessment of healthcare staff in an organisation as opposed to potentially lengthy interview processes. This also allows for tailored interventions to be developed based on local results.

As theory can help to explore influences on performance of evidence-based practice it can be used to explore potential barriers to practice before interventions are implemented. Boscart et al. (2012) aimed to explore barriers and facilitators to the introduction of a new EMS for hand hygiene as well as to existing hand hygiene practice in a hospital setting. Ten interviews, with questions informed by the TDF, were conducted with nursing staff and administrative staff (IPC nurse, unit manager, and director of care). The authors found differences between the responses from the nurses and administrators. In general, nurses felt they had sufficient knowledge, skills, and capabilities to perform hand hygiene, and discussed the routine nature of hand hygiene to their practice. Administrators thought nurses potentially lacked in knowledge and decision making and identified potential environmental barriers nurses may encounter to performance of hand hygiene. Discussing hand hygiene practice and the EMS enabled the authors to pinpoint specific areas they could target when

implementing the EMS in order to aid its success. Interviews also highlighted differences in views dependent on job role which could be considered when planning implementation strategies.

Staff decision making

The decision for individuals to perform hand hygiene is influenced by both automatic and conscious processes. To explore how healthcare staff decided when to clean their hands during practice Fuller et al. (2014) observed care provision and asked staff about their non-compliance with hand hygiene immediately following the event. The TDF was used to code and analyse the reasons given for non-compliance. Just over two thirds (142/207, 67%) of coding related to two domains of the TDF, 1) memory, attention, and decision processes and 2) knowledge. Fuller et al. (2014) surmised that this indicated that both automatic and conscious process need to be targeted when designing interventions due to the dynamic nature of behavioural influences.

Interventions to improve hand hygiene

Hand hygiene is often the focus of improvement interventions. McAteer et al. (2014) explored why an intervention may succeed in some settings but not others. They assessed the implementation of an intervention to improve hand hygiene which was trialled using a stepped wedge cluster randomised controlled trial in 16 NHS trusts. The intervention itself was based on goal setting and control theory, involving observation of staff, feedback, and goal setting. Ward coordinators, who delivered the intervention, from 17/33 (52%) of the wards involved were interviewed to explore experienced successes and challenges. Interview questions were based on nine TDF domains thought most relevant to the topic, answers related to these domains were coded with a number which represented how likely it was to contribute to intervention success. McAteer et al. (2014) found that domains most related to successful implementation were linked to professional identity in that the tasks were already part of the ward coordinator role, knowledge of the intervention, skills around implementation, motivation to deliver the intervention, and behavioural regulation with regard to prioritising goals.

Antimicrobial stewardship

Antimicrobial stewardship focuses on optimising the use of antibiotics in order to minimise unnecessary use, or overuse. This is considered critical in reducing and controlling the emergence of antimicrobial resistant pathogens. Three studies were found which focused on perceived barriers and facilitators to antimicrobial stewardship. All were based in different settings covering long-term care (Chambers et al., 2019), hospital (Fisher et al., 2018), and

community pharmacy (Jones et al., 2018). In all studies the TDF was used to inform a question schedule or analyse data collected via interviews or surveys. Two studies (Fisher et al., 2018; Jones et al., 2018) went on to map the identified domains onto the COM-B to ascertain the relevant behaviour change techniques.

Fisher et al. (2018) used semi-structured interviews with 15 nurses at one hospital to explore the barriers and facilitators to stepdown from IV to oral antibiotics on hospital wards. Interview schedules were developed using the TDF and responses analysed using content analysis focusing on the TDF domains. All TDF domains, except that of emotion were represented in the data. More than half of the coded responses represented just four domains: beliefs about consequences, knowledge, environmental context and resources, and social/professional role and identity. Domains were mapped onto the COM-B system in order to identify the potential development of interventions to promote the stepdown to oral antibiotics.

Jones et al. (2018) focused on current and potential use of AMS in the community pharmacy setting. This was explored through interviews and focus groups with 58 participants working within community pharmacies and GP surgeries. The question schedule was informed by the TDF, with responses showing comments coded into all 14 domains. Identified domains were mapped onto COM-B to identify relevant interventions, this led to recommendations as to how practice could be improved. Recommendations were focused on four key TDF domains: environmental context and resources, beliefs about consequences, memory, attention and decision-making, and professional role and identity.

One study developed a theory-informed AMS programme. Chambers et al. (2019) explored the barriers and facilitators to management and treatment of UTI by surveying 381 people working in long-term care. Responses were coded and mapped onto the TDF domains which identified eight domains as relevant to appropriate prescribing practice. Relevant domains were then mapped onto a specialised database which suggested interventions to improve drug prescribing practice. Interventions were chosen which had the potential to address the TDF constructs identified. Focus groups with staff from two long-term care facilities were held to explore acceptability and feasibility of proposed interventions in the care setting.

MRSA screening

The routine screening of patients for MRSA helps to appropriately manage those colonised and reduce the risk to other patients. One study used a mixed methods approach to explore

the MRSA screening behaviours of UK hospital staff (Currie et al., 2019). The TDF was used to design a question schedule and analyse the results of interviews and focus groups with 49 nurses and clinical staff. This identified key barriers and enablers to screening behaviour which were used to design a national survey to explore the issue. Three-quarters of survey respondents (76%, 343/450) reported their compliance with MRSA screening procedures as more than 90%, this was considered optimum compliance according to local standards. Logistic regression found three predictors for more than 90% compliance: 1) screening as part of admission process (it was seen as easy to complete due to admission routine), 2) feedback regarding compliance levels to screening (staff were aware of their performance), and 3) clinical area (the influence of ward culture). The authors recommend targeting these areas in order to influence and embed screening behaviour.

3.2.4 Discussion of findings

This scoping review has shown how behaviour change theories have been used to explore the application of evidence-based IPC practices in relation to hand hygiene, antimicrobial stewardship, and MRSA screening. The reviewed studies encompassed a range of settings and staff roles with most exploring perceived barriers and facilitators to existing IPC practices by healthcare staff. This can help to explore determinants of ingrained practice and identify potential interventions specific to the setting. Only three of the studies (Dyson et al., 2013; Chambers et al., 2019; Smith et al., 2019) described an intervention or development of a tool which targeted the behavioural determinants identified.

Use of a theoretical framework within the studies ensured a wide range of behavioural determinants were explored, including ones which were not previously reported to be of influence on the behaviour. This is demonstrated by Dyson et al. (2011) finding that theory-informed questions elicited discussion from participants of a wider scope of behavioural determinants than questions based on published literature. This broader assessment of the range of barriers and facilitators identifies potentially unknown influences on IPC behaviours which can be targeted in the design of interventions.

Some domains were frequently identified across all three IPC behaviours: beliefs about consequences, environmental context and resources, and social/professional role and identity (Table 3.3, overleaf). These may be key areas to consider when planning interventions in IPC practice. Awareness of the consequences of an infection occurring or its potential spread to other patients or the HCW themselves was a facilitator for performance of hand hygiene (Smith et al., 2019). However, attribution of the occurrence of infection to behaviour is problematic due to the period of intermission between the two events. Due to

this delay in consequences, encouraging IPC behaviour may require greater focus on the formation of habitual behaviour and developing emotion-based motivations to perform behaviour (Cioffi and Cioffi, 2014). Where a specific behaviour was to be avoided, e.g. prescribing antimicrobial agents, some HCWs worried that if a patient was not treated they may develop an infection (Chambers et al., 2019). This perception of a potentially negative consequence can be addressed by providing support and education to promote recognition of the balance between the appropriate use of antibiotics and potential harm from over usage.

Table 3.3 The TDF domains identified in reviewed studies.

TDF domain	**Domains identified in each study**		
	Hand hygiene	**Antimicrobial stewardship**	**MRSA screening**
Behavioural Regulation	1, 2, 3, 4, 5, 6	9, 10	11
Beliefs about Capabilities	1, 3, 5, 6, 7	9, 10	
Beliefs about Consequences	1, 2, 3, 4, 6, 7	8, 9, 10	11
Emotions	1, 2, 3, 4, 5,	8, 10	
Environmental Context and Resources	1, 2, 3, 4, 5, 6, 7	8, 9, 10	11
Goals	1, 7	9, 10	
Intentions	1	9, 10	
Knowledge	1, 2, 3, 4, 5, 7	8, 9, 10	
Memory, Attention and Decision Processes	1, 2, 3, 4, 6, 7	9, 10	
Optimism	1	9, 10	
Reinforcement	1, 2	8, 10	11
Skills	1, 2, 3, 4, 5, 7	8, 9, 10	
Social Influences	1, 2, 3, 4, 5, 6, 7	8, 9, 10	
Social/Professional Role and Identity	1, 2, 3, 5, 6, 7	8, 9, 10	11

Note: Studies are identified by numbers used in Table 3.2.

For staff to adhere to preferred IPC behaviours they require an environment that supports these actions. For hand hygiene the location of alcohol-based hand rub at the point-of-care enables HCWs to decontaminate their hands close to where contamination occurs. This point-of-care location has been found to increase compliance with hand hygiene (Traore et al., 2007). This sort of environmental or resource change may require the introduction of new systems and processes or adapting something which is already in place. The idea of an enabling environment also links to the concept of making IPC behaviours an essential part of the professional role. Creating an environment which encourages IPC behaviours makes it easier for them to be performed as a core part of everyday practice and create a strong link to a sense of professionalism.

Other domains featured in some studies but not in others, although sometimes this was due to questionnaire design and whether they included all domains in the questions. The differences between the findings of the studies also demonstrates the importance of exploring determinants of behaviour within individual settings rather than assuming we understand why a behaviour is, or is not, performed consistently. Identification of these specific barriers and facilitators is vital before designing or introducing interventions. Engaging staff in this process may also demonstrate to them that any intervention to be introduced will consider issues specific to their experience and context.

The influence of different factors on behaviour was shown to vary according to occupational group (Boscart et al., 2012; Dyson et al., 2013; Squires et al., 2014). This is of importance when thinking about improving IPC practice in a ward setting where different team members may benefit from tailored support or different approaches to training. Squires et al. (2014) found a lack of knowledge and skills around hand hygiene among physicians even though it would be part of their basic training. Assumptions may commonly be made about level of knowledge and skills in relation to IPC practices, therefore additional ward-based training and feedback may benefit staff (Tavolacci et al., 2008).

Most studies in this review involved interviews with staff which can be time consuming to complete and analyse. The survey instrument developed by Dyson et al. (2013) demonstrates an approach for assessing determinants of behaviour at scale across an organisation, obviating the need for interviews. By developing such theory-based instruments, IPC practitioners can target larger cohorts of staff across different settings to define the specific factors influencing behaviour at a local level. Ensuring these tools have an underlying theoretical base also allows for relevant behaviour change techniques to be identified and included in the design of interventions.

The successful implementation of behaviour change strategies is key to the effectiveness of interventions. Using behaviour change theory to explore potential barriers and facilitators prior to the design, or implementation, of an intervention allows for it to be tailored to each specific context. In addition, after an intervention has been implemented the reasons behind its success or failure can be explored using the same framework (McAteer et al., 2014). This can highlight key areas to address or support when implementing interventions in similar settings, or to inform adaptations to improve the intervention.

Limitations of the review

The scope of the identified studies is currently narrow and focused on exploring three IPC practices. Some papers relied on self-reported compliance with IPC behaviour which could have led to social desirability bias where participants report they perform behaviour more than they do in reality. Combining staff interviews with observation of care delivery or reviewing audit data may present a more accurate picture of compliance where this is important. The studies identified for inclusion in this review were only conducted in two countries, the UK and Canada, thus behavioural determinants may vary further depending on the country the research is conducted in. Future research should aim to extend the scope of theory-based analysis of behaviour related to a wider range of IPC practices. Areas of interest could include use of PPE including glove use, implementation of care pathways and bundles, and adherence to isolation precautions.

3.2.5 Conclusions

The TDF, BCW, and COM-B have been used in a small number of studies related to IPC practices. The use of behaviour change theories in this field has helped to establish a range of determinants involved in the performance of behaviour. Identifying these factors allows them to be targeted to support the translation of evidence into practice, ensuring it meets recommended standards and guidelines. It would be of benefit for IPC practitioners to utilise these methods to explore practice and support behaviour change. The small number of published studies and IPC behaviours explored indicate more research in this area is required which is underpinned by theoretical frameworks.

3.3 Impact of scoping review on thesis

Exploring a broad literature base of IPC practices revealed that behaviour change theory has been applied most in the area of hand hygiene research, with the TDF applied in most of the included studies. As the TDF was developed from other behavioural theories it includes a wide scope of potential influences upon behaviour. As demonstrated in this chapter there are many factors which can impact the performance of hand hygiene and it is a more complex behaviour than it first appears. This scoping review has demonstrated the importance of incorporating a theoretical framework into this research. Use of the TDF is suited to the aims of the second phase of this study which involves interviews with HCWs regarding their experiences of hand hygiene in practice. The inclusion of a theoretical framework to develop a question schedule and exploration of findings ensures data collection and analysis is built upon a sound framework which explores a range of relevant factors which could impact behaviour.

3.4 Chapter summary

This chapter, along with the previous, has highlighted the importance of hand hygiene as an IPC practice in the reduction and control of HCAI due to the ways that pathogens can be spread during the provision of patient care. The literature demonstrates that compliance with the 5MHH in clinical practice is low, often performed less than half of the time it is required. The important role of hand hygiene in preventing HCAI and the challenges in assuring compliance with best practice are also illustrated in the scoping review where most IPC studies informed by behaviour change theory were focused on hand hygiene. This shows the prominence of the need for improvement to this area of practice. The next chapter presents the methodology for the current research, including the research approach and methods used.

Chapter 4 Methodology

4.1 Chapter overview

This chapter describes the rationale and aims of this research, along with the methodology and methods used to achieve these aims. Following this, Section 4.3 explores the impact which the COVID-19 pandemic had upon the research plan. The research approach, exploring the research design including the chosen philosophical perspective are then described. The mixed methods research design is discussed, and reasons for the suitability of this approach determined. Finally, Section 4.5 describes how the research was performed, the chosen methods of data collection, and data analysis for the two phases.

4.2 Rationale, aims and objectives of this thesis

The potential role of new technologies such as EMSs to monitor hand hygiene activity and generate compliance rates could provide HCWs with a source of ongoing feedback, whilst avoiding the Hawthorne effect. In order to build trust in the data generated by EMSs it is imperative that the denominator of expected opportunities for hand hygiene is representative of actual clinical practice. Healthcare worker's perceptions of EMSs and the data it produces is important if it is to impact on practice at an individual level and encourage adoption of this technology across the sector. Existing data from research conducted in other countries informing this number may not be reflective of healthcare practice in the UK. Potentially important differences in the UK healthcare setting may impact the number of opportunities for hand hygiene that experience. This represents a key gap in the literature.

In its first phase, this research will observe care provision on two UK hospital wards to explore the frequency of HHOs for HCWs. This will capture the reality of hand hygiene in everyday practice, and the number of observed HHOs can be used to inform a denominator for an EMS. Data from an EMS, to be installed on the wards where observations will be performed, will be compared to findings from the observations. Compliance rates from observation of practice can then be compared to that generated by the EMS.

Alongside a realistic estimate of the number of HHOs in everyday practice, how HCWs understand and implement the 5MHH will impact the generation of HHOs and compliance levels. This includes the application of hand hygiene in the context of the ward environment and interpretation of patient zoning, including equipment which is frequently used with successive patients and moved around the ward. In addition, the role of IPC practitioners is central in the audit process, how they perceive audit and the potential impact of EMSs upon their practice may influence their acceptance and future adoption.

The second phase comprises individual interviews with HCWs which aim to gather in-depth perspectives about application of hand hygiene in daily practice, audit processes, including perceptions of EMSs, and any impact of COVID-19 upon hand hygiene behaviour. To explore these subjects, it is key to speak directly with those providing direct patient care, as well as IPC practitioners who often lead hand hygiene audit programmes and education. Hand hygiene practice observed in the first phase will inform the topics included in the interviews in the second phase.

Overall, this research aims to explore how EMSs could be used to drive hand hygiene practice through exploration of opportunities for hand hygiene in frontline practice to inform an accurate denominator for EMSs. This is coupled with exploration of HCWs perceptions and understandings of various aspects of hand hygiene behaviour and audit to gain a wider perspective on factors driving the performance of hand hygiene.

In summary, the objectives for this study are:

1) To understand how many opportunities for hand hygiene there are based on the 5MHH on UK inpatient hospital wards.
    - Determine the frequency, occurrence, and distribution of HHOs in order to inform an accurate denominator for EMSs.
    - Compare and evaluate compliance data collected by direct observations with data generated by an EMS.

2) To explore HCWs understandings, perceptions, and experiences of hand hygiene in clinical practice.
    - Understand how frontline staff understand and apply the 5MHH in clinical practice.
    - Explore frontline HCWs and IPC practitioners' experiences of audit and feedback, including the potential role of EMSs on practice.
    - Gauge the impact of COVID-19 upon individual hand hygiene practice.

To achieve these objectives a mixed methods approach to the research will be adopted. This supports a two-phase approach to the research, with the first phase involving collection of quantitative data via observational methods. This will be followed by a qualitative phase comprising interviews with frontline HCWs which will further explore key elements of practice observed in the first phase.

4.3 Impact of the COVID-19 pandemic on the thesis

The final aims and objectives presented in Section 4.2 are revised from original plans at the outset of this research. Changes were made to elements of the original plans due to the COVID-19 pandemic. This was as a response to the ensuing restrictions and government guidance at the time, and the wider impact these had on access to hospitals and the research timeline. Although adaption is a usual part of any research process, this project was particularly impacted upon as data collection was based in a large acute hospital and included frontline HCWs. The occurrence of the restrictions brought in during the pandemic were unforeseen, and their duration was unknown. Therefore, a pragmatic approach to the collection of data had to be taken in order to progress the research under these exceptional circumstances.

Impact on Phase 1

After some initial data collection on the two hospital wards observation of practice temporarily ceased in early March 2020. From the beginning of the first UK government lockdown in mid-March 2020 the hospital site was open to essential staff only, meaning the researcher could not go on site. Limited access to the hospital after the first lockdown meant it was not possible to include a wider array of HCWs, such as doctors and allied health professionals, in observations as it was thought of primary importance to finish the data collection for the registered nurses and nursing assistants.

During the first year of the pandemic, due to the demand for hand sanitiser across the health and social care system, the management of stock became centralised within the NHS rather than managed by procurement teams within individual hospitals. This affected the availability of items from the hospital's preferred suppliers, resulting in a lack of ABHR stock on both wards that was compatible with the wall-mounted and bed-end dispensers which were linked to the DebMed GMS. Once stocks were depleted these dispensers were not restocked until much later in the pandemic. Instead, an assortment of bottles of sanitiser were supplied and placed at the entrances to the ward bays and side rooms on small tables.

In addition, bed-end dispensers were removed from all beds on the wards to reduce the number of items in the patient bed space which could potentially be contaminated and require cleaning. These changes had a considerable impact on the ways in which HCWs were able to access and use ABHR during patient care. The issues experienced during the pandemic raise the importance of supply chain resilience for items and equipment linked to specific hospital infrastructure within a pandemic situation, particularly those related to essential IPC practices.

Stock issues continued for months, and bed-end dispensers were not reinstated during the relevant study period. Thus, part of the original aim of the project was amended. Originally the accuracy of the GMS was going to be compared to data gathered through periods of direct observation across the entire ward whilst the GMS was running. This was not possible due to hospital access and stock issues which meant the system was not operational. As the GMS had been installed and generating compliance data during Phase 1 it was decided that this compliance data could be explored and compared to compliance findings from the observations of practice which focused on exploration of the number HHOs. Though these observations were not across the entire ward it was thought they provided a reasonable approximation of ward-level practice.

Impact on Phase 2

The pandemic also impacted the second phase of the study. The original intention was to interview HCWs from the hospital wards on which observations were performed. Due to the hospital research and development department pausing all research studies in March 2020 and the gradual restarting of existing studies before the approval of new studies, the wait for approval was prohibitively long. Therefore, the recruitment approach was changed to target students from the University of West London (UWL) who were also qualified to work in the relevant professional roles. An amendment to the existing ethical approval was submitted and approved for this change.

The pandemic had a huge impact on the day-to-day practice of IPC teams and frontline HCWs due to the increased focus on the application of IPC practices, such as hand hygiene and PPE usage, to help control nosocomial spread of COVID-19 in both patients and HCWs. Following the first cases of COVID-19 in the UK the key role of hand hygiene for HCWs in reducing the spread of the virus was emphasised in government guidance (Public Health England, 2021). Therefore, the question schedules were adapted to add a section exploring whether COVID-19 impacted HCWs perceptions and practice of hand hygiene, and whether IPC practitioners identified any changes in hand hygiene practice due to the pandemic.

4.4 Research approach

4.4.1 Philosophical perspectives in research

Research paradigms provide philosophical frameworks which underpin ones understanding of the nature of knowledge, this in turn guides the direction of research inquiry (Morgan, 2007). Each paradigm takes a stance in attempting to explain how we understand the reality

around us, and in turn how knowledge can be gained and understood. This is often referred to as a worldview and as researchers the paradigm we work within impacts how we view, seek, and understand knowledge (Weaver and Olson, 2006). When used in research these paradigms can inform the kind of questions posed, methods employed, and appropriate analysis (Bergman, 2010). Paradigms which are either aligned with quantitative methods or with qualitative methods are seen by some as disparate due to their polarised worldviews (Johnson and Onwuegbuzie, 2004).

Quantitative research design has a long history dating back to the late 19th century. The dominant paradigm in quantitative research is positivism. Positivists take a scientific approach to research by testing and rejecting hypotheses linked to their research questions. They view the world as an objective reality which is external to the individual, and which can be observed, measured, and quantified. The positivist researcher tries to manage any potential biases by carefully controlling the collection and analysis of data, including minimising the potential impact of the researcher themselves. This means a stringent separation between the researcher and the participant is required to prevent bias (Park, Konge and Artino, 2020). This approach is seen as generating robust knowledge which reflects reality. However, the positivist paradigm can be criticised for being unable to capture the unobservable aspects of phenomena due to its strict understanding of reality (Coleman, 2019).

Qualitative research methodology emerged more recently in the mid-20th century, with one of the main paradigms being constructivism. Constructivists see knowledge as socially constructed, with individuals creating meaning through their individual experiences of the world around them (Bogna, Raineri and Dell, 2020). This is built upon exchanges and interactions with others within the society they are located. Therefore, knowledge is seen as subjective, created from individual perspectives which form multiple realities. Due to this, knowledge tends to be sought through interviews with participants or observations to capture in-depth data. This data is then analysed by the researcher to explore how participants form understandings and meanings about their experience of phenomena. Thus, the researcher's role in this process is acknowledged as they themselves are interpreting meaning from the data. Meaning can therefore be seen as co-constructed in an iterative rather than linear process. Constructivism can be seen as limited in that research findings are related to specific participants in a specific context and is not reproducible (Bogna, Raineri and Dell, 2020).

Both the positivist and constructivist paradigms are essential to answering the research question. The positivist paradigm allows for the systematic observation and quantification of behaviour. Thus, the frequency of opportunities for hand hygiene based on the 5MHH can be observed and compliance data compared to data generated by an EMS. Without this approach to data collection the reality of practice would not be known and there would be a reliance on individual self-reporting of hand hygiene behaviour which is prone to bias and would not allow for comparisons of data. Although positivism can provide insight into the burden of hand hygiene in practice, it does not explore the various behavioural components which influence an individual's decision to perform hand hygiene. The constructivist paradigm allows for interrogation of factors which can help to explain individual behaviour, which the positivist cannot provide. Constructivism captures an individual's perceptions and understandings of hand hygiene and the context in which it is applied. This facilitates exploration of the complexity of this crucial IPC behaviour in practice.

Due to the differences in their view of the world these two paradigms could be seen by some as taking opposing positions. However, others see them as existing on a continuum which means they are able to be integrated to varying degrees (Onwuegbuzie and Leech, 2005). At the centre of this continuum would be the mixed methods approach, which embraces the use of both quantitative and qualitative components taking place in a single study. Multi-method research designs emerged from the 1950s onwards (Tashakkori and Teddlie, 2010), with the more formal self-identified mixed methods approach becoming explicit in the late 1980s (Creswell and Plano Clark, 2011).

A mixed methods approach involves the deliberative collection of both quantitative and qualitative data within a single study, with data sets integrated through merging, building upon findings, or embedding in a larger framework (Creswell and Creswell, 2018). This approach aligns with the philosophical paradigm of pragmatism, which focuses on the use of differing methodologies and methods as tools of inquiry within one study. Following a period where there were two dominant research approaches, there can now be seen to be three: quantitative, qualitative, and mixed methods (Johnson, Onwuegbuzie and Turner, 2007).

4.4.2 The theoretical lens of pragmatism

Pragmatism is suited to the mixed methods approach as it emphasises the utilisation of any appropriate methods in order to address the research question. It does not privilege one methodology over another, seeing them as each serving their own specific purpose in the production of knowledge, and does not view them as competing (Cornish and Gillespie, 2009). Dewey, a prominent philosopher who wrote on pragmatism in the early 20th century,

proposed that it is researchers themselves who have placed paradigms in seemingly opposing standpoints (Morgan, 2007). Pragmatism is not concerned with abstracted concepts which place limitations on the research process, it moves away from the idea of warring paradigms and any potential restrictions on the methods available to researchers (Morgan, 2014).

It can be seen as taking a 'bottom up' approach by focusing on the problem of interest, rather than 'top down' from an epistemological position which in turn can be seen to direct, and constrain, the methods available to the researcher (Morgan, 2007). A pragmatic approach is not only taken for reasons of methodological practicality. One of its central underpinnings is the idea of solving problems through action. Dewey views the pursuit of knowledge as occurring through a process of inquiry, with research being one form of inquiry, and systematic inquiry designed to solve problems by interrogating them from multiple perspectives (Mertens, 2017). The inquiry process involves gaining knowledge by identifying an area of interest, examining beliefs through action, and the asking and answering of questions (Morgan, 2014). Inquiry is a part of what Dewey termed intelligent action, addressing societal issues through investigation, the outcomes of which can be termed 'warranted assertions' rather than knowledge. Through seeking these assertions, they can then be tested with further action to explore their potential implications for practice (Hall, 2013).

4.4.3 Taking a mixed methods approach

Mixed methods can be seen as a distinctive methodology focused on meaningful engagement with the components of inquiry (Greene, 2008). The main caveats of mixed methods research are: the use of both quantitative and qualitative methods in one study; specificity of when and how each data set will be collected and analysed; explanation of how the data sets relate to one another; and typically, a philosophical approach of pragmatism (Denscombe, 2008). The mixed methods approach lends itself to the development of a deeper and broader understanding of the phenomena of interest due to its use of both quantitative and qualitative methods, rather than a singular approach (McKim, 2017).

Mixed methods can be adopted for differing purposes. Early research into the development of a conceptual framework for mixed methods presented reasons for collecting data in this way. These include: offering triangulation of different methods; collecting complementary data to elaborate on or clarify results; develop or inform the other method; initiation of contradictory questions or results; or expansion of the phenomena of inquiry to give it greater breadth (Greene, Caracelli and Graham, 1989; Morse, 1991). These potential

justifications for researchers taking a mixed methods approach can provide confidence in research findings, development of creative data collection methods, a rich data set, exploration or integration of theories, and the discovery of contradictory findings (Johnson, Onwuegbuzie and Turner, 2007).

The mixing of data can take place at different times within a study depending on the research question. This could be done during data collection, data analysis, or interpretation of findings. The extent to which data is mixed in published mixed methods studies is variable. Though the aim is to converge evidence to produce something larger than the sum of its parts (Yin, 2006). At a minimum this involves integration of conclusions drawn from each component of study (Bazeley, 2009). When and how mixed methods study designs approach this mixing has been explored by Leech and Onwuegbuzie (2009). They propose three discreet dimensions to mixed methods design: 1) degree of mixing (fully or partially mixed), 2) time orientation (whether study phases run concurrently or sequentially), 3) emphasis of approach (whether the phases have equal or dominant status in relation to each other).

Mixed methods are particularly suited to healthcare research where they can be used to explore the complexity of phenomena (Östlund et al., 2011). Its growing use in this area is reflected in the increasing number of mixed methods research publications in the health sciences field (Ivankova and Kawamura, 2010). An exploration of Department of Health funded mixed methods studies in health services research in England found researcher's rationales for adopting a mixed methods approach were: in order to be comprehensive; to engage with the complexity of health by focusing on patient and provider voices; and to explore interventions in the often-complex environment in which they are delivered (O'Cathain, Murphy and Nicholl, 2007).

4.4.4 Overview of study design

This study used a mixed methods sequential explanatory design, employing both quantitative and qualitative methods (Teddlie and Tashakkori, 2006). This type of design comprises two phases: first the quantitative data is collected and analysed, the results of which are expanded in the second qualitative phase of data collection and analysis (Creswell et al., 2006). Figure 4.1 (overleaf) shows a visual model of the design, using formatting specific to the mixed methods approach (Schoonenboom and Johnson, 2017).

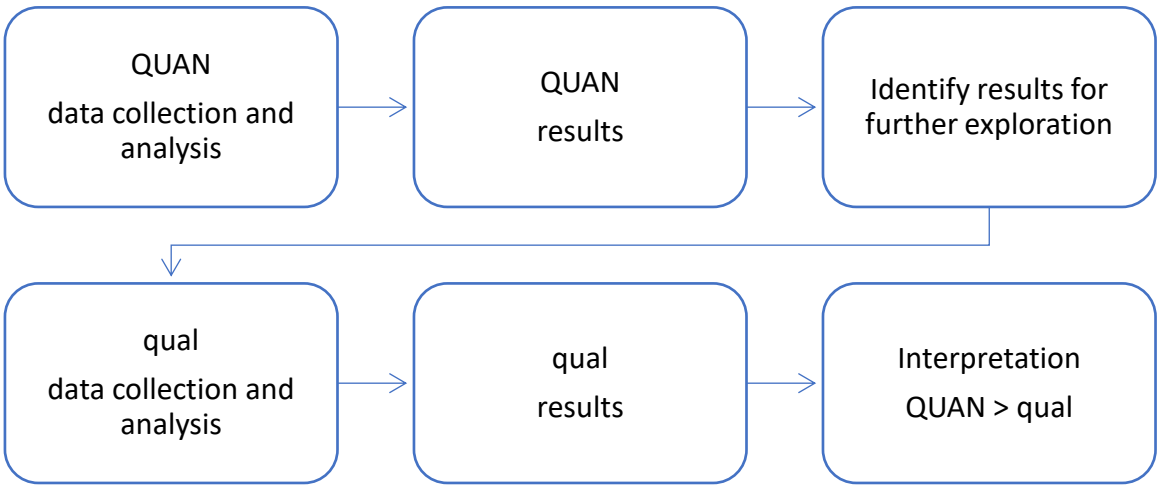

Figure 4.1 Visual model of mixed methods explanatory sequential design (adapted from Teddlie and Tashakkori, 2006).

This study comprised two phases occurring in sequence. The first used quantitative methods to establish HHOs and explore compliance data from an EMS, and the second used qualitative methods to explore HCWs perceptions and understandings of various aspects of hand hygiene practice and audit, including any impact of the COVID-19 pandemic on practice. The reason for using a sequential explanatory design was to use the second phase to further explore practice observed in the first phase. This enables a broader picture of hand hygiene behaviour to be built, with data sets being mixed at the interpretation of findings stage. The planned phases of the study are detailed in Figure 4.2 (overleaf).

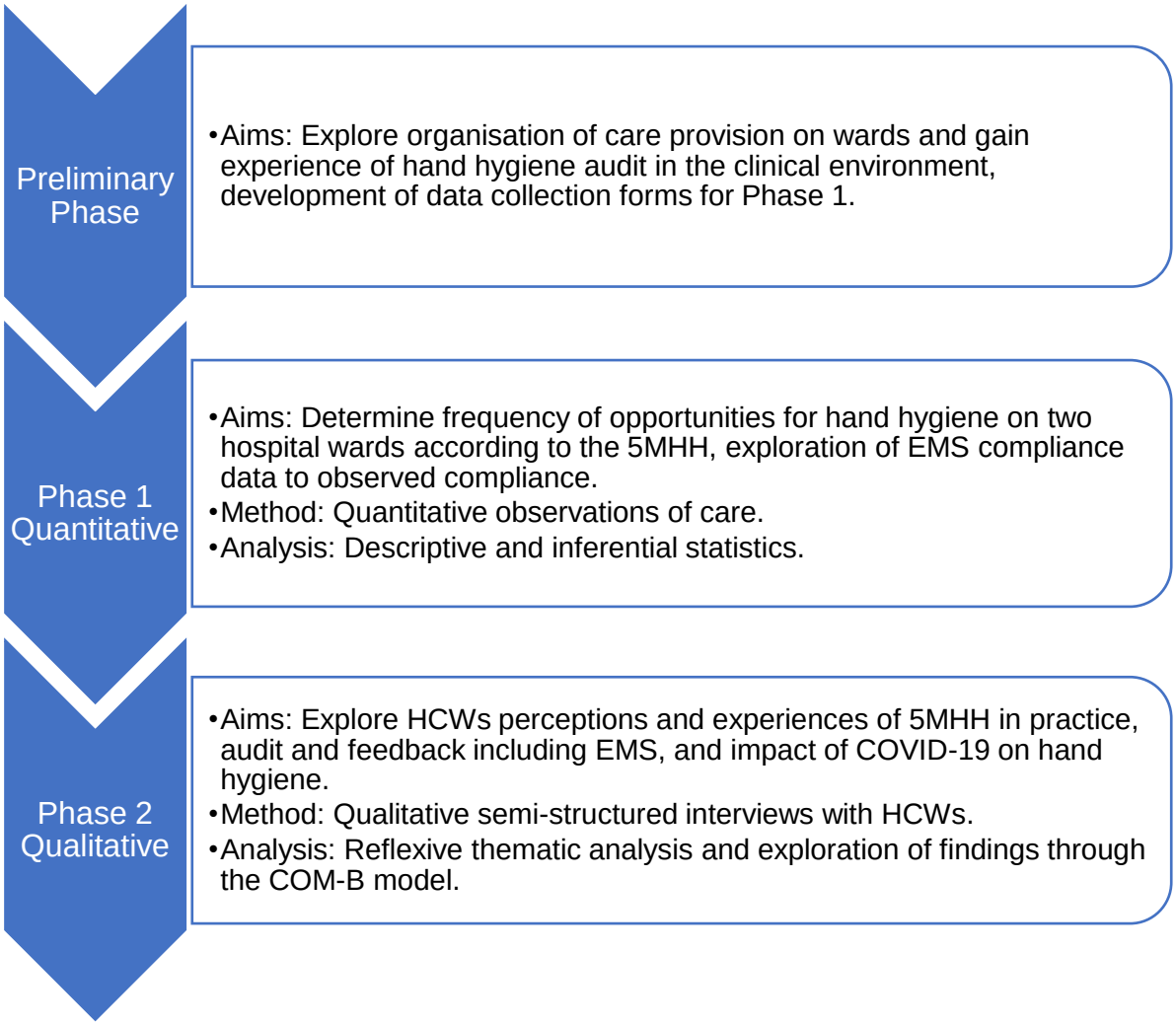

Figure 4.2 Diagram illustrating the planned phases of the study.

A preliminary phase was undertaken to gain knowledge of hand hygiene practice in the study hospital setting. This included shadowing IPC nurses (IPCNs) during hand hygiene audits which provided experience of identifying the 5MHH in clinical practice. In addition, initial observations were performed on the two study wards to discern detail around the organisation of care, and to develop and refine data collection methods.

Phase 1 of the study involved direct observational audit of HCWs on two UK hospital wards as they provided standard patient care. Detailed data was collected which captured the types of care activities performed as well as other items touched by HCWs during the workflow of activities. The resulting occurrence of opportunities for hand hygiene according to the 5MHH was then identified. From this data it was also possible to explore compliance with the 5MHH as performance of hand hygiene was also captured. This could be compared to compliance data generated by the EMS installed on the wards. Collecting data via observational methods can assist researchers in understanding behaviour within context and

informing questions to be addressed later with participants (Kawulich, 2005). This aligned with the mixed methods approach by observing hand hygiene behaviour in Phase 1 and using the findings to develop questions for HCWs about potential motivations and influences informing practice.

The development of Phase 2 was informed by observations of practice and findings from Phase 1. The second phase comprised individual semi-structured interviews with HCWs, this method allowed for the collection of in-depth perspectives of experiences, perceptions, and opinions from participants. Interviews were analysed using reflexive thematic analysis and themes then interrogated using the TDF and COM-B. These provided frameworks to identify potential factors which influenced the performance of hand hygiene behaviour.

4.4.5 Rationale for using mixed methods approach

A pragmatic mixed methods approach was appropriate to this study as it enabled investigation of hand hygiene behaviour through its active performance in the clinical setting as well as exploration of underlying factors shaping its expression through interviews with HCWs. The quantitative phase comprised observations of practice via audit of hand hygiene during patient care. This was required in order to establish an average number of HHOs on hospital wards and exploration of compliance data generated by an EMS. It was key to observe practice in the ward environment to gain insight into the situational context in which hand hygiene was performed. The qualitative phase explored the hand hygiene behaviour observed in the quantitative phase through interviews with HCWs. This was important in order to gain a deeper and more nuanced understanding of hand hygiene behaviour alongside expectations and experiences of auditing. This second phase built upon the first to create a comprehensive picture of hand hygiene practice, and it aligns with the chosen mixed methods sequential explanatory design.

4.5 Methods

4.5.1 Introduction

This section describes how data collection and analysis was performed in each phase of the study. It also describes the preliminary phase which involved initial observations on hospital wards and discussions with IPC practitioners regarding local application of the 5MHH. This informed the development of data collection forms and clarification regarding identification of the 5MHH in practice. Phase 1 aimed to establish and verify hand hygiene practice. This involved auditing staff against the 5MHH to determine the average number of HHOs. Compliance generated by an EMS installed on the wards was compared to compliance data

captured during direct observation of hand hygiene practice. Phase 2 comprised interviews with HCWs exploring their understandings and perceptions of the 5MHH in practice, the audit and feedback process, and any impact of COVID-19 on hand hygiene.

4.5.2 Preliminary phase

Hand hygiene in practice

The researcher started visiting the study site, a large NHS hospital in London, in order to become familiar with IPC practice. This involved shadowing IPCNs when they performed audits of hand hygiene, observing and identifying the 5MHH as they occur in clinical practice. Preliminary observations were conducted on both study wards to establish how care provision was organised and delivered. The researcher visited the wards with a member of the supervisory team to explore possible data collection methods. Time was then spent developing and testing data collection forms before data collection began. This preliminary phase also served as an introductory period for staff to grow accustomed to the researcher's presence on the ward.

These preliminary observations led to queries from the researcher regarding how the 5MHH were applied locally, and whether there were any local practices which differed from the 5MHH as published by the WHO (World Health Organization, 2009). A stakeholder discussion was held with ten practitioners from the hospital IPC team to explore these questions and seek consensus regarding application of the 5MHH as applied by HCWs in practice and the IPC team when auditing. During the stakeholder discussion there were some differences in the interpretation of the 5MHH amongst the IPC team. It was noted by the team that discussing the 5MHH in such detail as a group was not something they had done before, and it had raised some interesting points of debate for them. There were no official local adaptations to the 5MHH being used in the hospital. Thus, the information gained from the discussion was balanced with the WHO's 5MHH guidelines, and current literature around transmission of pathogens in the healthcare environment to clarify expected hand hygiene practices.

Preliminary observations highlighted the need to clarify the key concepts of the patient zone and healthcare zone before observations began. This was seen as important as HCWs understanding of these zones is likely to impact whether hand hygiene is recognised in the workflow and performed at the appropriate time. If these zones are not understood, HCWs risk either touching the patient after potentially contaminating their hands in the healthcare zone or contaminating the healthcare zone after touching the patient or patient zone. Preliminary observations suggested that zoning appeared to be further complicated by the

use of patient-shared equipment and portable medical equipment, such as mobile vital signs stands and COW or WOW. These portable items were often moved in and out of the patient zone by staff, and sometimes used with consecutive patients. These items were not observed to be consistently cleaned between each use and were therefore liable to be contaminated. A list was created for reference of items defined as belonging to the patient zone and healthcare zone by referring to the 5MHH guidelines and from the stakeholder discussion (Table 4.1).

Table 4.1 Categorisation of items assigned to patient zone and healthcare zone.

Patient zone	Healthcare zone
• Medical equipment remaining in the patient zone for the duration of their stay • Over-bed table and all items on over-bed table • Bedside locker • Patient chair • Infusion tubing • Patient's belongings • Bed rails and bed linen	• Patient shared equipment (e.g., commodes) • Oxygen and suction connectors (behind bedhead) • Call bell reset (behind bedhead) • Computer/workstation on wheels • Patient privacy curtains • Medical chart/patient notes • Mobile stands (e.g., vital signs equipment)

Commonly occurring practices which were observed during episodes of care were explored to achieve consistency when identifying the occurrence of each of the 5MHH. Key situations of issue which arose and were discussed with the IPC team are presented in Table 4.2 (overleaf). They are presented alongside the decision of how hand hygiene should be expected to be applied to provide clarity as to occurrence of the number of HHOs.

Table 4.2 Queries in the application of the 5MHH in practice.

Observed practice including item/care task	Description of expected practice
Patient privacy curtains *Observed practice*: Touching curtains on way into patient zone or closing curtains from inside the patient zone. Curtains pushed open to exit patient zone with same gloves used during episode of care.	*Expected practice*: The curtains are part of the healthcare zone. If before M1/M2 the bed-end dispenser should be used to cleanse hands after closing the curtain. If after M3/M4/M5 hands should be decontaminated using bed-end dispenser before opening curtain, including the removal of any gloves.
Computer on wheels *Observed practice*: The COW is often used at the patient bedside, the HCW may move directly between the patient and the COW, providing patient care and entering information on the COW. The COW may be used in one patient zone and taken directly to be used in the next patient zone. The COW is not consistently cleaned between patients.	*Expected practice*: The COW is part of the healthcare zone and should be assumed to be contaminated as frequent cleaning is not guaranteed. The HCW should clean their hands after touching the patient (M4) or patient zone (M5) and before touching the COW. The HCW should also clean their hands when moving from using the COW to touching the patient (M1).
Delivering meal trays *Observed practice*: Healthcare workers delivering meal trays to patients and not cleansing hands.	*Expected practice*: If HCWs touch any items in the patient zone, most likely to be items on the overbed table, then hand hygiene (M5) is required when leaving the zone.
Leaving and re-entering the patient zone *Observed practice*: Healthcare workers may leave the patient zone temporarily, for example to dispose of an item in the clinical waste bin and return immediately to the patient zone to continue their task.	*Expected practice*: As long as no items in the healthcare zone (including patient privacy curtains) were touched this was not counted as an opportunity (M4/M5) for hand hygiene until the episode of care was complete.

Note: M1, M2, M3, M4, M5 refer to moments 1 to 5 of the 5MHH

Electronic monitoring system

During the preliminary stage, the two wards were assessed to explore how many wall-mounted and bed-end dispensers were present in order to plan for installation of an EMS during Phase 1. The DebMed Group Monitoring System (GMS) was retrofitted into the existing DebMed wall-mounted soap and ABHR dispensers. A new style of bed-end dispensers were installed, as with the previous dispensers these hooked over the bed-end and fitted the existing bottles of ABHR which were used on the ward. A gateway hub was

installed on one ward which collected and sent dispenser usage data from both wards due, this was possible as the two wards were located closely to each other in the building.

The GMS collected data in four stages, 1) a dispenser is used which sends an activation signal to the gateway modem, 2) the gateway modem sends on these signals to DebMed via wireless internet, 3) DebMed collects dispenser activation data and converts into compliance data, 4) compliance data displayed via a dashboard at the hospital (Figure 4.3). The dashboard was not installed at the hospital during Phase 1 due to delays from the impact of COVID-19. However, the dispensers were collecting dispenser activation data on both wards during a three-month period when Phase 1 observation data collection was underway.

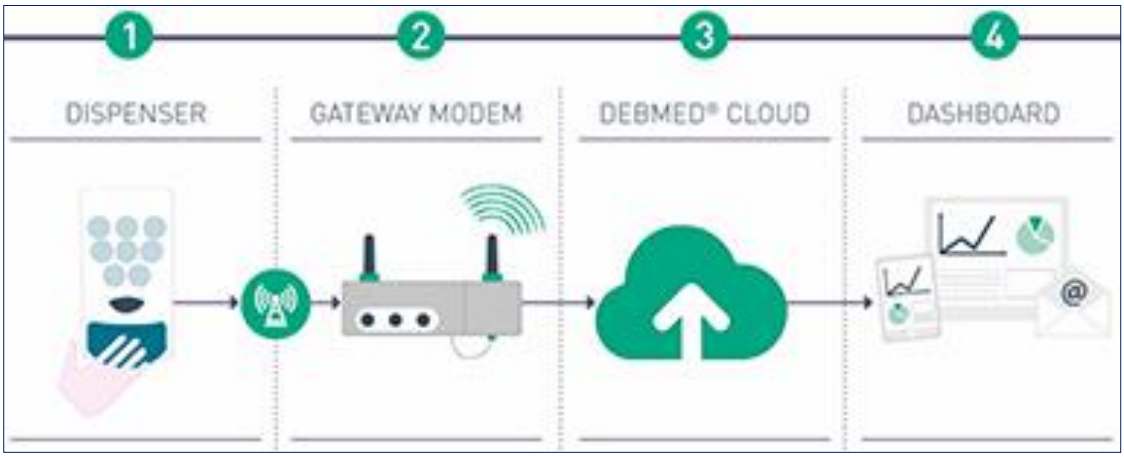

Figure 4.3 Infographic showing data journey of DebMed Group Monitoring System (Image: DebMed/SC Johnson).

The DebMed GMS was using the company's existing denominator of expected HHOs (Table 4.3). This was based on number of nurses usually on shift, and average patient occupancy for each of the wards. Published literature regarding the development of the denominator is not yet available, though it was not based on actual observed practice on UK hospital wards.

Table 4.3 DebMed GMS existing denominator data.

	Ward A	Ward B
HHOs per ward per day	1794	1596
HHOs per patient per day	69	76

The denominator used for Ward A (average occupancy of 26 patients) was 1794 HHOs per weekday and 1716 per weekend day. For Ward B (average occupancy of 21 patients) the denominator was 1596 HHOs per weekday and 1554 per weekend day. These numbers were based on the number of expected HHOs per patient per day, this was 69 (Ward A) and

76 (Ward B). This provided a denominator of expected HHOs for each hour, averaged across the day. The dispenser activations were then divided by the number of expected HHOs and calculated as a percentage compliance rate.

4.5.3 Phase 1: Hand hygiene in practice

Introduction

Phase 1 involved observation of patient care on two hospital wards to explore the average number of HHOs experienced by HCWs. The aim of these observations was to develop an expected number of HHOs on a UK hospital ward. Observations also generated a compliance rate to the 5MHH which was compared to compliance data generated by the GMS running on the wards during the same time period when observations were performed.

Sampling

This phase was similar to audit and can be seen as taking a purposeful random sample. A purposive sample was required due to the need to observe the hand hygiene practice of individuals performing particular job roles. Within this purposive sample individual HCWs were randomly chosen for observation. The HCWs observed were registered nurses working as staff nurses, and nursing assistants who are sometimes titled healthcare assistants. These roles were key to observe due to their primary role in frontline patient care provision on inpatient wards.

Setting

Observations took place on two wards within a large NHS hospital in London. Ward A was an inpatient medical ward with 28 beds, and Ward B was an inpatient surgical ward with 24 beds. The wards which participated in this study were identified by the hospital IPC team as being open to involvement in research and had engaged with other projects in the past.

Ward A

This 28-bed medical ward comprised five patient bays, two with six beds and three with four beds, and four individual patient side rooms. Average bed occupancy rate, based on the previous 12 months, was 93% (26/28) at the time of data collection. Wall-mounted ABHR dispensers were located in the corridor outside each bay, with additional dispensers outside the sluice, medication/supplies room, and at the central nurse's station. Each bay had within it a hand washing sink with hand soap dispenser, additional sinks were located at the nurse's station and in the sluice. Each patient bed space had a point-of-care bed-end dispenser which clipped onto the bedrail at the foot of the bed, this contained a 400ml bottle of ABHR.

During the day shift (07:30 to 20:00) there were usually 7 registered nurses and 3 nursing assistants working, and during the night shift (19:30 to 08:00) there were usually 4 registered nurses and 2 nursing assistants. On each shift one registered nurse was allocated as the nurse in charge. All HCWs on shift were allocated to work in specific bays for their shift. This allocation was communicated at shift handover which took place for the day shift at 07:30 and for the night shift 19:30. Allocations were also written on the ward board; this was a large whiteboard divided by bays and bed numbers displaying patient information and with HCWs names next to the bays to which they were assigned.

Ward B

This 24-bed surgical ward comprised four bays, two with six beds and two with four beds, and four individual patient side rooms. Average bed occupancy rate, based on the previous 12 months, was 88% (21/24) at the time of data collection. The ABHR dispenser and handwashing sink layout was the same as in Ward A. During the day shift (07:30 to 20:00) there were usually 6 registered nurses and 3 nursing assistants working, and during the night shift (19:30 to 08:00) there were usually 4 registered nurses and 2 nursing assistants. On each shift one registered nurse (RN) was allocated as the nurse in charge. Healthcare workers were allocated to work covering specific bed numbers for their shift. Communication of this information was the same as in Ward A, during shift handover and on the ward board.

Ward A and Ward B

On both wards safe staffing levels were calculated according to staff skill mix and number of patients. Each ward had a ward manager, who was a RN, who worked 07:00 to 18:00. At certain times of year registered nurses were allocated a student nurse to work alongside them for the shift. Student nurses were supernumerary and as such were not included in the Trust's safe staffing numbers, therefore they were not included in observations as their numbers fluctuated across the year.

Both wards had a kitchenette with a catering assistant serving meals and drinks. Breakfast was served at 08:00, with lunch at 12:00, and dinner at 17:30. Visiting hours ran from 14:00 to 19:00 (Ward A) and 14:00 to 20:00 (Ward B). Staff breaks were staggered to ensure sufficient staff on duty at all times. Day shift included two break times for staff, one in the morning and one in the afternoon. Night shift included two breaks though often these were combined by staff into one longer break. During the day shift a huddle occurred once a day at around 13:00, at this time staff provided any important patient updates, received key Trust

messaging, and occasionally outside visitors attended to lead discussion around a particular patient care topic.

Hand hygiene audits were normally performed monthly on the wards by the IPC team via direct observation of practice. This involved generation of a compliance rate based on ten opportunities for hand hygiene which were observed, and detail captured on compliance. The ten HHOs were captured individually meaning a whole sequence of care was not observed and the moments were viewed in isolation.

Inclusion and exclusion criteria

Those included in the observations of care were registered nurses and nursing assistants who were permanent staff members. Agency workers were excluded as they may not have received in-house hand hygiene training from the organisation. Trainees such as student nurses or student nursing associates were also excluded as they were. The nurse in charge was excluded from observation due to differing workload but was included in number of staff on shift.

Ethical considerations

Ethical approval for Phase 1 was received from the UWL College of Nursing, Midwifery and Healthcare Research Ethics Committee (UWL/REC/CNMH-00517) (Appendix 5). The researcher secured an honorary contract with the NHS Trust. As observations consisted of standard care provision by HCWs with no change to, or impact on, patient care this was considered as clinical audit by the host hospital. The director of IPC at the hospital registered this phase of the project on the hospital's internal audit system. As HCWs are expected as part of their professional role to regularly have their practice observed as part of audit processes, written consent was not required from ward staff.

An information sheet was created which was displayed in the staff rooms on the two study wards (Appendix 6). The researcher attended staff huddles with an IPCN to discuss the study and aims of the observations which was to observe hand hygiene and the frequency of the occurrence of HHOs according to the 5MHH. Staff were reminded that the purpose of observations was not to monitor individual staff performance or provide feedback about hand hygiene practice. If any practice was observed which was concerning, the researcher informed the IPCN assigned to the ward to follow-up. No information was collected which would allow for identification of individual HCWs, only job role was recorded. No patient information was captured and care behind patient privacy curtains or doors was not observed.

Data collection

Observations of care provision were performed by the doctoral researcher. The researcher had previous experience of observing care provision in a nursing care home setting. The preliminary phase of this study further familiarised the researcher with the specific skills needed to observe hand hygiene practice in the hospital ward setting.

A data collection form was developed during the preliminary phase (Appendix 7). Two forms were piloted and further revised as they did not capture sufficient detail. In order to capture the detail required, an open data capture form was developed. This allowed for detail to be recorded regarding each successive contact made by HCWs during care provision, in the order which they occurred. It was important to capture entire episodes of care as opposed to individual stand-alone HHOs, therefore all successive contacts which occurred during a care activity were observed and recorded. Thus, individual HCWs were observed rather than observation of an individual patient bed space or bay. This ensured HHOs were captured as HCWs moved around the ward.

The form prompted recording of general information from the observation period including shift type (day/night), number of staff on shift, number of patients presently admitted on the ward, and space for any field notes. Other staff activities also recorded on the form included the performance of hand hygiene and glove usage. Glove usage was seen as a potentially important aspect of practice to capture due to its potential impact on hand hygiene performance. Although gloves are indicated for use for some care tasks they are often used when not indicated. The wearing of gloves does not mean hand hygiene can be omitted, thus when gloves were worn the identification of the 5MHH in the workflow was the same as if the HCW was not wearing gloves. The occurrence of a HHO whilst wearing gloves would require the HCW to take off their gloves, perform hand hygiene, and don new gloves if required.

From the data collection form, the type of hand hygiene indication and number of HHOs could be identified in the recorded workflow. This identification was performed either whilst collecting data or following the end of the data collection period. Where two indications for hand hygiene coincided the initial indication type was coded as the HHO as recommended by the WHO (World Health Organization, 2009).

Hourly observation periods were chosen to establish an average number of HHOs for each hour of the day. An observation timetable was designed to cover 24-hours of the day, with

the aim of observing each hour on three separate occasions. Day shift observations took place for a minimum of 1 hour and maximum of 2 hours in succession. A maximum 2 hours of observation was determined to avoid observer fatigue (Stone et al., 2012). Night shift observations took place for a minimum of 1 hour and maximum of 6 hours. This was due to practical issues of site access and travel during the night hours. Observer fatigue was avoided due to the lower levels of HCW activity during the night shift.

The job roles focused upon for observation were registered nurses and nursing assistants. Staff members were randomly chosen for observation based on the order in which they were listed on the ward board, with a focus upon one job role for each hour of observation. Each individual HCW was observed for a 15-minute period, resulting in four expected staff observation periods per hour. This was done to achieve an overview of work on the ward and cause as little impact as possible on normal working practice. It was also important to observe different staff to provide an overview of care delivery as performed on each ward which took into account potential difference in individual ways of working. If a staff member was in the middle of providing patient care after 15 minutes the observation continued until that activity was completed, in order to capture the whole sequence of care.

If it was not possible to locate a member of staff, for example if they were providing care behind patient privacy curtains, were on break, or attending training then the next staff member listed on the ward board was observed. On occasions where staff break times, or attendance to training, resulted in fewer staff being on the ward this sometimes resulted in a single member of staff being observed for longer than the 15-minute period as there were no other staff to observe. This observation continued until another member of staff returned and could be observed. Therefore, there could be fewer than four staff observation periods an hour due to reduced staff presence. There could also be more than four staff observation periods if a staff member already under observation left the ward during their observation period, for example to go on break, if this occurred another staff member was observed.

Staff were observed regardless of whether they were carrying out direct patient care at the time of observation. This ensured the reality of care delivery was captured, including periods of low activity and non-patient related activity. This avoided overestimation of HHOs and provided a more representative view of care provision. If care was delivered behind closed patient privacy curtains or in a closed side room the observer queried with the staff member what tasks they had performed following their completion. From this an approximation of HHOs was made based on the type of tasks performed.

If a bay was closed due to an infection outbreak, then staff assigned to that bay were excluded from observations due to increased contact precautions as this was not reflective of standard care. Observations were paused if HCWs were involved with assisting in emergency medical treatment, such as a cardiac arrest, as this was also not reflective of standard care (World Health Organization, 2009).

The DebMed GMS was installed on both wards during Phase 1 data collection. Across the two wards the system comprised 103 dispensers (24 wall-mounted soap dispensers, 20 wall-mounted ABHR dispensers, 56 bed-end ABHR dispensers) which constantly collected data on the number of dispenser activations. There was no change in workflow required by HCWs after installation of the GMS, the only noticeable change was the different appearance of the bed-end dispensers. Staff were asked to ensure the bed-end dispensers were kept on the ward as they were susceptible to being left on the bed-end when a patient was being transferred, this message was reinforced with posters on the exit doors and verbal reminders from the researcher.

Data analysis

Data exploring hand hygiene indications, opportunities for hand hygiene, type of indication, glove use, and compliance with hand hygiene were summarised using descriptive statistics to generate frequencies, percentages, and means. An average number of HHOs was generated per hour per job role, across shifts, and across 24-hours of the day. This informed the development of the number of HHOs per patient per day.

Potential differences in these variables were explored where appropriate focusing on differences between job roles, ward, shift type, and indication type according to the 5MHH. Contingency tables were used to explore potential relationships between variables. To examine any associations between variables a chi-square test was performed where appropriate. A *p-value* of ≤ 0.05 was considered statistically significant.

Due to the detailed nature of the data collected it was possible to analyse HCWs adherence to the observed HHOs. An opportunity for hand hygiene was fulfilled either by hand washing or use of ABHR at the correct time in the workflow as indicated by the 5MHH. Compliance with the observed HHOs is presented in frequencies and percentages with 95% confidence intervals. The compliance data as reported by the GMS is explored and presented in frequencies and percentages.

It was also possible to explore the occurrence of the performance of hand hygiene when it was not related to an opportunity. These non-indicated hand hygiene events were the times when hand hygiene was performed but no indication from the 5MHH could be identified in the workflow. Activity in the recorded workflow was explored to look for potential motivations for staff cleansing their hands at these non-indicated moments, these are presented as frequencies and percentages.

Exploration of any differences in compliance with hand hygiene and use of gloves focused on the time period before and after the COVID-19 pandemic. Data were classified as occurring during COVID-19 from observations performed following the time of the first case of COVID-19 detected in the UK, this being the week commencing 27th January 2020 (Moss et al., 2020). By this point there was already an increased focus on IPC in relation to COVID-19, with Public Health England releasing guidance for healthcare settings in January 2020 (Public Health England, 2020). At the end of January 2020, a Level 4 National Incident was declared by NHS England and Improvement, the highest stage of emergency alert and an initial step in mounting the COVID-19 response (The Health Foundation, 2022).

4.5.4 Phase 2: Healthcare workers experiences and perceptions of hand hygiene

Introduction

Phase 2 explored HCWs experiences of hand hygiene and systems of auditing in clinical practice. It explored the understanding and application of the 5MHH in clinical practice, audit and feedback including perceptions of EMSs, and impact of COVID-19 upon hand hygiene behaviour. This phase was informed by findings from the first, with the aim being to further explore hand hygiene as it is applied in practice.

Sampling and recruitment

A non-probabilistic purposive sample of students working in relevant roles was recruited via UWL. The students recruited had experience of working as registered nurses, IPCNs, or nursing assistants. A purposive sample was sought due to the need to recruit individuals with the relevant professional experience. The supervisory team assisted in identifying potential participants and cohorts. Participants were recruited by sharing information about the study via the recruitment poster, announcements in classes (online and in-person), the UWL student union society of nursing, midwifery and healthcare, and emails sent via course leaders. This allowed students to volunteer participation through initiating contact with the researcher with the aim of avoiding any feeling of pressure to participate.

To encourage sufficient numbers of participants the offer of a £10 Amazon voucher was included following the first month of recruitment activity. An amendment regarding this was submitted to the UWL CNMH REC, which was approved. Both the participant information sheet and consent form were changed to reflect that a £10 Amazon voucher would be sent to participants following successful participation in an interview. This incentive did not impact participation being voluntary and the requirement of provision of consent to take part in the research. The incentive acted as compensation for the time commitment which was required for the interview. This incentive was provided retrospectively for those who had already completed an interview and they were sent the £10 voucher via email.

The aim was to recruit around 5 to 6 participants per job role, for a total of between 15 and 18 participants. This number is suggested as sufficient by Terry et al. (2017) in that it generates a range of accounts whilst remaining manageable. The occurrence of data saturation also guided participant numbers, this can be seen to be achieved when no more novel themes in the data are generated (Braun et al., 2019).

Ethical considerations

As outlined in Chapter 4, Section 4.3, the recruitment of HCWs in Phase 2 was affected by the COVID-19 pandemic and ensuing restrictions which impacted access to the host hospital. Therefore, a minor amendment to ethical approval was submitted to the UWL CNMH REC. This included a change to recruiting students from UWL CNMH who were qualified in the relevant roles and also included the offer of an incentive for participation (a £10 gift voucher). Approval for this amendment was received (UWL/REC/CNMH-00884) (Appendix 8).

A participant information sheet was provided to potential participants to give them time to decide if they would like to participate in the study (Appendix 9). Written informed consent was obtained from participants, with a signed copy of the consent form given to each participant for their records and one copy kept by the researcher (Appendix 10). It was important that participants were informed they could withdraw their consent at any time, without having to provide a reason and leave the study.

Participants' contact details were collected only in order to manage their participation in the research, these details were deleted once the study was completed and summary of the research findings shared. Participants were asked to provide general demographic information and professional characteristics (e.g., job role, length of time in role), this data was treated as confidential. Electronic files were stored on a secure OneDrive platform

hosted by UWL, accessible only via password protected computers. Any electronic folders or documents containing personal data were password protected. Research data containing personal information is held on the UWL system for 5 years for audit purposes before being deleted.

Participants were reminded at the beginning of the interview that if they did not want to answer a particular question, they could ask for the interviewer to move on to the next question. Due to its potential impact on hand hygiene behaviour questions regarding the COVID-19 pandemic were included in the question schedules. When this section of interview commenced, participants were asked if they were happy to discuss the topic of COVID-19 before proceeding in case they had experienced any distress during this time and would prefer not to discuss the topic.

In order to protect participant's identities, during transcription of interviews all identifying information (e.g., names and locations) were removed and participant codes used. Participants were informed that the data they provided in the interview would be analysed to establish themes within their experiences and presented in a doctoral thesis and academic papers for publication, including the use of anonymised quotations.

Data collection

Once informed consent was obtained, participants took part in semi-structured one-to-one interviews with the researcher. These were conducted virtually via Microsoft Teams or Zoom. Use of video conferencing was necessary due to the impact of the COVID-19 pandemic in terms of social distancing and the clinical workload of participants. The use of an alternative to face-to-face interviews is not novel in qualitative research, with telephone interviews, email, and instant messaging being utilised (Gray et al., 2020). Moving on from these technologies, video conferencing platforms allow for video and audio to be used synchronously which helps to build rapport between interviewer and participant. Collecting data via video conferencing has become a key data collection tool since the COVID-19 pandemic and can be more convenient and accessible for participants, with no travelling required meaning participation involves less of a time commitment (Gray et al., 2020).

Use of individual semi-structured interviews was used to elicit in-depth perspectives from participants. Two question schedules were developed which were informed by hand hygiene practice observed in Phase 1. One question schedule was designed for registered nurses and nursing assistants (Appendix 11) and another for IPCNs (Appendix 12), this was due to the differing duties these roles entail. Topics covered included understanding of the 5MHH in

practice, experience and perceptions of audit including EMSs, and any impact of COVID-19 upon hand hygiene practice.

The TDF was used to develop the question schedules by including questions which related to its 14 domains. The importance of including a framework of behaviour change theory when exploring clinical practice was emphasised in the scoping review (Chapter 3, Section 3.3). Of particular note was the Dyson et al. (2011) paper which found that using a questionnaire informed by the TDF elicited discussion of more potential influences upon hand hygiene behaviour than one which used questions based only on previous literature. It was therefore important to design the question schedules in relation to the TDF domains.

Data analysis

Interviews were recorded on a Dictaphone (Sony ICD-PX370) and transcribed verbatim by the researcher. Transcripts were imported into NVivo 12 computer software to manage data analysis. Data was analysed using reflexive thematic analysis (RTA) (Braun et al., 2019). Thematic analysis is frequently used to explore participants lived experience. It can also be utilised to explore "*factors that influence, underpin, or contextualize particular processes or phenomena*" [p.850] (Braun et al., 2019). Thematic analysis is not bound to a particular theoretical position as is the case with other approaches such as interpretative phenomenological analysis or grounded theory. This means it is flexible in its application and is appropriate for use within the qualitative phase of a pragmatic mixed methods study.

Although not tied to a particular theoretical framework, analysis is performed in a methodical way (Braun and Clarke, 2006; Braun et al., 2019). It is suitable for conducting analysis across a data set, facilitating summarisation of a range of responses (Braun et al., 2019). It is also recognised that RTA is an iterative process, which involves continually revisiting the data and developing themes which reflect shared meanings within the participants experiences. Reflexive thematic analysis recognises the role of the researcher in analysing data, themes are not there to emerge they are generated by the researcher as the outcome of their analysis (Braun and Clarke, 2019).

Braun and Clarke propose a six-stage approach to analysis, they also place emphasis upon the iterative nature of these steps, analysis is unlikely to be linear (Braun and Clarke, 2006; Braun et al., 2019). To ensure rigour certain strategies can be applied in practice at each stage of analysis, Table 4.4 (overleaf) describes each stage of RTA alongside strategies suggested by Nowell et al. (2017) to establish trustworthiness.

Table 4.4 Phases of Reflexive Thematic Analysis, and what can be done to demonstrate rigour. Based on (Braun and Clarke, 2006; Nowell et al., 2017; Braun et al., 2019).

Phases of RTA	What is involved in analysis	Establishing trustworthiness
Familiarization	Focus on becoming immersed in the data, reading and re-reading transcripts. Engage with the data, making casual notes about interesting features both in individual transcripts and across the data set.	Prolonged engagement with data; document thoughts about potential codes; keep records of all data field notes, transcripts, and reflexive journals; store data in well organised way.
Generating codes	Engagement becomes more systematic, exploring meaning in the data. Labelling chunks of text with codes which may be inductive (starting from the data), or deductive (importing ideas and concepts from outside of the data). Codes may be semantic (at a surface level, staying close to the words used by participants) or latent (a deeper or conceptual level of meaning).	Peer debriefing; reflexive journaling; audit trail of code generation; documentation of team meetings and peer debriefings.
Constructing themes	The creation of broader themes from the codes, collating relevant codes into overarching themes. Explore relationships between codes and themes.	Keep detailed notes about development and hierarchies of concepts and themes; diagramming to make sense of theme connections; researcher triangulation.
Revising themes	Ensure themes clearly and concisely capture what is meaningful in the data. Some themes may merge, some may be divided into further separate themes.	Researcher triangulation; test for referential adequacy by returning to raw data; themes and subthemes vetted by team members.
Defining themes	Explore the essence of the themes, ensure they are organised coherently and that each theme tells a story. Refine the names of the themes, keeping them concise and meaningful.	Researcher triangulation; peer debriefing; team consensus; documentation of team meetings regarding themes.
Producing the report	Can continue to be a time for tweaking and revising themes. A time to be aware of how the themes flow as a story of the data analysed, aiming to keep it logical and interesting.	Member checking; peer debriefing; describing process of coding and analysis in sufficient detail; thick descriptions of context; description of the audit trail; report on reasons for theoretical, methodological, and analytical choices throughout study.

Following use of RTA for each individual interview, themes were developed which encompassed experiences across the participants. Not all themes were demonstrated by all participants. The findings from Phase 1 and Phase 2 were then brought together and further explored under the elements of the COM-B model. This was done to explore the potential underlying motivations and influences upon hand hygiene behaviour. Thus, the COM-B provided a structure for which to further interrogate the data and organise the findings.

4.6 Chapter summary

This study aims to develop an average number of opportunities for hand hygiene on UK hospital wards and explore compliance data generated by an EMS when compared to observed practice. It also aims to explore HCWs perceptions of the 5MHH in practice, audit and feedback, and impact of COVID-19 upon hand hygiene. This chapter has described the research approach and philosophical grounding of the study. The choice of a mixed methods methodology aligns with the pragmatic approach required to investigate the research question. Both the quantitative and qualitative approaches to data collection and analysis have been described, including ethical considerations. The choice of using both quantitative observations of practice and qualitative interviews is appropriate as it provides the insight required to answer the research question. The following chapter presents findings from Phase 1, the quantitative component of the study.

Chapter 5 Phase 1 results: Hand hygiene in practice

5.1 Chapter overview

This chapter presents the findings of Phase 1 of the study, the quantitative element. Key to the development or calibration of a counter-based EMS is to establish what hand hygiene activity would be expected on a ward to generate compliance rates which accurately reflect the 5MHH in practice. This chapter presents the average number of HHOs for HCWs determined from observations of standard care practice on two UK hospital wards. Observed compliance with HHOs, and compliance as reported by an EMS installed on the wards during data collection is also explored. A brief overview of the methodology is provided, followed by results from observations. Finally key findings and implications with reference to existing literature are then discussed.

5.2 Methods

5.2.1 Summary of the methodology

The methodology for this phase of the study has been described in Chapter 4, Section 4.5.3. Direct observations of frontline patient care provided by registered nurses and nursing assistants were performed on two inpatient wards during 2019 and 2020. Ethical approval was provided by the UWL CNMH REC and relevant local approvals were in place before observations began. Data capture included the types of tasks performed by registered nurses and nursing assistants, from this the occurrence of opportunities according to the 5MHH were identified in the workflow. During 2019 and early 2020 the DebMed GMS counter-based monitoring system was also installed and functional on the wards.

5.2.2 Setting

Phase 1 took place in a large NHS teaching hospital in London which provides a wide range of secondary and tertiary health care services. Observations were conducted on two inpatient wards, Ward A (medical specialty) and Ward B (surgical specialty). Ward A comprised 28 beds with 93% (26/28) average occupancy, and Ward B comprised 24 beds with 88% (21/24) average occupancy based on the previous 12 months.

5.2.3 Participants

Participants were HCWs present on the ward at the time of each observation period. Due to their role in frontline patient care the HCW roles observed were registered nurses and nursing assistants. Participants were randomly selected for observation based upon the order they were assigned to bays or beds as listed on the ward board. This board listed each HCWs patient care duties for the shift by allocating them to specific bays or bed numbers.

No personal identifying information was collected, only the job role of the HCW under observation. No patient details were collected. The researcher spent several weeks during the preliminary phase of the research conducting general observations on the wards to gain insight into the day-to-day running of the wards. This also helped ward staff become comfortable with the researcher's presence before data collection began.

5.3 Results

Data collection was conducted between June 2019 and September 2020. Due to the COVID-19 pandemic there was a period of six months between March 2020 and August 2020 where data collection was paused as the hospital was open only to essential staff. Upon resumption of data collection in August 2020 it was possible only to collect night shift data on Ward A. Therefore, the majority of night shift data was collected only on one ward and following the first wave of the COVID-19 pandemic. A total of 187 hours of observations took place, 144 on Ward A and 43 on Ward B. Of these 115 hours were during the day shift (Ward A 72 hours; Ward B 43 hours) and 72 hours during the night shift (Ward A).

The total number of individual staff observation periods was 739 (Table 5.1). These were periods during which the hand hygiene activity of an individual HCW was observed. Observations were designed with the aim of observing four HCWs an hour, with individuals observed for a 15-minute period. A mean of four HCWs (minimum 1; maximum 7) were observed per hour across the day shift and night shift.

Table 5.1 Number of staff observation periods by job role, ward, and shift type.

	Ward A Day shift	**Ward B Day shift**	**Ward A Night shift**	**Total**
Registered nurses	146	53	145	344
Nursing assistants	146	113	136	395
Total	292	166	281	739

5.3.1 Indications and opportunities for hand hygiene

The total number of observed indications for hand hygiene across both wards was 1629, with 1567 opportunities for hand hygiene. Thus, there were 62 times when two indications for hand hygiene coincided. At these times one hand hygiene event would fulfil the prevention of potential cross-contamination for both indications. The most common coinciding moments were a moment 4 followed by a moment 1 which accounted for 37/62 (60%) of coinciding indications Table 5.2 (overleaf). This situation would likely arise when a

HCW leaves a patient zone after having touched the patient and then moves into another patient zone and touches that patient.

Table 5.2 Number and type of coinciding indications for hand hygiene.

		Indication following the HHO		Total
		Moment 1	Moment 2	
Indication categorised as the HHO	Moment 3	7	7	14
	Moment 4	37	3	40
	Moment 5	7	1	8
	Total	51	11	62

5.3.2 Number and type of hand hygiene opportunities

An overall total of 1567 opportunities for hand hygiene were observed, this comprised 1095 (70%) on Ward A (733 during day shift; 362 during night shift) and 472 (30%) on Ward B (day shift only). There were significantly more HHOs observed during the day shift than the night shift (p = <.001). A breakdown of total HHOs including both registered nurses and nursing assistants by ward, shift, and type of moment according to the 5MHH is detailed in Figure 5.1.

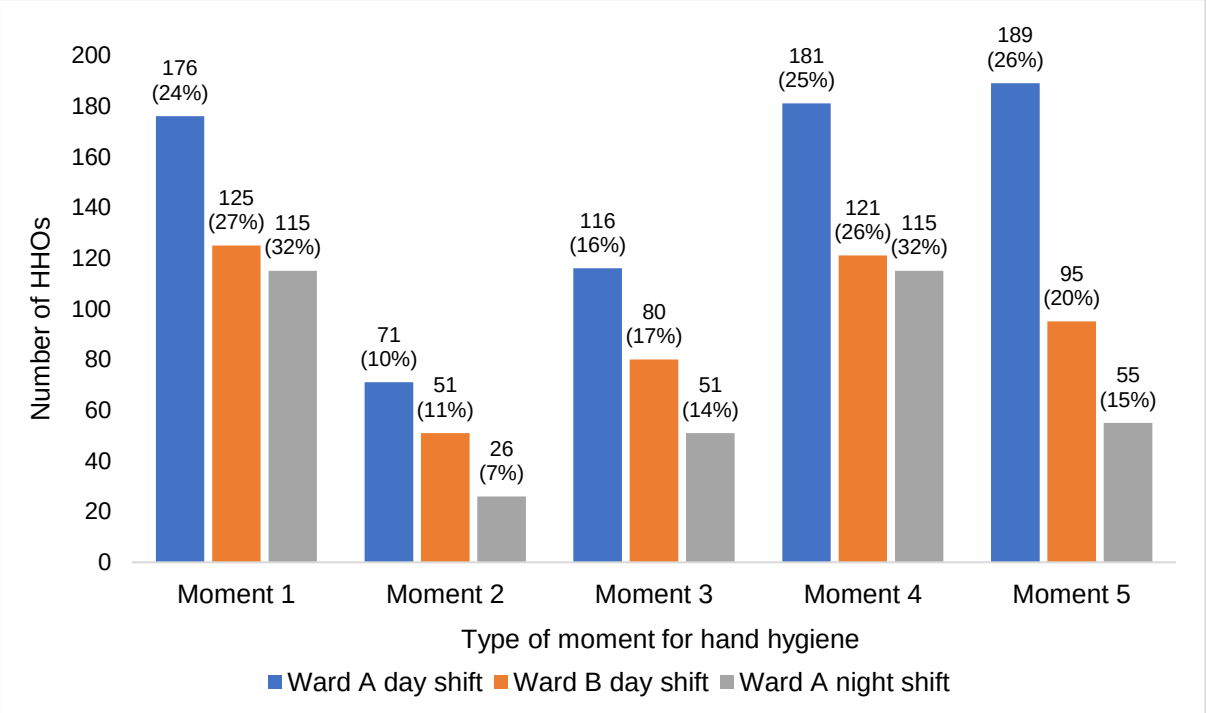

Figure 5.1 Overall number of HHOs (% within ward/shift) observed by ward and moment type.

5.3.2.1 HHOs during the day shift

A total of 1205 HHOs occurred during the day shift across both wards, based on 115 hours of observation. As the number of HHOs was not significantly different (p = .578) the data from Ward A and B was combined. The total number of observed HHOs as distributed across each hour of the day shift, including moment type, is presented in Figure 5.2.

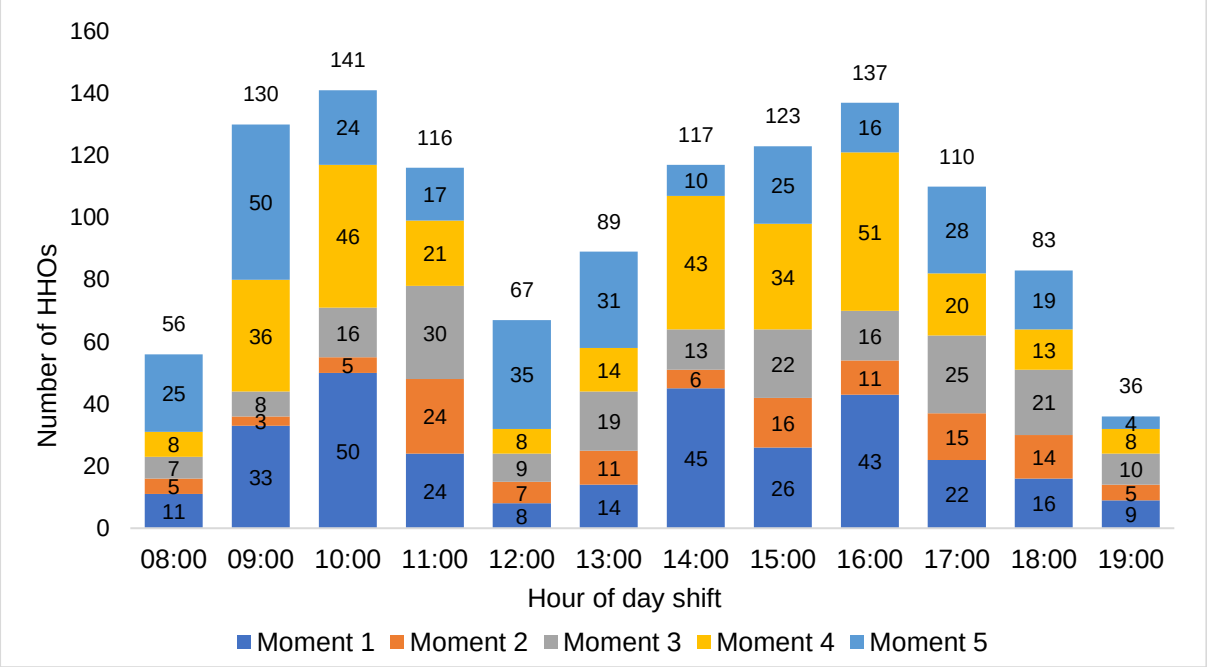

Figure 5.2 Total number of observed HHOs for each hour of the day shift including moment type (Ward A and B combined).

The majority of HHOs occurred during the hours where concentrated direct patient care was provided. This is evident at 09:00 to 11:00 and 15:00 to 17:00 when registered nurses perform medication rounds. At these times nursing assistants tended to take observations of patient's vital signs and assist patients with personal care such as washing and dressing. Times of lower HHOs at 08:00 and 19:00 are when staff are handing over to the next shift. They are also lower around 12:00 which is when lunch was served, this involved less patient contact as HCWs tended to touch only the patient zone when delivering meal trays which mainly resulted in occurrence of moment 5.

It was noted in field notes that patient-shared equipment and portable medical equipment was used often during medication rounds and patient observations (e.g., observation trolley, COW). As these items were not consistently cleaned between uses, they were presumed to be a source of potential contamination. When used at the patient bedside HCWs often moved their hands from the equipment to the patient and back which created multiple HHOs, particularly moment 1 and moment 4.

5.3.2.2 HHOs by role during the day shift

When looking at the total number of HHOs across staff roles, nursing assistants experienced almost two-thirds of the observed HHOs (65%, 1018/1567) when compared to registered nurses (35%, 549/1567). The burden of HHOs across the day shift based on job role was explored. The total number of observed HHOs was 430 (36%, 430/1205) for registered nurses and 775 (64%, 775/1205) for nursing assistants. A series of chi-square tests for independence (with Yates' continuity correction) were performed to examine the relationship between the distribution of each moment as related to job role (Table 5.3). Overall nursing assistants experienced significantly more HHOs than registered nurses (p = <.001, phi = .254). Moment 1 through to moment 4 all had a significant relationship to job role.

Table 5.3 Total number of HHOs during day shift experienced by moment type and job role.

	Total number of observed HHOs			
	Registered nurses	**Nursing assistants**	**Total**	***p-value***
Moment 1	75	226	301	<.001
Moment 2	74	48	122	<.001
Moment 3	96	100	196	<.001
Moment 4	77	225	302	<.001
Moment 5	108	176	284	.383
Total	430	775	1205	<.001

Figure 5.3 (overleaf) shows a graph reporting the number and percent proportion of HHOs for each job role, shown by type of moment. When looking at the types of HHOs which occurred, 81% (627/775) of nursing assistants HHOs comprised moments 1, 4 and 5. Whereas the occurrence of moments for registered nurses was more evenly distributed within their role.

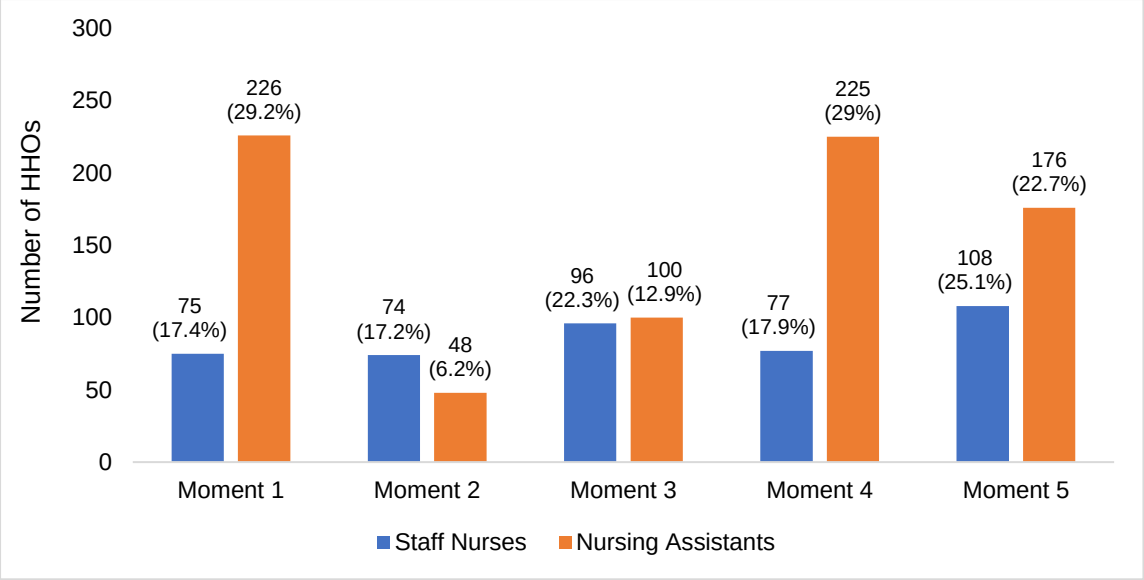

Figure 5.3 Total number (% within job role) of observed HHOs during day shift by moment type and job role.

The occurrence of the different types of moments can be seen to be largely reflective of the types of patient care tasks provided by the differing roles (Table 5.4). With nursing assistants interacting with patients or the patient zone mainly during tasks such as performing observations of vital signs, repositioning patients, and assisting with personal care. These tasks tend to generate the occurrence of moment 1 and moment 4. The number of times moment 3 occurred was similar across both staff groups, though proportionally more for registered nurses. This indicates both groups experienced potential exposure to bodily fluids, albeit by performing different types of patient care tasks.

Table 5.4 Commonly observed patient care tasks by staff role.

Registered nurses	Nursing assistants
Administering IV medication	Blood glucose monitoring
Cannula insertion/removal	Changing bed linen
Dressing changes	Changing patient incontinence pads
Emptying drains/catheters	Washing patients
Nasogastric tube feeding	Providing meals and drinks
Oxygen administration	Repositioning patients
Preparing/dispensing medication	Taking patient vital signs observations
Taking patient vital signs observations	Disposing of fluids (commodes/urinal bottles)
Tracheostomy suctioning	

5.3.2.3 HHOs during the night shift

A total of 362 HHOs occurred during the night shift, with 72 hours of observation undertaken on Ward A only. The occurrence of the total number of observed HHOs across the night shift is presented in Figure 5.4.

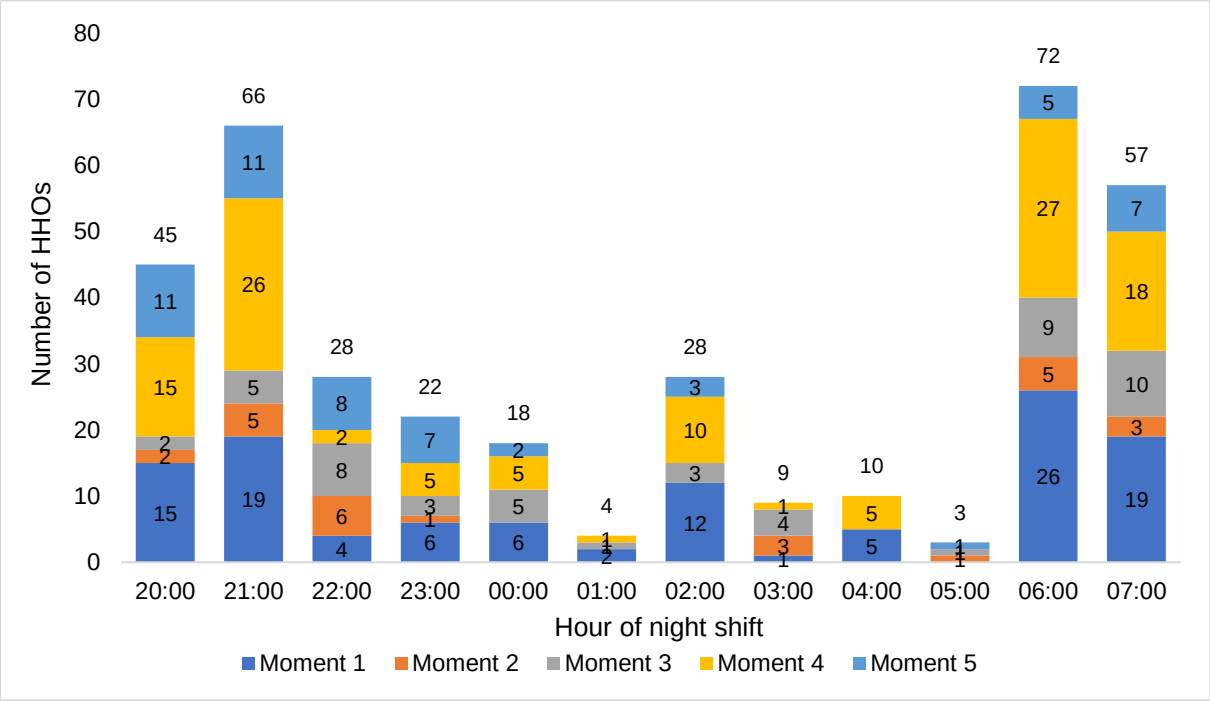

Figure 5.4 Total number of observed HHOs for each hour of the night shift including moment type (Ward A).

The overall lower number of HHOs during the night shift reflects the lower activity levels on the ward. The hourly number of HHOs was highest following shift handover between 20:00 and 22:00 and before the next shift arrival and handover between 06:00 and 08:00. This also reflected registered nurses performing the medication rounds at 21:00 and 06:00, as well as nursing assistants performing observations of vital signs. During the night-time hours of 00:00 and 05:00 activities decreased as patients were more likely to be asleep. At 2am there was a slight increase in HHOs, this was mainly due to nursing assistants performing observations of vital signs.

5.3.2.4 HHOs by role during the night shift

The burden of HHOs across the night shift based on job role was explored. The total number of observed HHOs was 119 (33%, 119/362) for registered nurses and 243 (67%, 243/362) for nursing assistants. A series of chi-square tests for independence (with Yates' continuity correction) were performed to examine the relationship between the distribution of each moment as related to job role (Table 5.5, overleaf). Overall, as with the day shift, nursing

assistants experienced significantly more HHOs than registered nurses during the night shift (p = <.001, phi = .348). Occurrence of moments 1, 2, 4, and 5 all had a significant relationship to job role.

Table 5.5 Total number of HHOs during night shift experienced by moment type and job role.

	Total number of observed HHOs			
	Registered nurses	**Nursing assistants**	**Total**	***p-value***
Moment 1	26	89	115	.007
Moment 2	14	12	26	.032
Moment 3	18	33	51	.813
Moment 4	25	90	115	.003
Moment 5	36	19	55	<.001
Total	119	243	360	<.001

Figure 5.5 shows a graph reporting the number and percent proportion of HHOs for each job role, shown by type of moment. Within the nursing assistant role, most moments were either moment 1 or 4, these accounted for 74% of all moments. As with the day shift, the proportion of moment types for registered nurses was more evenly spread, with the highest proportion being moment 5 accounting for 30% of all moments.

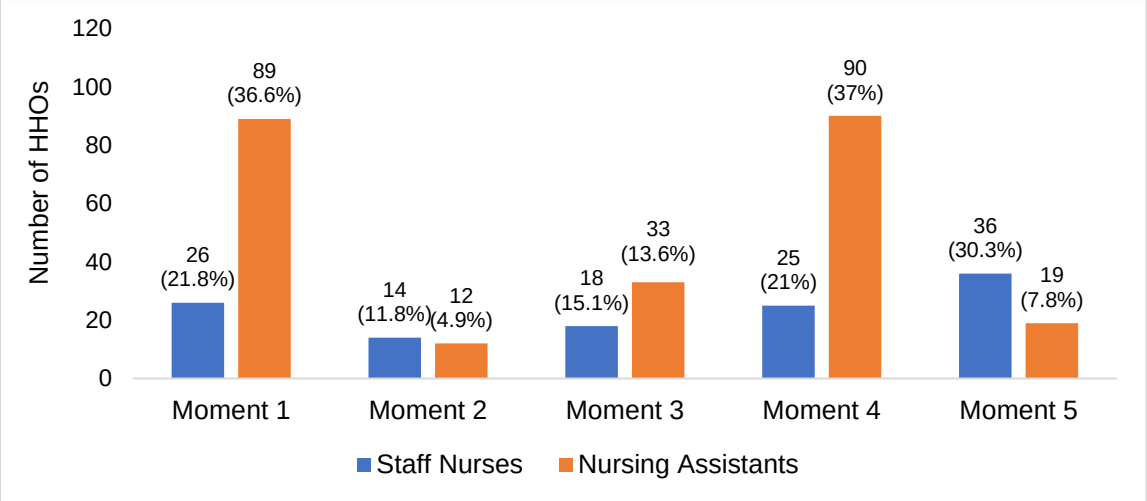

Figure 5.5 Total number (% within job role) of observed HHOs during night shift by moment type and staff role.

5.3.3 Compliance with hand hygiene

Due to the detailed data collected which included tasks in the workflow and hand hygiene activity it was possible to explore the data for compliance with the 5MHH. A HHO was considered complied with if hand cleansing was performed at the appropriate time either by hand washing or use of ABHR. Overall compliance with the total number of observed HHOs was 20%, 314/1567 (95% CI: 18.1%-22.1%), with 80%, 1253/1567 (95% CI: 77.9%-81.9%)

of opportunities not complied with. Compliance on Ward A was 21% (233/1095) and on Ward B was 17% (81/472). There was no significant association between compliance with hand hygiene and ward type (p = .06).

As data collection took place both before and after the first wave of the COVID-19 pandemic in early 2020 any potential impact upon hand hygiene compliance between these two periods could be explored. It is noted that most data collected after the beginning of the COVID-19 pandemic (after 27th January 2020) occurred during the night shift only (Table 5.6). Across both wards overall pre-COVID-19 compliance levels were 21% (239/1155), with compliance post-COVID-19 being 18% (75/412). There was no significant association between compliance with hand hygiene and whether observations were performed either pre or post the COVID-19 pandemic (p = .28).

Table 5.6 Number of hours observation prior to and during COVID-19 by ward and shift.

	Pre-COVID-19	During COVID-19
Day shift		
Ward A	64	8
Ward B	33	10
Total	97	18
Night shift		
Ward A	6	66
Ward B	0	0
Total	6	66

5.3.3.1 Compliance by shift type

During the day shift overall compliance was 21% (251/1205), non-compliance was 79% (954/1205). For the night shift overall compliance was 17% (63/362), non-compliance was 83% (299/362). There was no significant association between compliance with hand hygiene and shift type (p = .18).

5.3.3.2 Compliance by type of moment

Compliance with each type of moment as indicated by the 5MHH was explored. A series of chi-square tests for independence (with Yates' continuity correction) were performed to examine the relationship between each moment and compliance (Table 5.7, overleaf). There was a significant association between compliance with hand hygiene and type of opportunity (p = <.001, phi = 0.35). This indicates there was a moderate relationship between compliance and type of moment.

Table 5.7 Compliance with HHOs by type of moment.

	Number of observed HHOs			
	Complied	**Not complied**	**Total**	***p-value***
Moment 1	13	403	416	<.001
Moment 2	12	136	148	<.001
Moment 3	99	148	247	<.001
Moment 4	74	343	417	.196
Moment 5	116	223	339	<.001
Total	314	1253	1567	<.001

Figure 5.6 shows overall percentage compliance with each HHO by moment type. There were particularly low levels of compliance for moment 1 (3%, 13/403) and moment 2 (8%, 12/136). The highest levels of compliance were for moment 3, following BBF exposure risk (40%, 99/148) and moment 5 (34%, 116/223).

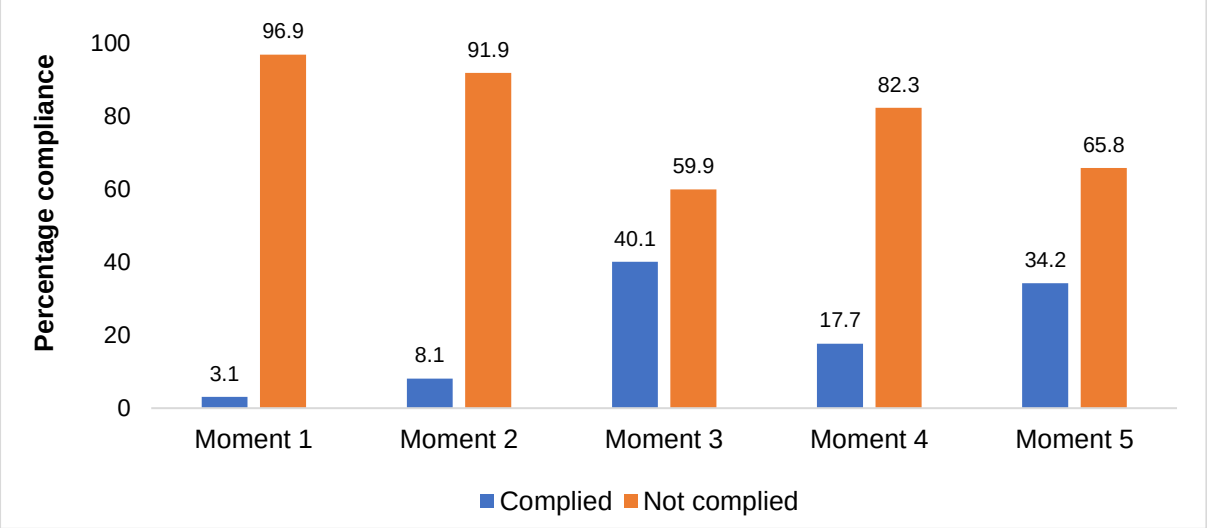

Figure 5.6 Percentage compliance by moment type.

To explore differences between moments chi-squared tests were run between moments of particular interest. The difference between compliance before patient contact (moment 1) and after patient contact (moment 4) was significant (p = <0.001, phi = -.239), indicating HCWs were more likely to clean their hands after patient contact than before. Similarly, HCWs were significantly more likely to comply with moment 3 (following BBF exposure risk) than moment 2 (before clean/aseptic procedure) (p = <0.001, phi = -.344). When considering the two moments before patient contact, HCWs were more likely to comply to moment 2 than moment 1 (p = .022, phi = -.107).

5.3.3.3 Compliance by job role

When exploring compliance by job role, overall compliance for registered nurses was 25% (138/549) meaning 75% (411/549) of HHOs were not complied with. Overall compliance for nursing assistants was 17% (176/1018), with 83% (842/1018) of HHOs not complied with. There was a significant association between compliance with hand hygiene and job role (p = <.001, phi = -0.09), with a strong relationship between job role and compliance. This indicates that registered nurses were more likely to adhere to HHOs than nursing assistants.

Compliance was also explored by type of moment by job role (Figure 5.7). This shows registered nurses had higher compliance with each type of moment when compared to nursing assistants. The largest difference was after moment 3 where registered nurses showed an adherence of 45% (51/114) compared to nursing assistants at 36% (48/133).

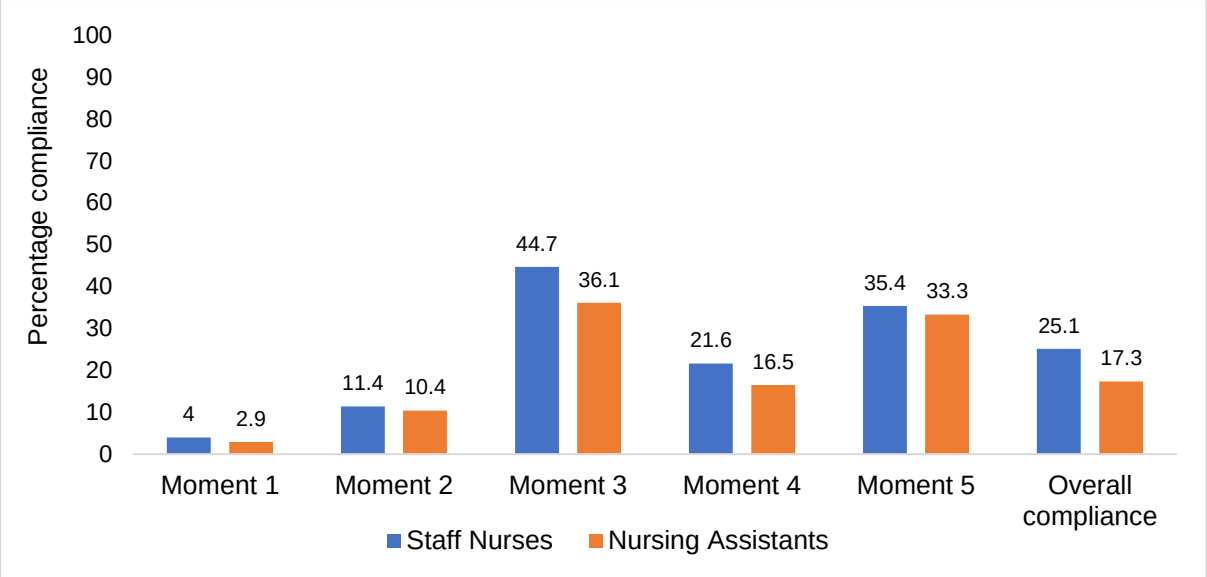

Figure 5.7 Percentage compliance by moment type and staff role.

5.3.3.4 Hand hygiene opportunities and workflow

During observations it was noted that common ways of working were key in the generation of HHOs. These workflows were not systematically identified in the data as this was beyond the scope of the aims, however they do provide some insight into care provision within the clinical setting and how this has the potential to impact hand hygiene. Part of an observed care episode is shown in Table 5.8 (overleaf) which details the movements of the HCW, the types of moments generated, and whether the moments were complied with.

Table 5.8 Example of HCW workflow and generation of HHOs.

Workflow	Type of opportunity	Compliance
HCW enters patient zone with COW		
HCW touches patient bed rail and tubing		
	Moment 5	Not complied
Types on COW (in patient zone)		
	Moment 1	Not complied
Takes off blood pressure cuff and oximeter		
	Moment 4	Not complied
Exits patient zone (with COW)		
Types on COW in corridor		

This example demonstrates that once the COW was in the patient zone it was treated as if it belonged to the patient zone, with no hand hygiene performed when moving between the patient or patient zone and the COW, and vice versa. In this ward COW did not undergo routine cleaning following each patient care sequence, it should therefore be treated as potentially contaminated thus it generates multiple HHOs during care provision. This would be moment 1 when moving to touch the patient, and moment 4 when moving from the patient to the COW. The same pattern was observed for movement between other items such as the blood pressure monitors, blood glucose monitors, and other items on the vital signs trolley. This episode of care also shows that leaving the patient zone itself is not a consistent prompt to perform hand hygiene following the completion of the care task.

5.3.4 Average number of hand hygiene opportunities derived from observation data

For each hour of the day where repeated observations were performed the mean number of observed HHOs per hour was generated. This was done both for each ward individually, each job role and overall, across both wards and job roles.

Ward A

Accounting for average staffing numbers the mean number of expected HHOs across 24-hours in total for Ward A was 1479. The day shift comprised a total of 1158 HHOs, with a mean of 97 HHOs per hour. The night shift comprised a total of 321 HHOs, with a mean of 27 HHOs per hour.

For an individual staff nurse there was an average of 146 HHOs across 24-hours, comprising 106 (mean 9 per hour) during the day shift and 40 (mean 3 per hour) during the night shift. For an individual nursing assistant there was an average of 219 HHOs across 24-hours, comprising 138 (mean 12 per hour) during the day shift and 81 (mean 7 per hour)

during the night shift. The mean number of HHOs for each hour of the day, for each job role along with a total based on average shift staffing is presented in Table 5.9.

Table 5.9 Mean number of expected HHOs per individual HCW by job role and average number of expected HHOs for a staffed shift (Ward A).

Hour	Average HHOs per staff nurse	Average HHOs per nursing assistant	Total HHOs per shift*
Day shift			
0800	9.33	8.33	90.33
0900	10.33	18.00	126.33
1000	15.00	15.33	151.00
1100	11.33	15.67	126.33
1200	7.00	5.00	64.00
1300	10.33	5.00	87.33
1400	7.00	4.67	63.00
1500	8.33	22.33	125.33
1600	6.00	21.33	106.00
1700	8.67	10.00	90.67
1800	11.33	7.00	100.33
1900	1.67	5.33	27.67
Average HHOs per hour	8.86	11.50	96.53
Night shift			
2000	2.33	12.67	34.67
2100	6.00	16.00	56.00
2200	5.33	4.00	29.33
2300	5.33	2.00	25.33
0000	2.67	3.33	17.33
0100	0.00	1.33	2.67
0200	2.00	7.33	22.67
0300	2.00	1.00	10.00
0400	1.33	2.00	9.33
0500	0.67	0.33	3.33
0600	10.33	13.67	68.67
0700	1.67	17.33	41.33
Average HHOs per hour	3.31	6.75	26.72

*Shift staffing for the day shift was 7 registered nurses and 3 nursing assistants, and for the night shift was 4 registered nurses and 2 nursing assistants.

Ward B

Accounting for average staffing numbers the total mean number of expected HHOs across 24-hours for Ward B was 1392. The day shift comprised 1071 HHOs, with a mean of 89 HHOs per hour. The night shift comprises 321 HHOs, with a mean of 27 HHOs per hour. Data for the night shift calculations is based on data collection from Ward A only.

For an individual staff nurse there was a mean of 149 HHOs across 24-hours, comprising 109 (mean 9 per hour) during the day shift and 40 (mean 3 per hour) during the night shift. For an individual nursing assistant there was a mean of 220 HHOs across 24-hours, comprising 139 (mean 12 per hour) during the day shift and 81 (mean 7 per hour) during the night shift. The mean number of HHOs for each hour of the day, for each job role along with a total based on average shift staffing is presented in Table 5.10.

Table 5.10 Mean number of expected HHOs per individual HCW by job role and average number of expected HHOs for a staffed shift (Ward B).

Hour	Average HHOs per staff nurse	Average HHOs per nursing assistant	Total HHOs per shift*
Day shift			
0800	2.00	1.00	15.00
0900	13.00	10.67	110.00
1000	17.00	11.00	135.00
1100	9.00	8.67	80.00
1200	8.00	7.67	71.00
1300	11.00	10.67	98.00
1400	6.00	25.33	112.00
1500	10.00	7.00	81.00
1600	2.00	17.00	63.00
1700	15.00	13.00	129.00
1800	8.00	20.00	108.00
1900	8.00	7.00	69.00
Average HHOs per hour	9.08	11.58	89.25
Night shift**			
2000	2.33	12.67	34.67
2100	6.00	16.00	56.00
2200	5.33	4.00	29.33
2300	5.33	2.00	25.33
0000	2.67	3.33	17.33
0100	0.00	1.33	2.67
0200	2.00	7.33	22.67
0300	2.00	1.00	10.00
0400	1.33	2.00	9.33
0500	0.67	0.33	3.33
0600	10.33	13.67	68.67
0700	1.67	17.33	41.33
Average HHOs per hour	3.31	6.75	26.72

*Shift staffing for the day shift was 6 registered nurses and 3 nursing assistants, and for the night shift was 4 registered nurses and 2 nursing assistants.
**Night shift data collected on Ward A only.

5.3.5 Hand hygiene opportunities per patient per day

From the average number of HHOs developed for each job role, this was multiplied by average staffing levels and divided by average patient occupancy in order to develop an estimate of the number of HHOs per patient per day. Observed and pre-existing denominators are presented in Table 5.11.

Ward A

When exploring HHOs based on average occupancy of the ward (26 patients) the number of HHOs per patient per day was 57. With this being 45 during the day shift, and 12 during the night shift. This would be a total of 1479 HHOs per day across the ward based on 26 patients.

Ward B

When exploring HHOs based on average occupancy of the ward (21 patients) the number of HHOs per patient per day was 66. With this being 51 during the day shift, and 15 during the night shift. This would be a total of 1392 HHOs per day across the ward based on 21 patients.

Table 5.11 Observed HHOs and existing DebMed GMS denominator data.

	Ward A	**Ward B**
Observed HHOs total per day	1479	1392
DebMed GMS expected total per day	1794	1596
Observed HHOs per patient/day	56.88	66.27
DebMed GMS expected per patient/day	69	76

5.3.6 Glove usage

Overall, gloves were worn during just over half of the observed HHOs. The total number of times gloves were worn during a HHO was 803 (51%, 803/1567), with gloves not worn during 764 (49%, 764/1567) HHOs. The specific reason for glove use as presented by the WHO was not explored in the data (World Health Organization, 2009a). However, it is likely that some of the time gloves were not required for the activity performed.

Compliance with hand hygiene was very similar for both times when gloves were worn and when they were not worn, with compliance being around 20% in both groups (Table 5.12, overleaf). There was no significant association between compliance with hand hygiene and

glove use (p = .90). Therefore, whether or not HCWs were wearing gloves did not impact their level of hand hygiene compliance.

Table 5.12 Number of times gloves were worn during HHO by compliance (%) to hand hygiene.

	Gloves worn	Gloves not worn	Total
Complied	160 (20%)	154 (20%)	314 (20%)
Not complied	643 (80%)	610 (80%)	1253 (80%)
Total	803 (100%)	764 (100%)	1567 (100%)

When comparing glove use during HHOs before and after the first wave of the COVID-19 pandemic glove use during HHOs rose from 41% (474/1155) pre-COVID-19 to 80% (329/412) post-COVID-19. Hand hygiene compliance when gloves were worn pre and post COVID-19 was not significantly different (p = .205), with compliance pre-pandemic at 22% (102/474) and post-pandemic 18% (58/329).

5.3.7 Non-indicated hand hygiene events

As data collection included detail of all hand hygiene activity it was possible to explore times when hand hygiene was performed by staff, but it was unrelated to the 5MHH. This was either due to being performed for another reason than occurrence of one of the 5MHH or was performed at the wrong time which meant it did not adhere to the moment. These can be seen as non-indicated hand hygiene events.

In total 230 non-indicated hand hygiene events were observed, 168 during day shift observations and 62 during night shift observations. Adding these non-indicated hand hygiene events to those performed in compliance with indicated HHOs results in a total of 544 times that a hand hygiene event was observed on the wards. Of these events, 58% (314/544) were performed in compliance with an indication from the 5MHH, and 42% (230/544) were not necessarily related to the 5MHH. The non-indicated hand hygiene events in the recorded workflow were explored to identify potential reasons behind their occurrence (Table 5.13, overleaf).

Table 5.13 Non-indicated hand hygiene.

Reason for hand hygiene event in workflow	Number (%)
Performed earlier than indication by the 5MHH	66 (29%)
Upon leaving the patient zone having made no contact with the patient or patient zone	36 (16%)
No clear reason	26 (11%)
After taking gloves off*	16 (7%)
Upon leaving multi-bedded bay	16 (7%)
After non-patient care related tasks	14 (6%)
Before putting gloves on*	13 (6%)
Repeated hand hygiene *(hand hygiene performed twice in succession)*	10 (4%)
Upon entering patient zone	10 (4%)
Performed later than indication by the 5MHH	9 (4%)
When leaving the ward	8 (4%)
After assisting with meal delivery to patients	3 (1%)
After removing medical face mask	1 (0.4%)
Upon entering multi-bedded bay	1 (0.4%)
Upon entering the ward	1 (0.4%)
Total	230 (100%)

*These are not included in the 5MHH but are recommended in practice and should potentially be discounted as non-indicated hand hygiene.

Staff may have felt they were adhering to the 5MHH for some of the non-indicated hand hygiene events observed. For instance, exploration of workflow showed that 75 (33%) non-indicated events were performed either too early (9, 4%) or too late (66, 29%) to comply with the actual opportunity. In the case of hand hygiene events performed too early, the HCW cleansed their hands and then touched something in the healthcare zone before the actual indication occurred before they began delivering patient care (Figure 5.8). Hand hygiene that was performed too late occurred after the indication had passed following the completion of a patient care task as the HCW immediately touched the healthcare zone and then cleansed their hands (Figure 5.9, overleaf). This means that these hand hygiene events occurred either before or after the actual indication and HCWs hands risked contamination from the healthcare zone to the patient or from the patient or patient zone to the healthcare zone.

Figure 5.8 Visual example of hand hygiene performed too early: 1) HCW washes hands, 2) HCW takes COW into patient zone and types, 3) HCW touches patient.

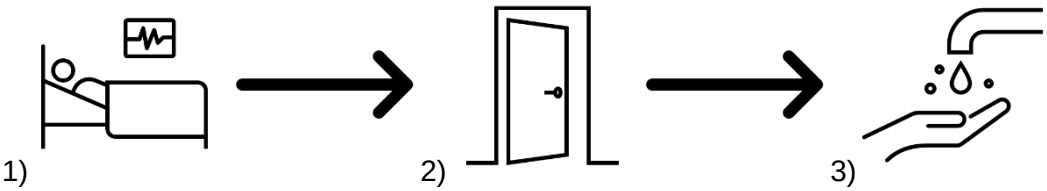

Figure 5.9 Visual example of hand hygiene performed too late: 1) HCW finishes patient care task, 2) HCW opens door/patient privacy curtain, 3) HCW washes hands.

This happened similarly with glove use, hand hygiene may have been performed before donning gloves (13, 6%) however subsequent interaction with the healthcare zone before touching the patient (moment 1) or performing a clean procedure (moment 2) meant the indication for hand hygiene occurred later. Or hand hygiene was performed after removing gloves (16, 7%) though the indicated had passed due to interaction with the healthcare zone. In addition, sometimes gloves were used for non-patient care related purposes and thus hand hygiene was non-indicated.

Movement into and out of the patient zone can be seen as a potential prompt for performance of hand hygiene, with 10 (4%) events performed upon entering a patient zone and 36 (16%) upon leaving a patient zone. As these were non-indicated events the patient zone or patient themselves was not touched, thus no indications were generated which required hand hygiene.

Other non-indicated hand hygiene events could have been performed due to habit or personal preference, for instance following food service or non-patient related tasks. This demonstrates how some hand hygiene performed on wards will be unrelated to the 5MHH. Repeated hand hygiene was observed on 10 (4%) occasions, this could have been due to the observer's presence and the HCW wanting to ensure it was seen that they were performing hand hygiene frequently. This is a very small number (2%, 10/544) in the context of the total hand hygiene actions observed.

5.3.8 Compliance as measured by electronic monitoring system

Data on dispenser activations was collected by the DebMed GMS during an 18-week period from November 2019 to March 2020. There were ten days when the GMS did not collect data due to technical issues, therefore data was collected on 115 days. Over this period a total of 98,560 dispenser activations were collected, 50,135 in Ward A and 48,425 in Ward B. This was a mean of 436 per day (Ward A) and 421 per day (Ward B). Based on the existing GMS denominator the overall compliance rate indicated by these activations across

the period was 26% (98560/386010), with a rate of 25% (50135/203814) on Ward A and 27% (48425/182196) on Ward B.

Across the 18 weeks, data from between 19 and 48 (mean 31) dispensers were not captured by the gateway each day. With the number of dispensers not registering with the gateway increasing as time elapsed. This was either due to bed-end dispensers moving out of the range of the gateway (e.g., being taken off the ward on a bed-end during patient transfer) or a hardware issue with the dispenser meaning it was not sending its activation signal to the gateway.

Figure 5.10 shows the mean number of times dispensers were activated during each hour, beginning with the first hour of the day shift (08:00), across the month of November (4 days missing data, 27 days total). The average number of activations on each ward per hour is similar. The activations also reflect the fluctuation of hand hygiene activity across 24-hours of the day. This month is presented as the system was installed in November and an average of 70% of dispensers were reporting data across this period, this was the highest for the data collection period.

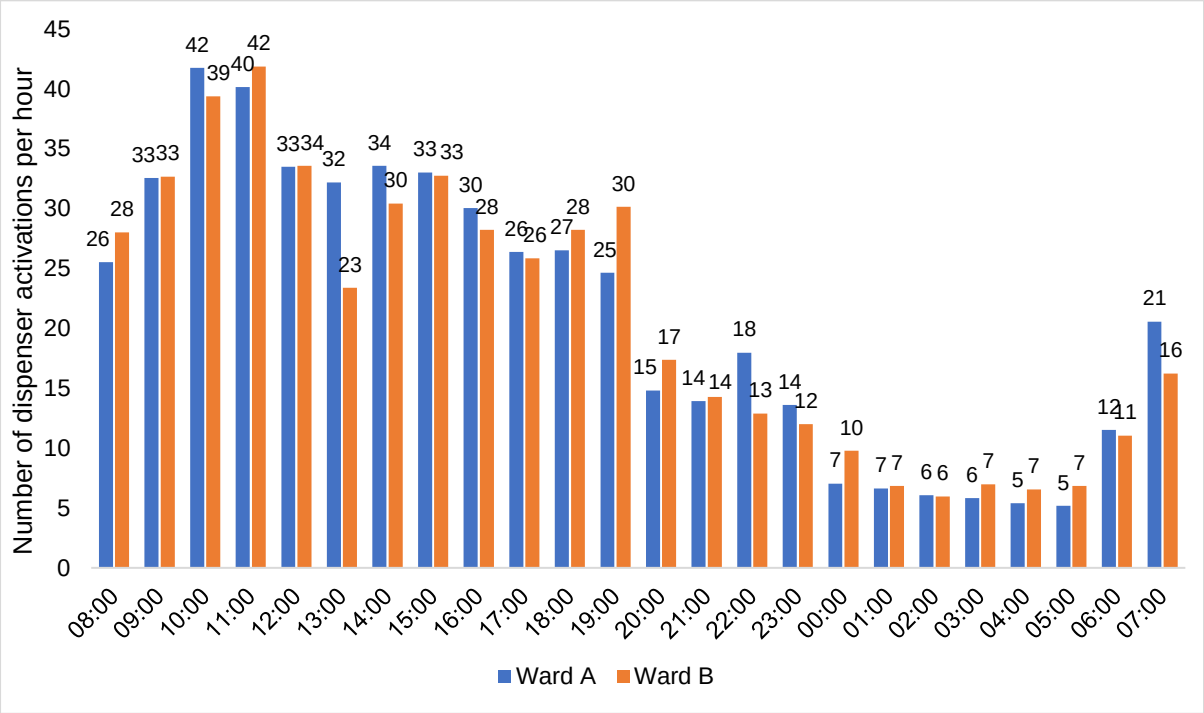

Figure 5.10 Average number of dispenser activations for November (27 days) by hour of day and ward.

It was possible to explore usage by type of dispenser: wall-mounted soap, wall-mounted ABHR and bed-end ABHR (Figure 5.11, overleaf). Usage of the wall-mounted soap and

ABHR dispensers remained relatively stable across the data collection period. When looking specifically at the wall-mounted dispensers, Ward A used more ABHR (average 63%) than soap (average 27%) whereas Ward B used similar amounts of both ABHR (average 49%) and soap (average 43%).

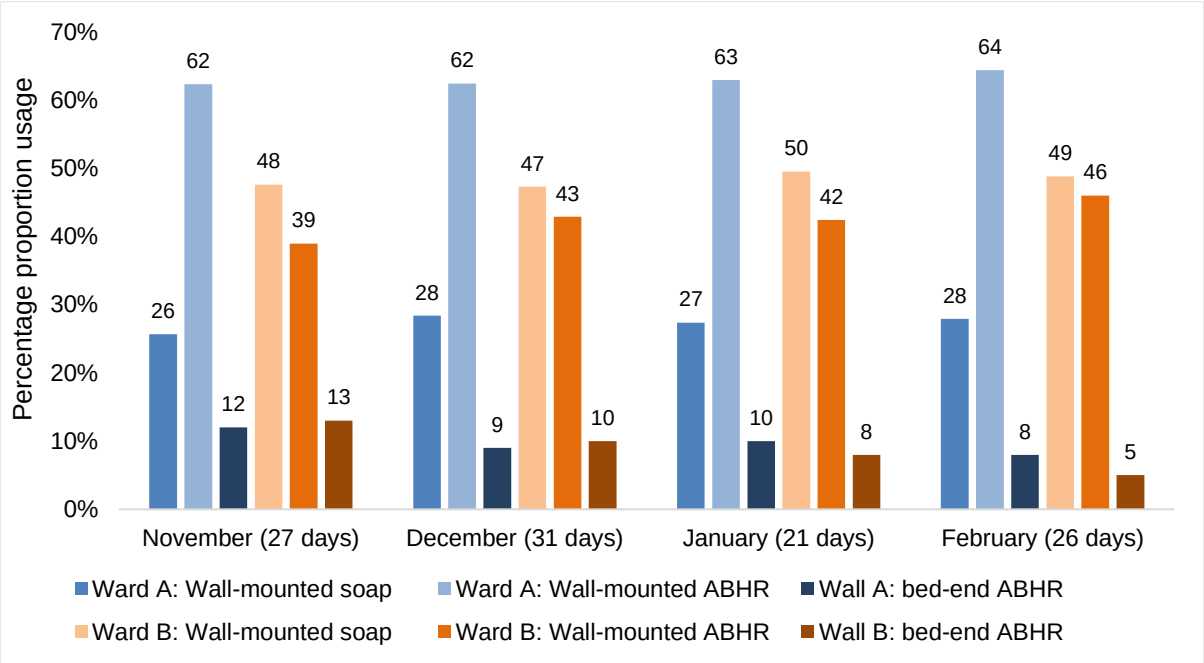

Figure 5.11 Proportion of dispenser usage by dispenser type for Ward A and Ward B.

There was a decreasing number of reporting bed-end dispensers across the measurement period, starting at 70% in November 2019 and decreasing through December (62%) and January (52%), to 44% in February 2020. This was due to activations either not being recognised due to hardware issues in the dispenser or the GMS dispensers being replaced with ordinary dispensers when they went missing off the ward whilst attached to patient beds. For the whole period (115 days) the average proportional use of the bed-end dispensers was similar across both wards, 10% (Ward A) and 9% (Ward B). When focusing in on November, when an 70% of the bed-end dispensers were reporting, there was a higher proportion of activations (Ward A 12%, Ward B 14%) when compared to the data from the rest of the period.

5.4 Discussion

5.4.1 Key findings and implications

Opportunities for hand hygiene

The observation of frontline HCWs has facilitated generation of an average number of expected HHOs on UK hospital wards. By directly observing practice which included entire episodes of care provision and observing individual HCWs regardless of whether they were performing active patient care allowed for the reality of care provision to be captured. Therefore, the data reflects fluctuations in activity levels across the day and night, inclusive of periods of lower activity.

The number of HHOs per patient per day in this study was similar to those reported in the literature review based on large hospital settings (Steed et al., 2011; Diller et al., 2014; Azim, Juergens and McLaws, 2016). Though this study observed a lower number of HHOs per patient during the night shift, similar to that observed in the community hospital setting (Steed et al., 2011). Compared to the number of HHOs expected by the DebMed GMS this study found a slightly lower number of HHOs based on actual observed practice.

This study found an increased burden of HHOs for nursing assistants when compared to registered nurses, with nursing assistants experiencing around two-thirds of all HHOs observed. The literature review discussed studies which found differences in the burden of HHOs dependent on job role, though this was focused on nurses and physicians (Azim, Juergens and McLaws, 2016). The types of HHOs experienced by HCWs generally reflected the differences in their workload and types of tasks performed. Nursing assistants interacted more frequently with patients throughout the day providing care and performing small tasks which generated HHOs. Registered nurses care provision tended to be more focused and included invasive tasks as they performed medical interventions. These differences, and the impact they have on the number of HHOs, may be key when considering hand hygiene training. Particularly in reference to applying the 5MHH in everyday practice based on the reality of the job role.

Both roles included frequent use of patient-shared equipment and portable medical equipment. The literature review found that this type of equipment is easily contaminated (Po et al., 2009; Havill et al., 2011). Observations highlighted how this equipment can generate HHOs, especially when used at the patient bedside where it can generate multiple occurrences of moments 1 and 4, as HCWs move their hands from the equipment directly to the patient and back again. How HCWs perceive and understand the use of these types of

equipment and its impact on their hand hygiene is of interest due to the quantity of HHOs they can create in a short space of time and their potential role in the spread of infection.

Compliance with hand hygiene

The overall hand hygiene compliance rate of 20% is low when compared to rates discussed in the literature review. With the WHO systematic review reporting an average of 38.7% in 2009, these findings suggest that hand hygiene is a perpetual issue and has not improved over the decades following the publication of the 5MHH. Compliance was of a similar level during both the day and night shifts, and across wards. This further suggests that this compliance figure is an accurate reflection of overall ingrained practice.

Nursing assistants demonstrated lower compliance to performance of hand hygiene than registered nurses. Previous literature indicates that a higher burden of HHOs does not necessarily lead to lower compliance (Azim, Juergens and McLaws, 2016). This again indicates the importance of considering comprehensiveness of IPC training for staff at all levels, and the ways in which knowledge can be incorporated into everyday practice in a meaningful way for those in frontline practice.

Exploration into the types of HHOs which were complied with showed the lowest levels of compliance at moment 1 and moment 2. These are the ‘before’ moments of the 5MHH during care, indicated prior to touching a patient or performing a clean/aseptic procedure. This differentiation between compliance with the moments before patient contact being higher than the moments after patient contact has been reported in previous literature (Azim, Juergens and McLaws, 2016; Xu et al., 2022). There is potential for these moments to be perceived as less of a risk to HCWs themselves in terms of a sense of ‘clean’ and ‘dirty’ tasks as explored by Whitby, McLaws and Ross (2006).

The finding that the opportunity with the highest level of compliance was moment 3 is further evidence for a crucial driver of behaviour being the classification of clean or dirty tasks by individuals, and the motivation for protection of the self (Smiddy, O'Connell and Creedon, 2015). The types of care tasks which result in moment 3 are ones where HCWs experience the risk of exposure to blood and bodily fluids, these can be linked to a sense of disgust and avoidance of disease which drive hygiene behaviours (Curtis and Biran, 2001).

When looking at the workflow of HCWs, some of the non-indicated hand hygiene activity where hand hygiene was performed but was in fact too early or late, was probably assumed by HCWs to be compliant with one of the 5MHH. However, in reality they had touched

something in the time either before or after care provision which meant that their hand hygiene was performed at the wrong time. This presents a particular risk as the HCW may assume hand hygiene was performed correctly, whereas in reality there is a risk of cross-contamination.

Data from the electronic monitoring system

Observations of practice showed fluctuations in HHOs across the day, this was also reflected in the hand hygiene activity captured by the GMS. The overall compliance rate generated by the GMS was slightly higher than observed compliance. One potential practice observed which could impact the GMS compliance rate is the performance of non-indicated hand hygiene. This would have resulted in dispenser activations being recorded which were not related to the 5MHH. This sort of activity will cause 'noise' on an EMS, as it records dispenser activations but not the context of the prompt for performing hand hygiene. There will also have been transient dispenser usage by visitors to the ward, and usage by other healthcare professionals which will have led to additional activations and may explain why the EMS compliance rate was higher than the observed rate.

An issue which arose whilst the GMS was installed was non-reporting dispensers, these tended to be the bed-end dispensers which either had a hardware issue or were taken off the ward when a patient bed was moved and not returned. As observations were performed at a large and busy hospital the movement of beds was a real challenge, if a system was installed hospital-wide this would be less of an issue. When exploring dispenser usage proportionally the bed-end dispensers were used the least, accounting for only around 10% of hand hygiene events. This suggests that focusing on only wall-mounted dispenser usage may still provide a useful measure of hand hygiene compliance if there were to be issues with bed-end dispensers.

Interestingly the wards showed differences in their usage of the wall-mounted soap and ABHR dispensers with Ward A using more ABHR than soap and Ward B using similar proportion of both. As Ward A was focused on medical and respiratory care, and Ward B on surgical and gastrointestinal care, this potentially reflects their specialism. Staff in Ward B may come into more contact with bodily fluids during post-surgical care and caring for patients after colostomy, leading them to use more soap than ABHR. The use of wall-mounted dispensers may also be higher than the bed-end dispensers as some moments of hand hygiene occur in locations away from the patient zone, for example when disposing of item in the sluice hand hygiene will be performed there.

Hand hygiene compliance during the COVID-19 pandemic

The COVID-19 pandemic had no significant impact on observed hand hygiene compliance. If there was an initial impact on compliance rates, then practice had already returned to existing pre-pandemic levels by the time observations were performed around five months after the emergence of COVID-19. The literature is broadly similar as to the impact of the COVID-19 pandemic hand hygiene compliance indicating that although the pandemic may have initially increased compliance, potentially as opportunities for hand hygiene decreased due to fewer patients on outpatient and inpatient wards, this was not maintained (Moore et al., 2021; Makhni et al., 2021; Williams et al., 2021). Over time it appears complacency returned to practice, and ingrained levels of pre-pandemic hand hygiene practice return. This could also be influenced by an increase in knowledge about the COVID-19 and the availability of vaccination. It is interesting however that the initial increase in compliance shown in these studies demonstrates that with fewer patients to care for hand hygiene may be more consistently achievable.

Further reflecting how changes in patient numbers impacted hand hygiene in settings where patient numbers increased there was no initial uptick in compliance. One study conducted in an ICU in Brazil found no change in hand hygiene compliance as measured by an EMS (Casaroto et al., 2022). This type of specialist ward for critically ill patients experienced an increase in admissions, this in turn would have increased HHOs making increased compliance more difficult to achieve due to the increased workload.

The impact of glove wearing on hand hygiene compliance

Although worn during over half of HHOs, glove use did not impact hand hygiene compliance which remained around 20% for times when gloves were and were not worn. This could be due to the overall low levels of hand hygiene compliance under both circumstances. As glove usage does not change the occurrence and need for hand hygiene at each of the 5MHH in the workflow, if HHOs are not complied with when gloves are not worn there is perhaps even less of an incentive to comply to hand hygiene when gloves are worn, thus hand hygiene remained unaffected by glove use.

The large increase in HCWs wearing of gloves post-COVID-19 was unsurprising due to changes in PPE protocols for frontline HCWs who were advised to wear gloves when providing patient care regardless of the patient's COVID-19 status. Even with this marked increased in glove use, compliance was not impacted, suggesting ingrained patterns of hand hygiene practice.

Consistency of practice

The consistency of compliance rates across shift type, ward type, glove use status, and pre- and post-COVID-19 suggests ingrained ways of working and application of the 5MHH in practice. This could be linked to HCWs conception of the ward environment and how they apply the 5MHH within it. These findings can be seen to relate to Sax and Clack's (2015) concept of automatic thought processes and mental models of the healthcare environment driving hand hygiene behaviour. These mental models can be inaccurate and the 5MHH may not be appropriately integrated into the HCWs models. Some instances of the non-indicated hand hygiene activity demonstrated that, at times, HCWs were cleansing their hands though at the wrong moment in time to adhere to the 5MHH. This shows that the way HCWs apply 5MHH needs to account consciously for the complexity of the environment, and the importance of the patient zone and healthcare zone in relation to points of potential cross-contamination.

5.4.2 Strengths and limitations

The outbreak of the COVID-19 pandemic impacted data collection in this phase of the study. As the majority of data for the night shift was collected post-COVID-19 the HCWs observed may have behaved differently to the observations performed before the pandemic. However, the ward where observations took place was not a specialised COVID-19 ward. Patients were routinely tested for COVID-19 and any suspected cases were placed in individual patient side rooms. It is difficult to ascertain any impact of the pandemic upon HCWs hand hygiene motivations and beliefs from these observations, this will be an area explored in Phase 2 interviews.

The use of direct observation was a potential limitation due to presence of the researcher whilst HCWs performed their duties. As discussed in the literature review when individuals notice they are under observation they may change their hand hygiene behaviour (Srigley et al., 2014). As an indication of any impact of direct observations upon practice, there were a very small number of times when repeated hand hygiene was observed. This indicated a slight performative aspect to hand hygiene behaviour on these few occasions, and it could be that the HCW noticed they were under observation at these times. However, normal practice is indicated by the consistent compliance levels generated which suggests HCWs practices were minimally impacted by the presence of the researcher. This could be due to the long period over which data was collected, with staff becoming accustomed to the researcher's presence.

The occurrence of GMS dispensers which were not sending data due to being out of range or malfunction was particularly difficult to manage in a large hospital. There were many different staff and porters who were not always aware of the request to keep the bed-end dispensers on the ward when moving a patient bed, even though efforts had been made to support this with on-ward posters. The decline in the number of bed-end dispensers will have resulted in some dispenser activations not being counted on the GMS.

Observations of care took place on two inpatient wards within a busy city hospital. There is potential that this will not be representative of care provision and workflow in hospitals of a different size or rural location. Though, hospitals of any size will also be applying the 5MHH and as compliance is a widespread issue, it would be expected that elements of practice would be applicable across the sector.

5.5 Chapter summary

Observations of care have facilitated the development of an expected number of HHOs on UK hospital wards, accounting for the reality of care provision and fluctuations in activity across the day. There were clear differences for staff in the number of HHOs which arose during care provision. Compliance with HHOs was also explored which found low levels of adherence to the 5MHH, and differences between job role in compliance rates. Interestingly, observations found glove use and COVID-19 did not impact hand hygiene compliance rates. Ingrained ways of working utilising patient shared equipment and portable medical equipment were identified as having an important role in the generation of HHOs, and therefore compliance.

5.6 Conclusions and implications for the thesis

The findings from Phase 1 indicate a number of key areas requiring further exploration in Phase 2 of this study. Of interest when considering the impact of job role upon HHOs and compliance is how HCWs understand and apply the 5MHH in their daily practice. Some of the practice observed in Phase 1 demonstrated that recognition of the moments may be occurring too late or too early to comply with the actual indications for the 5MHH in the patient care episode. This is something which could be impacted by knowledge and perceptions of the care tasks undertaken and their related moments of potential cross-contamination. Relatedly, how HCWs integrate equipment into their workflow and understand its role in the generation of HHOs is key, particularly whether this is covered in staff training.

How HCWs and IPC practitioners perceive, and experience, hand hygiene audit is also key as audit provides a formalised moment of reflection upon practice and plays a role in driving improvement. The role of traditional direct observation, as well as the potential impact and acceptance of data produced by new technologies is of interest when considering the potential adoption of EMSs by frontline staff. Although observed compliance rates were unchanged by COVID-19, whether the emergence of a pandemic impacted the way HCWs felt about hand hygiene practice is a potentially important aspect of the emotional drivers of their practice.

Phase 2 takes a qualitative approach in the form of interviews with frontline HCWs and IPC practitioners to explore these topics in-depth. The following chapter reports the findings of Phase 2.

Chapter 6 Phase 2 Results: Healthcare workers experiences and perceptions of hand hygiene

6.1 Chapter overview

This chapter describes Phase 2 of the study, the qualitative element of the mixed methods approach. Phase 1 explored the reality of hand hygiene opportunities and practice on two inpatient wards in a UK hospital. This revealed how opportunities for the 5MHH are generated in practice and how common workflow patterns led to the occurrence of HHOs which in turn impacted compliance. In order to explore the findings of the first phase, the second phase gathered the experiences and perceptions of HCWs via semi-structured interviews. These interviews focused on application of the 5MHH, current and future auditing systems for hand hygiene, and how COVID-19 impacted hand hygiene practice. This chapter firstly provides a brief overview of the methodology, including data analysis. The findings are then presented, supported with quotes from participants, before key findings and implications with reference to existing literature are discussed.

6.2 Methods

6.2.1 Summary of the methodology

The methodology for this phase of the study has been described in Chapter 4, Section 4.5.4. Participants were recruited via UWL, all participants were students at the university who also worked professionally in the relevant healthcare roles. Two interview schedules, informed by the TDF, were developed which comprised open-ended questions around the topics of the application of the 5MHH in practice, hand hygiene auditing practices including EMSs, and the impact of COVID-19 on hand hygiene practice. Additional information collected from participants included their job role and how long they had worked in their role. Ethical approval was received from the UWL CNMH REC. All interviews were conducted via Microsoft Teams video call between June and September 2021. Interviews were recorded on a Sony Digital Voice Recorder and transcribed by the researcher.

6.2.2 Participant profiles

In total, eight participants were recruited and interviewed individually by the researcher via Microsoft Teams. Five participants worked as IPCNs, qualified nurses who specialise in IPC. Their role includes ensuring IPC guidance, policies, and procedures are in place and adhered to in their organisation. Three participants were registered nurses, they worked on the frontline providing direct patient care and were not specialist in IPC practice, e.g., IPC

champions or IPC link nurses. All participants worked in different healthcare organisations, most being hospitals, with one registered nurse working in a private General Practice. Overall, the interviews lasted an average of 54 minutes. Interviews with IPCNs lasted slightly longer on average (58 minutes) than interviews with registered nurses (40 minutes). Participant profiles are reported in Table 6.1, a participant code was assigned individuals to protect their anonymity.

Table 6.1 Participant profiles including time in role.

Participant	Job role	Time in role
IPCN01	IPC nurse	2.5 years
IPCN02	IPC nurse	1 year
IPCN03	IPC nurse	2 years
IPCN04	IPC nurse	2.5 years
IPCN05	IPC nurse	3.5 years
RN01	Registered nurse	5 years
RN02	Registered nurse	4 years
RN03	Registered nurse	2 years

6.2.3 Data analysis

Data were analysed using reflexive thematic analysis (RTA), as described in Chapter 4 Section 4.5.4. As interviews were transcribed by the researcher, this enabled further familiarisation with the data following the conduct of the interview. Each transcript was first analysed in Microsoft Word using the 'comments' feature to select text and develop initial codes. This initial coding allowed for more detailed codes and deep exploration of the interviewee's experiences. This ensured nuances in each interview were not lost by applying broader codes to potentially complex statements too early in the process of analysis. It also meant that these coded transcripts could be referred to during theme development and write-up to provide further depth and insight.

Following initial coding, transcripts were imported into NVivo 12. Transcripts were then coded with more succinct codes, working towards representation of broader themes within the data, whilst still capturing each participant's individual experiences. Each transcript was coded individually in order to capture and reflect each participant's thoughts and experiences closely. A table of codes for each participant was created which includes all their codes and selected quotes related to the code (Appendix 13). From this, common themes which could be attributed across the participants' experiences were developed. This was not simply informed by the frequency with which codes occurred, but also by particularly salient quotes or relationships between codes lending a depth of explanation to an aspect of the

participant's experiences. The construction, revision, and definition of themes was an iterative process throughout the analysis and write-up stage.

6.3 Findings

An overview of the six overarching themes and the sub-themes within these is shown in Table 6.2. This section will present a narrative account of the findings, supported with verbatim quotes from participants. Each overarching theme will be explored, along with inclusion of a table summarising the sub-themes and codes within each overarching theme.

Table 6.2 Summary of overarching themes and sub-themes.

Overarching themes	Sub-themes
1) A perceived hierarchy of hand hygiene audit	*1.1 Audit as a representation of practice*
	1.2 Incorporating EMSs into existing audit practice
2) Infection prevention and control as reactive rather than preventative	*2.1 Triggers for audits*
	2.2 Engagement stemming from audits
3) The application of the 5MHH in the ward environment	*3.1 Compliance with the 5MHH*
	3.2 Understanding zoning
	3.3 Potential for cross-contamination in workflow
4) Knowing and doing – the complexities of practice	*4.1 Challenges in the application of the 5MHH*
	4.2 Hand hygiene as embedded into daily practice
5) COVID-19 as both a driver and barrier to optimal hand hygiene practice	*5.1 A change in hand hygiene behaviour*
	5.2 Implications of PPE use
6) EMSs provide a passive system for hand hygiene measurement	*6.1 Building a picture of practice*
	6.2 Practice requires context

6.3.1 Overarching theme one: A perceived hierarchy of hand hygiene audit

Sub-themes and codes within this theme are shown in Table 6.3 (overleaf). The audits performed by either ward staff or IPCNs were viewed as having an inherent difference in the reliability of the data they generated. There were also differences in how direct observational audit was valued as a method of assessing practice when compared to EMSs. This resulted in an expressed hierarchy of audits and the data they generated.

Table 6.3 Overarching theme one, sub-themes, and codes.

Overarching theme	Sub-themes	Codes
1) A perceived hierarchy of hand hygiene audit	1.1 Audit as a representation of practice	*Audit data not representative of true practice*
		Revealing the reality of practice
		Box ticking exercise
		Audit as a time for providing education
		IPCN verification audit
		Ward skills for completing own audit
	1.2 Incorporating EMSs into existing audit practice	*Combining multiple monitoring streams*
		A way of pinpointing areas to further investigate

Sub-theme 1.1: Audit as a representation of practice

The main issue around the acceptance of hand hygiene compliance data generated by direct observational audit stemmed from whether the audits were ward-led or completed by the IPC team. As discussed in Chapter 1, Section 1.2.4 ward-led audits are those which are completed by a team member from the clinical area being audited. The IPCNs viewed compliance data from ward-led audits as unrepresentative of the reality of hand hygiene practice. Reports of high levels of hand hygiene compliance were a cause for concern, rather than an assurance of good practice: "…it's all 100% so there's a problem there…" [IPCN02], "…most times the ward hand hygiene is 90%, 100% - that's not realistic." [IPCN03].

The issue of whether ward staff had the knowledge and skills to perform a thorough audit was raised, as well as the potential for time pressures to impact the quality of audit data:

> "…there are factors that affect the audit being done by the infection control links (link practitioners) and the ward nurses. Number one would be their knowledge and skills, how they do or conduct a proper hand hygiene audit. Number two would be their workload, which has always been one of the issues…" [IPCN02]

The way in which wards viewed their own hand hygiene audits was also a concern, with IPCNs reporting that they could be seen by ward staff as "…a pointless exercise." [IPCN04] or a "tick box exercise" [IPCN04]. Again, time factors were found to play a role in the quality of ward-led audits with one IPCN recounting a time when she asked a ward nurse about their thoughts regarding monthly submission of hand hygiene audits:

> "…she said "it's like a tick box exercise, like when it's like near the end of the month, I will ask someone, 'oh, we need to do this', and they would be sitting probably in one corner just ticking the boxes" … That's why you always get 99%, 100%…" [IPCN04]

This lessened the impact which audit data could have upon practice, with the IPCN continuing: "…we're not really getting the essence of auditing and feeding back, we're not getting the most out of it because it's not improving practice, it's not changing anything." [IPCN04]. Another IPCN brought up a similar point: "I guess that impact's not there, it's just a task and it's being ticked off." [IPCN01].

As ward-led audit data was not seen a true representation of practice, IPCNs relied on their own audits as a way of exploring the reality of practice and "…finding out what is truly happening." [IPCN01]. They felt able to not only observe practice, but to use audit as an interrogation of hand hygiene practice within wider IPC guidance as this was their specialism:

> "…this is the reason why infection control nurses in our organisation carry out an independent hand hygiene audit from the ones that the ward is doing. What we often find is that the hand hygiene results are in a pristine condition like 100%, 99%, 95%, when in fact when we do our independent audit because we've got that critical eye for IPC, we get to see practices that are not supposed to be how it is, you know for guidance." [IPCN02]

These differences in the perceived quality of audits could lead to confusion for the ward staff who were accustomed to seeing high levels of compliance from ward-led audits, only to find lower compliance rates fed back to them when audits were performed by IPCNs: "…some will ask you 'well sister look at- what about this our 98%, why is it different?'…" [IPCN03].

Direct observational audits were seen as an opportunity to provide immediate feedback regarding hand hygiene practice. One registered nurse spoke about how the immediacy of feedback could be more effective as the practice performed would be at the forefront of the HCWs minds:

> "I think it's good practice to get to people straight away so they know and remember it's very close to when the audit was done, so I think it's most effective if you speak with people straight away." [RN02]

One IPCN also noted that the provision of real-time feedback and opportunity to challenge practice during direct observational audits may avoid potential harm:

> "…we're giving the feedback right there and then, so the staff gets challenged when they didn't wash their hands before they go to the patient so actually a potential harm…like we can do something about it because we have challenged the staff so we could be potentially stopping transmission." [IPCN04]

Sub-theme 1.2: Incorporating EMSs into existing audit practice

A further disparity was found between direct observational audits and use of an EMS for hand hygiene. Most IPCNs remained loyal to direct observational audits over the idea of an EMS as the sole generator of compliance data. There was a preference for combining both direct observational audit and an EMS to provide two parallel monitoring streams. Most IPCNs envisaged an EMS acting as an adjunct to their direct observational audits, rather than a system which would be relied on entirely: "I think it will really be useful but again, if used in conjunction with traditional auditing." [IPCN04]. Most of the reasoning behind this was related to the potential drawbacks of EMSs (discussed in Sub-theme 6.2: Practice requires context). A comment by one IPCN highlighted a key element of their role and the importance of remaining central to auditing practices as this allows them to be visible on the wards and promote hand hygiene practice in person:

> "I would say we still have a role, a bigger role for observational audits to take place side by side to be honest, anything that can help disseminate information about hand hygiene in a clinical setting is good, it's nothing bad." [IPCN03]

One IPCN thought that direct observational audits could be used to verify an EMS, "…to compare results…" [IPCN02]. Working in conjunction with an EMS and utilising the data it generates to direct further auditing practice was also raised as an idea by one IPCN, who proposed that an EMS could be used to pinpoint where to direct the focus of attention of the IPC team to do more in-depth audits:

> "…it will give a general kind of general understanding of what's going on out there and actually, it might help to streamline where we go and do our validation audits, because if you see that there's an area that's now decreased or increased their uptake, all of a sudden, it's 'OK, let's see what's going on here'…" [IPCN05]

Alongside the practicalities of collecting audit data and being present on the wards, IPCN05 noted that the data needs to be utilised and action taken to enact change: "I think with auditing, it's only as good as what you do with that result." [IPCN05].

6.3.2 Overarching theme two: Infection prevention and control as reactive rather than preventative

Sub-themes and codes within this theme are shown in Table 6.4. Most participants reported that their organisation had a regular audit cycle, normally completed monthly by ward staff with verification audits performed by IPCNs every six or twelve months. Ward-led audits often reported compliance as 90% or greater which was accepted, if not valued, as a true representation of practice until the consequence of potentially poor hand hygiene practice was evident (e.g., an outbreak of infection). As part of the response IPCNs often performed an additional audit which was perceived as more rigorous. Outbreaks also tended to increase buy-in from management and HCWs on the wards with relation to engagement in hand hygiene training. Thus, the expert knowledge of the IPCNs was applied in a way which was reactive to infection rather than preventative.

Table 6.4 Overarching theme two, sub-themes, and codes.

Overarching theme	Sub-themes	Codes
2) Infection prevention and control as reactive rather than preventative	2.1 Triggers for audits	*Audit triggered by infection rate or performance*
	2.2 Engagement stemming from audits	*The consequences of outbreaks*
		Consequences of audit
		Feedback as a means of changing behaviour

Sub-theme 2.1: Audit as a reaction to the consequences of poor practice

The IPCNs audits were performed outside of the regular audit program when there was a more serious trigger to action such as an outbreak or comment on practice from patients: "…we also look at different factors as to where we're going to I mean, which departments we're going to scrutinise a little bit more depending on the infections that they have, the infection rate, um if there are any complaints coming from the patients regarding practices that they see…" [IPCN02].

Outbreaks or increases in patient infection numbers were also a trigger to action. Then IPCNs may also look more closely at hand hygiene in the wider context of the ward itself. One IPCN said these kinds of events would mean they start focusing on the wider practice on the ward, including the sharing of equipment:

> "…when we've got outbreaks or when we've identified unusual increase in the number of cases of an organism on the ward, like MRSA, for example, or C. diff, that's when we start looking at 'oh have they been sharing equipment between the space?'…" [IPCN04]

Visits to wards for other reasons, such as when providing on-ward training, alongside the knowledge of potentially 'problematic' wards, also gave an opportunity for IPCNs to remain vigilant to the reality of hand hygiene practice outside the audit context. This then might prompt them to perform an audit:

> "…sometimes we have an outbreak, we have a problematic ward, that we think that their hand hygiene is not too good when I'm going around, I'm doing teaching, if they're not too good then I'll do an audit for them…" [IPCN03]

The issue of being reactive to infection rather than proactive was recognised by an IPCN who found that this was sometimes the by-product of the small size of the IPC team and workload:

> "…is because we are a very small team and because of the amount of workload that we have most of what we do is control rather than the prevention of infection, and I feel like sometimes we're fire-fighting, as much as we want to be proactive, it's not that possible all the time." [IPCN04]

Sub-theme 2.2: Engagement stemming from audits

When audits revealed low compliance or were performed in relation to the occurrence of outbreaks, specific actions followed. This could be the submission of action plans by the ward as to areas of practice they could improve, or the provision of education on the ward:

> "…if anything was scored below 80%, we would- an action plan would need to put in place, we would come back and re-audit within two weeks and then if it was still not any better, they would have to come up with a- even more rigorous action plan." [IPCN05]

One IPCN discussed how a ward with low compliance, or an outbreak, often demonstrated increased engagement with the IPC team. Outbreaks in particular appeared to provide a tangible and overt example of the potential of poor hand hygiene practice in the occurrence or spread of infection. This in turn made a low compliance score as reported by the IPC team more believable to HCWs:

> "…when you offer teaching, they will pull people around to do the teaching, they will give you a space in their handover to do that so I think it depends on when

> you- what is happening on the ward, more of outbreak they will engage with you more. If you don't have outbreak, they will just feel like as if your audit is not really reflecting for what they are thinking." [IPCN03]

The motivation behind this increased engagement was discussed, with the same IPCN positing that following outbreaks ward staff may feel a sense of personal responsibility for the occurrence of infection on the ward:

> "…because the outbreak situation, they feel like they've given patients infection and they feel that sense of- sense of guilt that they've given to patient this infection and maybe it's because they don't understand their hand hygiene and maybe they're not adhering to appropriate cleaning and things. So, this- it's just a sense of guilt because sometimes when you, when they say to you 'oh god, this person is going home with this infection now'…" [IPCN03]

6.3.3 Overarching theme three: The application of the 5MHH in the ward environment

Sub-themes and codes within this theme are shown in Table 6.5 (overleaf). Both the IPCNs and registered nurses identified moments of the 5MHH which, from their experience, had differing compliance. Certain moments were interpreted as easier to comply with. Moments after patient contact were seen as more likely to prompt hand hygiene performance than those before patient contact. The concepts of the patient zone and the healthcare zone were also discussed as to their usefulness in the application of the 5MHH in everyday practice. Interwoven with both the application of, and compliance with, the 5MHH and the concept of zoning were the ways in which HCWs worked within the confines of the ward environment whilst using or interacting with items such as shared patient equipment, COW, PPE, and patient privacy curtains.

Table 6.5 Overarching theme three, sub-themes, and codes.

Overarching theme	Sub-themes	Codes
3) The application of the 5MHH in the ward environment	3.1 Compliance with the 5MHH	*Reasons for non-compliance*
		5MHH which are more consistently complied with
	3.2 Understanding zoning	*Division of the patient and healthcare zone*
		Training in zoning
		Not recognising each patient zone
	3.3 Potential for cross-contamination in workflow	*The role of equipment in potential spread of infection*
		How gloves are used or misused
		Understanding the role of curtains in potential spread of infection
		Automatic ways of working could lead to cross-contamination

Sub-theme 3.1: Compliance with the 5MHH

The IPCNs discussed the reasons given to them by HCWs for non-compliance with hand hygiene during their day-to-day work. These included being busy or in a rush, having a lot of tasks to complete, being caught up in a task and forgetting, and not recognising the moment of hand hygiene. Resources were sometimes mentioned to IPCNs as being insufficient. This included no bed-end dispenser in the patient zone, and a preference for handwashing with the sink being too far away. When reflecting on their own practice two of the registered nurses identified similar factors to these which made it harder for them to perform hand hygiene which were being busy, insufficient staffing, and being distracted.

When discussing specific moments of the 5MHH where issues with compliance were commonly seen, moment 1 (before patient contact) was seen as the most problematic. One of the main reasons for this was identified by IPCNs as HCWs feeling as though their hands were already clean: "…in their mind they've already washed their hands in the corridor that's all." [IPCN03]. However, this hand cleansing was often too early as HCWs then touched other items before moment 1 occurred in the care sequence which resulted in a non-compliant moment. One IPCN also noted this happened for moment 2 (before a clean/aseptic procedure), with HCWs cleaning their hands too early before the procedure to be compliant: "…so that before aseptic technique as well is something people forget as they feel they've already cleaned their hands." [IPCN05].

One IPCN noted that poor compliance at moment 1 may also be linked to HCWs moving between patients within one bay:

> "I think it's moment 1, so approaching a patient and again, I think it's probably from like bay activity so they'll go from one to the other, might get lost in the moment and forget to do it at the particular sort of moments that they need to." [IPCN02]

Moment 5 was discussed by two IPCNs, one who noted that allied health professionals such as dieticians, speech and language therapists, and junior doctors often stated when challenged upon leaving a patient zone that they did not perform hand hygiene due to them not directly being in contact with the patient. Another supported this saying HCWs do not realise touching items within the patient bedspace requires them to perform hand hygiene after leaving the bedspace:

> "The one that people forget, the most obviously is 5, after contact with patient surroundings because- and you see it as well, you see someone go in and just put the tray table or someone's ringing the bell and they ask for the phone charger out the bag and you pass it them and people walk away without cleaning their hands." [IPCN05]

The most commonly mentioned moments within the 5MHH at which participant's experienced compliance would be more likely to occur were moment 3 (after body fluid exposure risk), moment 4 (after touching a patient), moment 5 (after touching patient surroundings) and one participant mentioned moment 2 (before a clean/aseptic procedure). Except for moment 2, all of these are the hand hygiene moments after patient contact.

The potential risk of being in contact with bodily fluids, at moment 3, was seen by IPCNs to be a strong motivator for HCWs to perform hand hygiene:

> "…staff are really, really good in decontaminating their hands after contact with patients or after contact with bodily fluids." [IPCN04]

> "…moment 3 also it's easy for them because it's body fluid exposure" [IPCN03]

The registered nurses reflected on their own practice and when they felt prompted to clean their hands. This elicited mention of times following direct patient contact, or potential contact with BBF. These circumstances were key in the perceived importance and ease of hand hygiene at these times:

> "…what we probably do quite well is like if we're doing something directly on the patient and with the handling fluids or we're taking bloods or I'm examining the patient… I have a feeling that it is maybe better if you're directly on the patient to remember to wash your hands, take things more serious." [RN02]

> "…maybe the one where you, kind of, you touch some unsterile thing, blood products or anything which is really infectious, that's very important." [RN03]

Before a clean/aseptic procedure (moment 2), was only mentioned by one IPCN who suggested that aseptic non-touch technique (ANTT) was a prompt for hand hygiene as it is embedded into the concept:

> "…the concept of aseptic technique they know the concept is there, the ANTT concept helping them to do moment 2." [IPCN03]

Sub-theme 3.2: Understanding zoning

The use of the concepts of the patient zone and the healthcare zone as linked to the 5MHH had a mixed level of use and understanding. Responses differed as to whether the concepts of the patient zone and the healthcare zone were specifically included in IPC training for frontline staff at an organisational level. Some found the concepts useful in teaching HCWs as a way of focusing hand hygiene practice in the patient zone:

> "…I'll go there and say your zone- the zone of your patient that's where we are more concerned about and that's why we base our five moments on, so it does help a lot with them, with their understanding." [IPCN03]

The same IPCN went on to discuss how the placement of hand hygiene dispensers does not encourage hand hygiene in the patient zone, as they tend to be situated in corridors or places outside of the patient bedspace. This potentially indicates to HCWs that these are the places where hand hygiene should be performed. The IPCN used the patient zone concept when teaching to indicate where hand hygiene should take place, this being as close to the patient as possible:

> "Patient zone, that's where your five moments is… I know we have gel by the corridor, I know we have hand hygiene sink by the corridor all those ones is just to be as a- it's just for us to be able to clean our hands when we when we want to clean our hands but in terms of preventing infection, in terms of healthcare acquired infection and as part of [inaudible], this is the important moment that you have to do your hand hygiene." [IPCN03]

The underuse, or lack of understanding, of the patient zone and healthcare zone as concepts by HCWs was recognised as having the potential to lead to issues when moving between different patient zones. The division of the zones was seen to be more difficult to apply in a bay setting where there are multiple patient zones within one large room:

> "If I'm going to contextualise that a little bit, at least from when I went to an area where there are bays. In terms of zoning, I think the healthcare worker zone and the patient zone is pretty much mixed up." [IPCN02]

To add to potential issues with clarity of the zones one IPCN noted that the conceptualisation of the patient zone and healthcare zone could vary between trusts:

> "…different trusts have different ways of how they interpret it, even amongst us as infection control nurses." [IPCN03]

Sub-theme 3.3: Potential for cross-contamination in the workflow

The ways in which HCWs worked within the ward environment caused challenges for hand hygiene compliance and led to the potential for cross-contamination. The consistent application of the 5MHH was affected by how staff interacted with the environment and the items within it. Items touched frequently during the delivery of patient care included the patient privacy curtains, blood pressure cuffs, blood glucose monitors, and COW.

The potential for cross-contamination from patient shared equipment was a known issue. Most IPCNs stated that they had observed equipment being used in a way which had the potential to spread infection, as items were seen to be used on successive patients without being cleaned. It appears this was an accepted occurrence, with the task of cleaning equipment in between each patient an idealised practice rather than a common one:

> "…we're lucky if people clean in between kind of, the conversation about sort of SATS probes and blood pressure cuffs, it would be ideal for them to be cleaned between, but the likelihood is that they'll go from patient to patient to patient…" [IPCN01]

Although with some equipment it would be necessary to clean in between patients as they come into direct contact with the patient (e.g., blood pressure cuffs), others such as the COW or WOW can have their risk mitigated by appropriately timed hand hygiene. This would need to occur between the times when HCWs move their hands from the patient to the COW or WOW and vice versa. One IPCN mentioned this was something which they focused upon when delivering teaching:

> "…so, something like COWs or WOWs, how often they should be wiping them down, but having quite a lot of focus on hand hygiene element…" [IPCN01]

Some of the IPCNs reported having experienced outbreaks which were found to be related to patient shared equipment, such as commodes. The registered nurses did not identify any experiences where shared equipment had been the cause of any outbreaks. Though one noted that their approach to practice was influenced by the potential issues which glove use and portable equipment may cause: "…you would not wear gloves for using computer equipment or portable equipment..." [RN02].

One IPCN discussed how the potential role of shared equipment in the spread of infection is explored after there has been an outbreak of infection. At these times the focus became wider than just hand hygiene on its own, and was expanded to include the ways in which HCWs were integrating patient shared equipment into their daily tasks:

> "…when we have an outbreak management meeting, cleaning up equipment and environmental cleaning is so important, part of our outbreak and how the environment looks is so very- it forms a major part of our training, our discussion when we're doing our outbreak meeting." [IPCN03]

Patient privacy curtains were a key item which had the potential to impact hand hygiene compliance, particularly within multi-bed bays. As discussed earlier, HCWs may clean their hands in the corridor and feel compliant with moment 1 however, when approaching the patient HCWs then touch the curtains on the way into the patient zone resulting in a non-compliant moment if hand hygiene is not then performed within the patient zone at the bedside.

> "Yes, it comes up frequently moment one…in their mind they wash it already, and they come and touch the curtain, they touch their equipment, so in their mind they've already washed their hands in the corridor..." [IPCN03]

The categorisation of the curtains as being part of the patient zone or healthcare zone was identified as a potential source of confusion for HCWs. For one IPCN this was a common issue and they would try to provide clarity to HCWs when discussing how to apply the 5MHH around the patient zone:

> "…they don't realise things like curtains are part of the patient zone… when you're stepping in beyond there and you're going into the patient environment that's when you need to be doing moment one or stepping away that's when you need to be doing moment 5… just sort of being really clear in the defining

of it because the curtains are always the one that will catch people out." [IPCN01]

One registered nurse reflected on their practice and how the curtains can end up being touched whilst performing patient care tasks, particularly when wearing gloves, due to reflexive ways of working:

> "I personally don't really like the curtains because you tend to touch the curtains and sometimes not think about you having gloves on, you should not touch it with gloves on, um at certain situations around the bed space I think the curtains are the worst um, because you always- sometimes someone looks into the curtain or shout something out for you and it's like a reflex you're touching the curtain with gloves on…" [RN02]

Glove use itself posed a potential issue, with glove wearing seen by IPCNs as often acting as a barrier to hand hygiene meaning they found that compliance differed depending on whether or not gloves were worn. One IPCN observed that when HCWs performed similar tasks, those wearing gloves were less likely to cleanse their hands than those not wearing gloves. This was also linked to the issue of gloves being worn throughout an entire care sequence of multiple tasks without being changed:

> "…when they don't use gloves, they're coming from the patient bedspace they normally tend to gel their hands, well if it's the same person doing a task using gloves, they will do a lot of tasks for that one patient with the one gloves and they won't change it." [IPCN03]

Another IPCN also observed HCWs wearing gloves to provide care without changing them between patients, they thought this was informed by the HCWs themselves feeling protected by their gloves:

> "…placing gloves on can make some practitioners feel that they don't need to change their gloves in between each patient…" [IPCN01]

This feeling of protection whilst wearing gloves was raised by another IPCN who had observed HCWs completing 'dirty' tasks with gloves on and not performing hand hygiene after removing them:

> "Surprisingly, I do see people empty catheters and bed pans with a pair of gloves on, take their gloves off and just walk off… you're basically touching something that as a human, you feel is dirty. So even those innate reminders are not there, so that's quite concerning." [IPCN05]

This was raised by another IPCN who found when challenging HCWs about a lack of hand hygiene whilst HCWs were wearing gloves they reported that they felt their hands were clean, so hand hygiene was not required:

> "…some of them would tell me that… 'I was wearing my gloves, um so I don't think my hands are dirty.'" [IPCN02]

The opposite was experienced by one IPCN who found that HCWs were more likely to clean their hands following glove removal, though not before donning gloves:

> "They would wash their hands after they removed gloves, sometimes, but more often than not, they won't decontaminate their hands before." [IPCN04]

One registered nurse described how distractions during patient care activities meant it was easy for them to touch something within the ward environment which then contravened the 5MHH:

> "…staffing as I said is an issue, distraction, you're being asked so many questions about your patient, your bed space, you know it's very easy if you're medication- you're doing medications and you're being distracted by something else, the phone rings, you have a phone at the bed space so you know, it's very difficult to sometimes not just go for it, just to collect yourself and you literally need to be on alert all the time and I think we're all human beings and we tend to- sometimes another task overtakes the task you're doing." [RN02]

This type of situation, where hand hygiene is not complied with or there is the potential for pathogens to spread between high touch surfaces, was highlighted by an IPCN who also recognised that such breaches were not intentional:

> "…nobody wants to harm patients intentionally, they- when they know that they're going to be transmitting infections or organisms, they're not going to do that, they don't do it intentionally. And sometimes they're in a rush, like with the amount of workload they have it's difficult for them to actually do what they should be doing." [IPCN04]

6.3.4 Overarching theme four: Knowing and doing – the complexities of hand hygiene practice

Sub-themes and codes within this theme are shown in Table 6.6 (overleaf) The application of the 5MHH in everyday practice is complex and requires more than just the possession of

knowledge. The difficulties and common challenges in application of the 5MHH in the ward setting are discussed and the potential motivations for performing hand hygiene.

Table 6.6 Overarching theme four, sub-themes, and codes.

Overarching theme	Sub-themes	Codes
4) Knowing and doing – the complexities of hand hygiene practice	4.1 Challenges in the application of the 5MHH	*Common misconceptions*
		Translating theory into practice
		Complexity of integrating hand hygiene into practice
	4.2 Hand hygiene as embedded into daily practice	*Hand hygiene as a blanket approach*
		5MHH as protection for patients
		5MHH as protection for the self

Sub-theme 4.1: Challenges in the application of the 5MHH

Participants discussed specific beliefs and attitudes which affected how the 5MHH were applied by HCWs in everyday practice. Individual interpretations as to when and how to apply the guidance was identified as a potential issue. With one IPCN stating of the 5MHH, "…although I think they're not, they're very kind of subjective to people and what their own interpretation is…" [IPCN05]. Thus, HCWs may work to their own conception of the 5MHH which is likely to vary from person to person.

Although HCWs may have knowledge of the 5MHH one IPCN reported that this was not necessarily enough to enact practice consistently, and wider factors were likely to be involved in successful application of hand hygiene. This again touched on the point of intentionality, with the IPCN finding that HCWs were sometimes aware that they were missing an opportunity to perform hand hygiene:

> "…it's not that they don't know that they should- they're supposed to do that because they hide or they say 'sorry', sometimes when I when I approach them, I haven't even said anything and it'd be like, 'oh, I'm really sorry', because they know I'm an infection control nurse and I was like 'oh, my God, so she knows that she shouldn't have done that but she still did do it'. So that's why I thought before, like, like we shouldn't like- yes the education is really important it's vital in the role that we do but it's not just all about education we can tell people what they need to do as much as we want but we- if we don't make it easy for them to do what they should be doing they're not going to do it." [IPCN04]

In order to support HCWs with the effective application of the 5MHH, one IPCN stated it was important to be present on the ward either auditing or providing training. The IPCN found that as HCWs work within the clinical environment and apply the 5MHH, they can see how to translate the concepts across into their specific practice and embed that learning more successfully than in a classroom setting:

> "…whilst doing it in their day to day working and I think it embeds slightly differently. Rather than just showing them a diagram with the five moments and they go 'Okay, yeah', and then they didn't do any of it [laughs]." [IPCN01]

The practicality of the 5MHH was raised by another IPCN with regards to how easily transferable it is to practice with regards to recognition of the specific moments within care provision:

> "…it's not really that practical, I would say. I mean, in terms of it- I just don't think that the staff or- it's really effective in terms of reminding staff when they should be washing their hands because they won't care whether it's moment 1, moment 2, or moment 3 what they need to know is when exactly they need to wash their hands." [IPCN04]

The same IPCN reflected on their own time working as a registered nurse and stated they did not critically analyse their tasks to break them down into the relevant moments of the 5MHH:

> "…even working on the wards, I would say it wouldn't necessarily- I wasn't necessarily thinking, 'oh, is this moment one?', 'do I wash my-', moment one obviously is quite easy to, to remember it's before patient contact, but other moments you won't be critically analysing things like that and 'Is this moment two? Is this moment three? Am I entering moment four now?'" [IPCN04]

As well as integrating the 5MHH into their practice, HCWs also need to provide patient care whilst using PPE and working within the ward environment. This was seen as something which is not necessarily a straightforward task for HCWs to do successfully:

> "I think that's quite tricky, isn't it, when you've got to be able to put the apron on, close your curtains, put your gloves on, do your hand hygiene at the right times, and they might not feel confident to do those things or they might not have been shown to do it that way, or they just might think that that's the right way to do it." [IPCN01]

Sub-theme 4.2: Hand hygiene as embedded into daily practice

When considering decision-making to perform hand hygiene, one registered nurse found it better to err on the side of caution and rather than analyse or debate whether hand hygiene was required, they would just perform it. This gave them reassurance that they had "done something" and a sense of agency over their actions. This seemed to be more of blanket approach to practice and not necessarily aligned to decision-making in relation to the specific moments of the 5MHH:

> "You don't need to doubt whether "should I wash my hands or not?", just wash it so that, you know, that's over because if- it is more trouble if you don't wash but if you wash, take off the colony whether it doesn't need or need, take off the colony and you can carry on with, you know, that's in your mind that you've done something." [RN01]

More specific factors in decision-making and motivations for performing hand hygiene were also discussed. The main motivations identified were for the protection of HCWs themselves and for the protection of patients. The IPCNs saw the role of hand hygiene in preventing patient harm as an important motivation which could be harnessed to encourage HCWs practice. When speaking about hand hygiene training for HCWs one IPCN talked about framing it around safety for themselves and their patients: "…aim it in a way that you're trying to keep them and their patients safe…" [IPCN01]. This rationale of patient safety could be raised when IPCNs were challenging the hand hygiene practice of HCWs as a way of focusing on the ultimate aim of hand hygiene:

> "I've heard comments from staff saying that they need to save time, like they've got -like, let's say 12 patients to look after and they can't be decontaminating their hands every time and they keep telling them that 'yeah, I know, like it's your time, but what about the patient's time? They've got families waiting for them at home, but if they pick up hospital acquired infections because you didn't wash your hands, it's not fair on them'." [IPCN04]

One IPCN raised the issue of missing equipment as having the potential to impact the ability of HCWs to perform hand hygiene and therefore having a negative impact on patient safety, specifically the bed-end dispensers not being present which was a frequent occurrence:

> "…every ward should have alcohol gel dispensers by the end of each bed, but it's always missing… I think that's it, it's that they don't have it there, and sometimes they don't realise the impact that it may have on the patient." [IPCN04]

The IPCNs often raised the issue of non-compliance with moment 1 of the 5MHH being linked to HCWs feeling like their hands are clean. Sometimes this occurred as HCWs performed hand hygiene too early to be compliant to the moment. One IPCN considered the deeper motivations which could be at play, and that this was also linked to a deeper feeling of cleanliness on the side of the HCWs: "…they're thinking that 'I'm the healthcare provider', you know, they don't realise that they could be vectors of infection and organisms…" [IPCN04].

Whereas one registered nurse did reflect on the potential role of the HCW in being a source of pathogens which could have consequences for patients, as well as themselves and their own family:

> "…you don't know what- the bugs you are bringing in and you're going to, especially in an elderly ward, immunocompromised patients, you don't know what bugs you're going to hand to them, when you simply shake hands or something because you don't know. So, this is what's keeping you safe and your family when you go home… So probably that that's the greatest- that's the message we need to push through…" [RN01]

A stronger motivation of hand hygiene seemed to be for protection of HCWs themselves, rather than patients. This was reflected in the participants' experiences that hand hygiene compliance was more common for the moments following patient contact than for those before patient contact. Two registered nurses spoke about the patient as a potential source of infection, one stating that the patients were "the carriers of some sort of bugs" [RN01]. One reinforced the importance of hand hygiene after patient contact due to potential infectious pathogens:

> "…once you've touched the patient, a patient area, that's definitely- because now you have a sick person that you've touched you do not know exactly what bacteria, what viruses he's brought in. So that's definitely the most important I feel…" [RN03]

This aligned with IPCNs perceptions of HCWs motivations for cleaning their hands after patient contact, and the potential lack of knowledge around the HCWs posing a risk to the patients:

> "…they think that 'I need to protect myself', they've got this perception that 'I might get something from the patient' without realising that the patients are more susceptible to whatever it is that's- that might be on their hands." [IPCN04]

6.3.5 Overarching theme five: COVID-19 as both a driver and barrier to optimal hand hygiene practice

Sub-themes and codes within this theme are shown in Table 6.7. At the beginning of the pandemic hand hygiene was seen as a key behaviour for the prevention and control of the spread of COVID-19, both in healthcare settings and wider society. Participants discussed motivations for HCWs performance of hand hygiene during this time. A major concern of HCWs was to avoid catching COVID-19. The use of PPE increased during the pandemic, with guidance released which mandated use of items such as gloves, aprons, and fluid resistant face masks when delivering care to all patients whether or not they had received a negative COVID-19 test result. Participants found this led to issues around overuse and overreliance on PPE.

Table 6.7 Overarching theme five, sub-themes, and codes.

Overarching theme	Sub-themes	Codes
5) COVID-19 as both a driver and barrier to optimal hand hygiene practice	5.1 A change in hand hygiene behaviour	*A temporary change*
		Increase in awareness of hand hygiene
		Increased hand hygiene not always linked to 5MHH
		Motivation to perform hand hygiene
	5.2 Implications of PPE use	*PPE leading to IPC issues*
		Wearing gloves has become habitual
		Staff reducing adherence to PPE use
		Increase seen in other infections

Sub-theme 5.1: A change in hand hygiene behaviour

Participants found that hand hygiene awareness and performance increased at the beginning of the pandemic. This included an increase in the provision of hand hygiene equipment around their healthcare settings and application of hand hygiene by HCWs in a wider sense:

> "…in terms of changes particularly during the onset of the pandemic and through the first- second wave, they were cleaning their hands as much as they could, they became obsessed with hand hygiene measures, soaps, disinfectants, not just that, even with disinfecting their workspaces and everything erm yeah something like that. So, definitely hand hygiene measures or the hand hygiene practices really shoot up like never before." [IPCN02]

One IPCN found there was an increase in awareness of hand hygiene, though this could be linked to the types of patients who HCWs were caring for as to the strength of the impact the pandemic had on hand hygiene behaviour:

> "…it's very dependent on where you go, who- what patients- demographic people are looking after in those areas erm, but it's definitely on people's minds, people are much more aware of it." [IPCN05]

The IPCNs noticed an initial increase in hand hygiene practice in their settings, though as time progressed most said that this had then been "starting to wear off" [IPCN02]. This linked to a comment from one registered nurse who thought that the increases in measures were more of a temporary effort: "At the moment, it is a temporary feeling, you know, we must do, when we are COVID free until then we must do this practice…" [RN01].

Two IPCNs found that although hand hygiene practices had increased this was not necessarily occurring at the moments of the 5MHH:

> "…you can see people just- they are cleaning their hands more but whether or not they're attached to specific moments erm, yeah, I think it's just generally like now when I come in in the morning, the main entrance, I see people cleaning their hands and they come in, they clean their hands before they put a mask on erm, a) because it's there, it never used to be actually as many dispensers there but people are thinking about just hand hygiene more." [IPCN05]

For one IPCN this resulted in a sense of frustration as they clearly stated that "...in terms of the hand hygiene in the five moments according to WHO, nothing has changed." [IPCN03] during or following the pandemic. This IPCN felt that the opportunity to capitalise on the increase in awareness of hand hygiene and focus it in on the 5MHH had been missed:

> "…nothing changed that- that moment when we have to do the moment in terms of spreading the transmission of COVID from one patient to another, it's nothing changed in there. There's no improvement in that one, but what has changed is the, the unnecessary stuff, I call them the unnecessary hand hygiene because, because now the Trust put something in each entrance you have the hand hygiene gel, you have your gel, you have your mask there, to gel your hands- to gel their hands and then that- that's all, nothing, nothing, what is happening in that patient zone, it remains the same. I wish, I wish this pandemic could have transformed that one in terms of, in terms of doing that." [IPCN03]

Participants discussed the main motivations for hand hygiene during the COVID-19 pandemic. Both IPCNs and registered nurses found self-protection was a major motivator for hand hygiene during this time. This was seen especially when caring for patients with COVID-19 when the focus was on “how are we going to protect ourselves” [RN03]. The worry about catching COVID-19 caused HCWs substantial anxiety and stress, further strengthening the motivation for self-protection:

> “…it's really scared us so that, you know, only method is wear mask and wash your hands, so we did really yeah.” [RN01]

> “…I think people were so paranoid and so scared that they wanted to protect themselves more so than the patient.” [RN02]

One IPCN observed practice which suggested that HCWs perceived patients as being the potential source of COVID-19, not their colleagues, this affected when they used their PPE: “they want to put on all this PPE” [IPCN03] and were later observed to have no PPE on when sitting with colleagues. These beliefs impacted their perceptions of risk:

> “…they forget that staff we are humans, just like our patients, but they see their patient like the reservoir of the COVID. They are- they themselves the staff they’re not reservoir at all… it makes it worse in terms of us seeing our patient as the key part in terms of preventing infection to them, we just- we just- now it's even worse, now we just want to protect ourselves.” [IPCN03]

Sub-theme 5.2: Implications of PPE use

The IPCNs noted a heavy reliance on PPE as a means of protection from COVID-19: “…they think that it's like a big shield that protects them from everything.” [IPCN04]. The use of PPE led to issues around its correct usage in the ward setting and difficulties in hand hygiene performance. In particular, the use of gloves was seen to discourage or prevent HCWs from performing hand hygiene at the required times. This led one IPCN to say “…people would rather protect themselves with a piece of plastic than they would actually clean their hands.” [IPCN05]. Another discussed how they saw the pandemic as leading to a decrease in appropriate hand hygiene due to glove usage:

> “…I think in some ways hand hygiene has become less in some of the areas because of the pandemic, and not- it's not because- it's counterintuitive isn't you’d think that because of the pandemic, they would be washing their hands more but the problem is the gloves because of the pandemic, they're so scared, they're going to be wearing gloves for everything that they're going to do and

> that stops them from washing their hands or from gelling their hands. But yeah, hand hygiene after removal probably increased, but not during patient care because they're wearing gloves most of the time." [IPCN04]

The registered nurse who worked in an ICU spoke about their experience around the use of PPE during the pandemic, particularly changes in practices which were in place at the beginning and how these potentially led to the spread of COVID-19: "…unfortunately, we learnt very quickly that we ourselves spread the COVID around in, you know, gelling our gloves, not taking the gloves off after each patient encounter really." [RN02]. Particular issues arose for this registered nurse and their unit around the use of long-sleeved gowns:

> "…you know with the gowns that was not helpful because, especially when proning patients you go with a long sleeve really under the patient and then because you're an enclosed COVID environment, would then go to the next patient with the same gown on. Obviously, you did not wash your arms. We learn that as well and that has been now tackled and changed, led to practice changes where we cut our arms off some gowns just to wash our arms, we always take our gloves off between patients and wash hands or gel hands." [RN02]

The two registered nurses who worked outside of an ICU setting stated that they did not experience any challenges with wearing PPE during the pandemic: "So we make sure if you're gloved, you know, remove your gloves, wash your hands before and after donning a glove, or wearing your mask, or using the eyeglasses, yeah before and after, yeah." [RN03].

The increase in glove usage over the pandemic resulted in issues around their continual usage even when gloves were no longer indicated for use, especially on wards which were once designated for COVID-19 patients:

> "…people just got into the habit of wearing gloves for everything… At the moment, they're no longer a COVID ward, they would wear gloves for, taking observations, for feeding patients even, and I'm like, 'no, you shouldn't'." [IPCN04]

On the other hand one IPCN noted that it had been difficult to get HCWs to continue to wear the appropriate PPE, with adherence reducing over time:

> "We're finding it difficult to make the staff members adhere to the appropriate use of PPE at the appropriate time now when in fact, two, three, four, five, six months ago they all wanted to wear FFP3s, they wanted to wear gloves. But

> now, like I said, it's starting to wear off and they just find it uncomfortable. They just find it too much, they're tired and they're fatigued with all of these crazy COVID things that they've gone through for the past year." [IPCN03]

Through their experiences during the COVID-19 pandemic both IPCNs and registered nurses found there was an increase in other infections amongst patients including MRSA bacteraemia, bloodstream infections, and skin infections. Participants linked these increases to various factors stemming from the pandemic and the ways in which HCWs were working within the ward environments. With one IPCN saying this indicated to them that: "…that's either people are not doing their hand hygiene properly or they're not cleaning the equipment they're using properly." [IPCN03].

Moving between different patients without appropriate hand hygiene in the ICU setting was identified as one of the ways which HCWs increased the risk of the spread of infection. This was further exacerbated due to changes in staffing, workload, and PPE requirements (e.g., use of gowns) which led HCWs to sometimes move between multiple patients whilst not having the opportunity to change their PPE:

> "…you have to go from one bed space very quickly to the other bed space and you might not be able- even if you wanted to do proper hand washing and taking gloves off you know, taking your apron off wash your hands before you go in the next bed space. And I think that has also led to a lot of infectious spread between patients and it was quite an issue in our unit, where also because of the long sleeves that we were wearing at the time, the gowns, we were tracking along, you know, germs from one bed space to the next because of long sleeve issues." [RN02]

Due to increased pressures within ICU this seemed to be a common occurrence, with one IPCN noting they had observed similar practices:

> "…particularly in ICU settings erm, we did have an increase in MRSA bacteraemias and other bloodstream infections. Not only was it the PPE, it was the fact that you've got critical care nurses caring for more than one patient who is very sick and you're stood in the middle of them, dealing with one patient with your gloves, your long sleeves gowns on and then the other patient's deteriorating and you quickly help them and people were gelling gloves- I saw some gelling gloves every so often as well and I try to remind that, you know, that's not good erm, just clean your hands…" [IPCN05]

6.3.6 Overarching theme six: EMSs provide a passive system for measurement

Sub-themes and codes within this theme are shown in Table 6.8. Participants discussed the perceived benefits and drawbacks of counter-based EMSs for monitoring hand hygiene practice. Both the pros and cons can be seen to be related to the passivity of an electronic system. With benefits stemming from its constant monitoring, such as capturing practice outside of the normal audit program. Alongside potential drawbacks, such as a system being unable to actively monitor the context within which hand hygiene occurs.

Table 6.8 Overarching theme six, sub-themes, and codes.

Overarching theme	**Sub-themes**	**Codes**
6) EMSs provide a passive system for hand hygiene measurement	6.1 Building a picture of practice	*Measure of reality of practice*
		Inclusion of time periods not normally audited
		Time could be spent on other IPC activities
		Working in the background collecting data
		Knowing there is constant monitoring could improve practice
	6.2 Practice requires context	*Does not highlight individual practice*
		Unable to specify hand hygiene practice issues in context
		Staff may perform hand hygiene to game the system

Sub-theme 6.1: Building a picture of practice

The passivity of the EMS was seen to allow for a more realistic picture of hand hygiene practice to be constructed. This was due to an EMS being able to run constantly, and unobtrusively, in the background allowing for more data to be captured than could be achieved via direct observational audit.

The EMS which was discussed captured hand hygiene activity through counters within existing dispensers. Two of the IPCNs thought that this kind of system would go largely unnoticed by HCWs, unlike direct observational audit. Due to its covert nature and ability to capture practice 24/7 two IPCNs thought this could reduce the impact of the Hawthorne effect on hand hygiene, capturing data which was more representative of everyday hand hygiene practice:

> “I think obviously an advantage is that it may not have that Hawthorne effect someone’s not stood there with a clipboard or with an iPad clearly doing

> something erm, so people will be more, you know, people will just be more natural" [IPCN05]
>
> "…it's doing it all the time so you're not going to get that Hawthorne effect… They're just going to be doing their normal practice." [IPCN01]

Two IPCN noted that use of an EMS would provide data regarding practice not usually included in direct observational audits, such as during night shifts and at weekends:

> "…night shifts and weekends is obviously something that people don't really audit… and I know that people tend to work very differently than they do in the day, so that would be good to get that data." [IPCN05]
>
> "…because when we've got outbreaks, we would be looking at hand hygiene scores and, you know, but those audits are happening during the day. So what if those transmissions are actually happening during the night when nobody's watching? So I think it's good to have that as well, and obviously people aren't going to do hand hygiene observations overnight. If you've got an electronic system, it will be a really good adjunct to the already existing auditing process in place." [IPCN04]

As an EMS would be able to operate in the background this was identified as allowing for a greater amount of data to be collected than during standard audits: "…it's not just that 20-minute period it's creating more levels of data so you can get more results from that." [IPCN05]. Three IPCN's highlighted various areas where they would focus any additional time an EMS may provide them with. This included: providing education and training around donning and doffing of PPE within the 5MHH; application of the 5MHH in clinical practice; developing hand hygiene interventions; conducting environmental audits; training around correct timing of equipment cleaning; and working with housekeeping staff to understand their processes. Opposing this, one IPCN stated of an EMS, "…it's a good addition, but I don't think it's going to free up a lot of time for the IPC practitioners." [IPCN04].

There was a perceived strength in the passivity of an EMS as one registered nurse highlighted that knowing there was a system monitoring practice may drive practice more than direct observation of practice:

> "…if they know that the numbers going to the machine, it is a self-responsibility that somebody's keeping an eye on me straight away… so everybody will be

alert about that, it is more, more I think people will be more compliant than if somebody's standing at the door with the diary or ticking the boxes." [RN01]

Sub-theme 6.2: Practice requires context

On the other hand, the passivity of the EMS meant participants had concerns that it could not detect nuance in practice or practical issues which may impact hand hygiene compliance. One IPCN thought that a ward-level approach to measurement may not motivate individuals to engage and take ownership of their hand hygiene practice. They suggested that if ward staff were allocated to particular bays and the system could break down compliance into smaller areas this may encourage staff feel as though the system is more focused on their individual practice:

"…when it's covering the whole ward, it tends to not to be more effective because people don't think that's- people, individual people don't own it but when it- place it in different bays individual nurses are responsible for the bays feel like they own it- it's our- it's me, my, my practice they are measuring." [IPCN03]

With a similar point, one IPCN noted that a ward-level system would not be able to break compliance down by professional role. This was something which they did in their current audits to ensure their feedback was given to the appropriate groups:

"…with our current audits we break it down, the different professions, like we've got for the nurses, healthcare assistants so that we know who to take it up to… in order for you to address the problem and to know who you need to take it up to, you need to find out who are not, you know, doing what they should be doing." [IPCN04]

There was a worry from one registered nurse that the good hand hygiene practice of some ward staff would disguise the poor practice of others, this issue could be masked by a ward-level system:

"…except maybe one person, multiple people, may not be doing adequate washing or hand hygiene, but maybe others, maybe somebody who is anxious staff somebody maybe to the extent that we cover everyone, you know." [RN01]

When HCWs are audited, they are working with the context of the ward. Gaining knowledge of specific problems which are affecting hand hygiene practice was important to IPCNs so "…they would know how to probably tackle it through different types of interventions." [IPCN02]. Without this information it would not be possible to design appropriate changes to

practice to drive change. Participants discussed the ways in which an EMS may not be able to distinguish issues which are related to the ward environment, or the ways in which HCWs work within it, which might be impacting on hand hygiene practices:

> "…it would be limited to the- just the quantitative side of things like how many, but you won't necessarily see why or what was the circumstances surrounding the failure, the failed hand hygiene…" [IPCN04]

> "…I think that would be a disadvantage and not knowing which moment, or which- which barriers there are for people when they're not complying it obviously makes it difficult to then do anything about it." [IPCN05]

Two registered nurses noted that an EMS may also not be able to quantify the quality, or correct timing, of practice:

> "It doesn't really tell you how well you do it, it only tells you that you do it..." [RN02]

> "…it's smart but it doesn't have a sense as to where it has to be done." [RN03]

Superfluous use of the dispensers which are part of an EMS was raised as a potential issue by three participants, two of them registered nurses. They were concerned that HCWs may use the dispensers when not required in order to game the system and increase compliance rates:

> "…well, actually we haven't seen the patient, but just to get a good rate, we have made sure we washed our hands." [RN03]

> "I think as any system that's electronic I think it can be cheated so that comes first to mind, so if someone wants to look good on their shift, they might just press the button so that comes to mind." [RN02]

6.4 Discussion

6.4.1 Key findings and implications

Interviewing frontline HCWs has provided experiential data which creates a richer picture of the application, and audit, of hand hygiene in everyday practice, along with the various factors which influence its performance. This section will discuss some of the main findings, relate them to other literature in the area, and explore wider implications to practice.

The current state of audit

The IPCNs interviewed raised the issue that, in their experience, data generated by ward-led direct observational audit of hand hygiene is an inaccurate representation of the reality of practice. This made high compliance rates submitted from ward-led audits a source of concern rather than an assurance of good practice. Previous literature has well established the disadvantages stemming from direct observational audit data, particularly the Hawthorne effect which clearly highlights that using this method is likely to provide inflated compliance results (Gould et al., 2020). Persisting with using this method of audit ultimately culminates in data which is known to be invalid and likely leads to overconfidence in current practice (Purssell et al., 2020).

There was recognition from both IPCNs and registered nurses that HCWs may perform hand hygiene more stringently when an audit was in progress. It appears the issues surrounding direct observational audit are often known to those who are subject to audit, and those who collect audit data. In a similar vein to these findings, one recent study found HCWs considered direct observation of hand hygiene to be ineffective and unhelpful due to the Hawthorne effect, and the risk of audit results being forged and inaccurate (Cawthorne and Cooke, 2020). This suggests that it is widely known that although direct audit is presently the gold-standard audit method, it captures imperfect data that does not reflect the reality of practice. Despite these limitations being widely known, the routine use of this approach to audit persists.

The audits which IPCNs conducted themselves were perceived as more valuable than ward-led audits. Their expertise in IPC meant that these audits were seen as an interrogation of practice which could situate hand hygiene in the larger context of the workings of the ward, and the ways in which care was delivered. Without this specialist knowledge it may be that HCWs lack the critical application of IPC principles, potentially missing nuances such as how hand hygiene is integrated into care when using patient shared equipment. Those not specialist in IPC are unlikely to view their daily tasks and environment through the lens of IPC. Alongside this, the competing priorities of frontline care make it challenging for audits to be performed thoroughly due to time constraints and staff availability (Livorsi et al., 2018).

Integrating technology into existing audit practice

The commitment which IPCNs had to their own audits also had practical implications for their thoughts on the role of an EMS for hand hygiene. There were concerns surrounding EMSs inability to capture detail regarding the quality of hand hygiene practice. This included aspects such as the technique (e.g., method and length of time hand cleansing is performed

for) and correct timing of hand hygiene according to the 5MHH. As these elements are captured in direct observational audits, they were important to IPCNs as they ensured not only that practice occurred but also determined the quality of that practice. Poor quality hand hygiene technique may not remove pathogens from hands adequately and so this is a crucial aspect to explore when evaluating practice (Creamer et al., 2010).

An EMS was seen as a helpful adjunct to IPCNs own direct observational audits of practice, not as a replacement. Indeed, other literature has raised the idea of embedding two methods of auditing hand hygiene to provide an effective assessment of practice (Cawthorne and Cooke, 2022; Magnus et al., 2015). An EMS could quantify the occurrence of hand hygiene activity, alongside direct observational audits which allow for qualitative exploration of the quality of that practice.

Participants recognised that using an EMS which acts passively to audit practice would avoid the Hawthorne effect. The impact of the Hawthorne effect during observational audit is well supported in the literature, and studies into EMSs show that they generate more realistic compliance rates that are unaffected by the Hawthorne effect (Gould et al., 2020; Hagel et al., 2015). Though there were some concerns that HCWs may 'game' an EMS by using it when not required to generate higher compliance rates, a concern which has been previously reported in the literature (Dyson and Madeo, 2017).

A focus on infection control rather than infection prevention

As a discipline, IPC seemed to work in a way which was reactive once an infection had occurred, rather than acting proactively and focusing on prevention. Outbreaks of infection were a demonstration of the consequences of poor IPC practice and potentially triggered a sense of personal responsibility in HCWs. As such this could lead to greater engagement with the IPC team in terms of providing time for training on the ward and ensuring staff attendance. This increased interest in hand hygiene by HCWs during outbreaks can be driven by a renewed focus on patient safety, stopping the outbreak, and protecting themselves from becoming infected (Kovacs-Litman et al., 2020). Interestingly, self-protection was not identified by participants as a reasoning for increased interest in hand hygiene during an outbreak.

Embedding the 5MHH in practice

Applying the 5MHH in practice means doing so within a dynamic hospital environment which has many items of equipment within it, as well as multiple patients. Embedding appropriate hand hygiene into practice conducted in this space is evidently challenging. The ways in

which patient shared equipment and COWs were observed by IPCNs to be used demonstrated that these items could be a risk in the spread of infection. Sax and Clack (2015) discuss ‘mental models’ which represent our unconscious understandings of our environment. Applying this to the ward environment, mental models for hand hygiene would potentially benefit from embedding of knowledge regarding the patient zone and the healthcare zone. These concepts did not seem central to the way in which the 5MHH were taught or applied. Though the zones may seem a relatively simple division of space, these concepts also need to account for the digital world of the ward environment, with portable equipment being moved in and out of patient zones and used in the patient bedspace. This would require a nuanced mental model which is flexible enough to apply principles of IPC to the various objects used in care delivery, many of which move around the ward and between patients.

Reasons reported to IPCNs for non-compliance such as being busy, forgetting or being distracted, not recognising the moment, lack of staffing, alongside insufficient resources are commonly found in the literature (Sadule-Rios and Aguilera, 2017; Smiddy, O'Connell and Creedon, 2015). When focusing on specific moments, other more nuanced issues were raised. The non-compliance at the moments of hand hygiene before patient care was a key issue. A common issue related to this being that HCWs may clean their hands and then touching items in the healthcare zone, such as equipment or the patient privacy curtains, before touching the patient which invalidates their hand hygiene activity and leads to non-compliance. Other literature reflects ongoing compliance issues with the moments before patient contact (Kim and Hwang, 2020). This is potentially influenced by HCWs perceptions of the patient as ‘contaminated’ and not themselves. The crucial focus here is for HCWs to cleanse their hands before patient contact to avoid the transmission of pathogens to patients, however literature also shows that holding this knowledge may not always influence practice (Woodard et al., 2019).

Elements of practice which were reported as particularly impacting the moments before patient contact were: the placement of hand hygiene dispensers in the corridor; HCWs perceiving their hands were already clean or were clean as they were wearing gloves; missing bed-end ABHR dispensers; working within a bay with multiple patient beds; and lack of awareness of the potential role of patient privacy curtains in the spread of infection. Gloves and curtains are commonly mentioned in the literature as being sources of contamination and a potential factor in the occurrence, and spread, of HCAI (Brown et al., 2020; Mahida et al., 2014; Jackson et al., 2018). The participant’s experiences further demonstrate that these are persistent issues.

It is crucial for HCWs to understand how the movement of their hands around the environment, including contact with equipment and curtains, results in hand contamination and the transfer of pathogens between surfaces. As this impacts the timing of the moments at which they should decontaminate their hands. These persistent issues suggest that when practicing hand hygiene, HCWs do not analyse their movements around the care setting or when providing patient care in terms of the 5MHH. How achievable it would be to do this consistently is a critical issue for the practicable application of the 5MHH.

The idea of taking a pragmatic approach to hand hygiene practice was raised in the literature more than 15 years ago by Cole (2007), who proposed that ongoing compliance issues raised the question of whether standards are achievable or merely theoretical. The 5MHH has recently come under renewed criticism with suggestions that it is not possible to adhere to them at every opportunity (Gould et al., 2021). Gould et al. (2021) propose the 5MHH could be augmented and applied at 'set points', though no further detail is provided so it is not clear how this would work in practice. They suggest this approach as they assume a stochastic model of infection transmission, reflecting that spread of infection is not determined in every instance of non-complied hand hygiene. They also highlight that these 'set points' would require adaption dependent on patient vulnerability and outbreak situations. This is presumably due to the potential for worse outcomes under these circumstances if the 5MHH are not adhered to stringently.

In response to Gould et al. (2021), Allegranzi et al. (2022) focus on a wider improvement strategy which may assist in implementing the 5MHH. This included tailoring training for the specific situation, providing suitable infrastructure in terms of equipment, alongside prompts to remind HCWs to perform hand hygiene. They do not suggest a pragmatic approach to the 5MHH as Gould et al. (2021) do. Allegranzi et al. (2022) present images showing the 5MHH tailored to different patient care environments (e.g., residential care homes, ambulances), and different care tasks (e.g., caring for a post-operative wound, administering a vaccination) (Appendix 14). Though these static images may act as a prompt or teaching aid, the 5MHH still require embedding into the dynamic working environment of individual HCWs. These two recent papers acknowledge the implications of applying hand hygiene guidance in the real world and the challenges this creates.

Motivations for applying knowledge in practice

The papers from Gould et al. (2021) and Allegranzi et al. (2022) do not discuss the individual motivations which may impact performance of hand hygiene, something which this phase of

the research found to be a key driver of practice. This appears to be the additional step between possessing the required knowledge to applying it consistently in everyday practice. The moments for hand hygiene after patient contact were reportedly easier for HCWs to comply with than those before patient contact. The main driver of this appeared to be self-protection, which was interlinked with the perception of the patient as a carrier of infection.

These findings clearly link back to the ideas of elective and inherent hand hygiene practice (Whitby, McLaws and Ross, 2006). The inherent feeling of needing to clean hands after patient contact appeared to make hand hygiene at these moments more achievable. Whereas the moments prior to patient contact would require elective hand hygiene. This would need to be driven by knowledge that a HCWs hands carry pathogens, either from their own resident flora or transient flora, which are a risk to the patient. As hand hygiene at these moments would need to be completed on what individuals perceive as their 'clean' hands, this lacks the visceral motivation of disgust or self-protection that occurs when hands are either overtly, or emotionally, dirty following patient contact (Whitby, McLaws and Ross, 2006; Curtis and Biran, 2001).

How COVID-19 impacted hand hygiene and IPC practices

The pandemic created a unique circumstance which further cemented the focus of HCWs to perform hand hygiene for the protection of the self, over the protection of patients. This focus on self-protection driving hand hygiene practice during the COVID-19 pandemic is something which has been reported in the literature (Huang, Boudjema and Brouqui, 2021; Stangerup et al., 2021). It was noted in this study that that HCWs viewed patients as a greater potential source of COVID-19 than their colleagues, which decreased their use of PPE in staff common areas. This issue was also noted by Rebmann et al. (2021) who found outbreaks of COVID-19 in HCWs where there had been a lack of mask wearing in staff rooms and non-patient care areas.

The use of PPE created issues of its own, with concerns that increased glove use made it more difficult for HCWs to comply with the 5MHH. It could also be that an increase in focus on the use of PPE created a feeling of reassurance for HCWs and had the potential to reduce hand hygiene practice (Tartari et al., 2020). As a consequence of increased PPE, and lack of hand hygiene, IPCNs recalled an increase in infections other than COVID-19. This is something which has been reported in the literature as an unintended consequence of IPC practices during the pandemic (Knight et al., 2021; Wee et al., 2021). One registered nurse recounted the wearing of long-sleeved gowns on the ICU, which were not always changed between patients, as a key factor in the spread of infection, along with decreased

staffing and increased patient numbers. The role of long-sleeved gowns has been reported as a particular issue in the COVID-19 pandemic as they can act as a barrier to hand hygiene, and sessional use of gowns may add to contamination of the environment as they are worn for longer periods and across different areas of the ward (Meda et al., 2020).

There was also a common experience of an initial increase in interest in hand hygiene by HCWs at the beginning of the pandemic which faded over time. Self-protection could again be a factor in this, as HCWs may have caught the virus and felt safer upon returning to work, and as the numbers of vaccinated HCWs increased this could have influenced HCWs to become less stringent in their IPC practices. In addition, engaging with increased in IPC measures such as PPE and hand hygiene for a prolonged period can lead to fatigue amongst HCWs (Rebmann et al., 2021).

6.4.2 Strengths and limitations

The COVID-19 pandemic created challenges for data collection in this phase of the study. Recruitment changed from recruiting HCWs at the hospital site where observations took place to recruiting UWL students who also worked professionally in the relevant roles. This was due to an exceedingly long wait for approval from the research and development department at the hospital site due to the closing down of all research studies during the first wave of the pandemic. The original plan to interview the HCWs who had been observed in Phase 1 would have provided insight into their specific observed practices. However, the participants who were recruited worked across different organisations. As they discussed similar experiences and issues this strongly suggests that these findings are universal to some extent and would be applicable in not only their organisations but the hospital where observations took place, and across the wider healthcare sector.

The university was delivering teaching online for most of the recruitment period due to COVID-19, this meant information about the study had to be shared via student message boards and webinars. It was particularly challenging to engage with those working as registered nurses or nursing assistants. Once teaching returned on campus, more information was provided to the relevant student groups in-person to try again to recruit participants working these roles. An incentive was also offered in the form of a £10 gift voucher to reimburse participants for their time. Ultimately, it was a disappointment not to recruit any nursing assistants for interview.

Reflecting on the differences between recruitment of these groups potentially indicates that the nursing assistants and registered nurses may not feel empowered or confident enough

to take part in research and reflect on their own practice. It may also be that those who did participate had a particular interest in hand hygiene. The specialist role of the IPCNs was evident in their passion for the subject, it was therefore relatively easy to recruit these individuals and gain insight from them during interviews as they are familiar with discussing hand hygiene practice in detail. This was more of a challenge with the registered nurses who did not have as much depth of insight as the IPCNs. There is a possibility that social desirability bias impacted the content of the interviews, particularly the registered nurses as the IPCNs were reflecting on practice in general rather than their own practice. Therefore, the registered nurses could have been providing answers which related to an idealised sense of their own practice rather than a candid reflection on their actual practice.

6.5 Chapter summary

The interviews with HCWs presented in this chapter have allowed for the exploration of staff perceptions and experiences across multiple healthcare organisations. The findings from observation of practice in Phase 1 were able to be explored with participants. Analysis revealed universal aspects in their experiences and raised key issues around the value of auditing, how EMSs could be adopted into existing IPC systems, application of the 5MHH in daily practice including the main drivers of hand hygiene behaviour, and the impact of COVID-19 on practice. Six themes were developed around these elements, evidenced with quotes from the participants.

6.6 Conclusions and implications for the thesis

The interviews in Phase 2 have raised important debates around the suitability of the current system of direct observational audits, as to whether they represent practice adequately enough to provide insight into HCWs hand hygiene practice and in turn, act as a driver for change. The ways in which new technologies could support, not replace, the expert audits performed by IPC practitioners was raised as a key reflection on how EMSs would be envisaged as being integrated into existing audit practice. How IPC often works in response to outbreaks of infection, rather than their proactive prevention, may have intrinsic links into existing practices on the frontline which are only challenged once the consequences of poor IPC practice are revealed, such as with the occurrence of infection.

Various environmental and practice factors influenced hand hygiene practice and demonstrated the potential complex task of incorporating practice into common ways of working within the ward environment. Additional to the ward layout and workflow are

individual motives and innate emotions, with the motivation to perform hand hygiene for the self-protection perceived to be the strongest driver of practice. This is likely to be interlinked with innate emotional responses of disgust and the categorisation of clean versus dirty patient care tasks, which elicit the need to cleanse hands. The ingrained ways in which patient care is delivered within the care environment also impacts the generation of hand hygiene opportunities and compliance.

How these findings relate to observed practice in Phase 1 will be explored in the next chapter which will bring together the findings from both phases and discuss them in relation to the elements of the COM-B model of behaviour.

Chapter 7 Discussion

7.1 Chapter overview

This chapter will explore and integrate the findings of both Phase 1 and Phase 2 of the research. In doing so it brings together the findings from observation of hand hygiene as applied in frontline practice, and the perceptions and experiences of those working on the frontline of direct patient care and IPC practitioners. The discussion is framed around the key findings and how they build an overall picture of hand hygiene, and how the components of COM-B could further explain practice. This provides a deeper exploration of the implications of the findings in light of capability, opportunity, and motivation leading to the performance of hand hygiene. A brief overview of the COM-B model will be provided in Section 7.2.

7.2 COM-B model

The COM-B model was described in Chapter 3, Section 3.2. The model was developed by Michie, van Stralen and West (2011) as part of the BCW which provides a practical tool for identifying key drivers of healthcare professionals' behaviour which also encompass the 14 domains of the TDF. In this research the questions schedules were designed using the TDF to ensure many differing aspects of behaviour which could influence hand hygiene practice were explored. This enables the factors underlying behaviour to be explored and in doing so provides a foundation for developing behaviour change interventions targeted at these factors.

Briefly, the COM-B itself explores an individual's capability to perform the behaviour which includes both physical and psychological capability. Opportunity considers the physical environment and systems within which the behaviour occurs, and social opportunity in terms of the wider culture where behaviour is embedded. Finally, motivation includes automatic drivers of behaviour and reflective conscious decision-making. The COM-B model has been used in previous research to inform the design of questionnaires related to exploring factors influencing HCWs hand hygiene practice (Lydon et al., 2019; Lambe et al., 2020).

The following section will discuss the key findings in terms of the various motivations, or lack thereof, for performing hand hygiene within the inpatient ward environment. This will touch upon how well audits currently motivate behaviour, the impact of outbreaks of infection on hand hygiene engagement and behaviour, the potential scale of improvement needed in the area of hand hygiene practice, and self-protection as a driver for hand hygiene both before and during the COVID-19 pandemic. There were key perceptions around differing levels of capability for conducting hand hygiene audits which impacted the acceptability of the data

they generated. Observed practice revealed that capability around the 5MHH themselves are likely a key driver in decision-making and practice. The opportunity to perform hand hygiene was also led by the actual physical environment, and social opportunities in terms of interpersonal dynamics on wards and within organisations, and the social norms stemming from embedded audit programmes.

7.3 Discussion of key findings and the elements of COM-B model

7.3.1 Auditing of hand hygiene practice and the drive for change

Systems of audit and feedback are used to monitor key IPC practices to ensure they meet the required standards, highlight areas for improvement, and to track progress over time. Audits also provide a way of measuring practice to provide feedback to HCWs regarding their performance. This is particularly important with hand hygiene as individuals often overstate their compliance levels in self-assessments as they are unable to accurately assess their own practice (Cole, 2009; Kelcikova et al., 2019; Lamping et al., 2022). For audits to do this effectively they need to provide data which is an accurate representation of the practice they measure.

The stark contrast between compliance with the 5MHH of 20% observed in this research and targets of 90% or over, which are commonly reported as being achieved in ward-led audits, highlights the potential discrepancy between the reality of hand hygiene practice and compliance rates generated via auditing. This finding is supportive of the assessment of the IPCN interviewees, that compliance rates of 90% or more are unlikely to be indicative of everyday hand hygiene practice on inpatient wards and at odds with their own experiences of seeing hand hygiene in practice.

The EMS running on two wards during Phase 1 of this research generated an average compliance rate of 26%. This is close to the observed compliance of 20%, and a much more realistic representation of hand hygiene practice than ward-led audits reporting >90%. Indeed, the observed and EMS generated compliance rates are similar to rates reported in recent literature. A study in Canada found 28% average hand hygiene compliance as measured by an EMS (Tremblay et al., 2022), and another EMS study in the USA found between 27% to 35% daily compliance on an ICU (Xu et al., 2022). These findings demonstrate that low hand hygiene compliance is an ongoing issue which is likely to be common across the healthcare sector.

Observation of practice found consistent hand hygiene compliance rates of around 20%. Compliance was similar across the two wards where observations were performed, during day shift and night shift, whether gloves were worn or not, and between the two periods of before and during the COVID-19 pandemic. This suggests that practice was ingrained at this level on the wards as the norm. As audits often report acceptable levels of hand hygiene there is no additional social pressure within ward teams to change practice from the norm as practice is not identified as lacking, creating further reinforcement of inadequate capabilities.

These findings indicate that audits which report high levels of compliance are likely to be inaccurate, this brings into debate their role in motivating practice. As audits often report >90% hand hygiene compliance this provides HCWs with data indicating they are meeting the required targets. This therefore does not provide any motivation for HCWs to reflect on, and potentially change, their hand hygiene practice. As previously discussed HCWs often overestimate their compliance with hand hygiene, Rushmer and Davies (2004) suggest that an active process of 'unlearning' may be required to challenge our previous beliefs and open them up to change. Provision of realistic data may go somewhere to prompting the beginning of this process by providing persuasive evidence of poor practice which cannot be ignored.

Audits could be reinforcing sub-par hand hygiene practices as they do not reflect the proportion of moments of non-compliance that are realistically likely to be occurring in practice. Currently, measurement of hand hygiene is stuck in a cycle of potentially poor practice validated by good audit results. In addition, there is complacency around the acceptance of these issues as simply a drawback of the method of direct observation and not recognising it as a prompt to change how audit is approached.

Currently audit programmes are in place for the provision of assurance of practice and quality, this is something required at an organisational and regulatory level. This is a potential issue as it is not the in best interests of those auditing to find anything less than an acceptable level of practice. There is no incentive for auditors to submit realistic audits as this would trigger further work for the ward in terms of action planning and re-auditing to check for improved compliance. Sykes et al. (2021) found HCWs expressed how previous punitive actions from the outcomes of audit led to potential misrepresentation of practice in future audits to avoid further action. This focus on achieving targets, rather than allowance for improvement of practice, has been raised in the literature as a common downfall of the audit process (Jeanes et al., 2020). This is potentially compounded in organisations where

compliance is displayed in public areas such as ward information boards or newsletters, which tend to be published as a demonstration of transparency to reassure patients.

From the viewpoint of ward staff, the motivation for performing hand hygiene audit appears to be to fulfil an administrative task rather than audit being viewed as an opportunity to understand, analyse, and ultimately improve practice. Systems of regular ward-led audits can be seen as a tick box exercise, with hand hygiene audits needing to be submitted at regular intervals, probably alongside other audits and checks. Hand hygiene audits which generate high compliance rates, even though unlikely to be seen as a true representation of practice by IPC practitioners, are nevertheless accepted within organisations. This is mutually beneficial across staff groups. For frontline staff in terms of extra work focused on hand hygiene, and for senior staff and managers as acceptable results are used as assurance of practice for patients and regulators.

An additional issue which may impact audit results which was highlighted by some IPCNs is that those conducting the ward-led audits may lack the skills and understanding to critique hand hygiene practice within their own ward setting. Indeed, Jeanes et al. (2019) posit that experienced auditors may be more successful at interrogating practice than novices. The authors present literature which finds experienced observers of practice engender an ease in detecting anomalies, with experts able to use their situational awareness to focus in on the behaviour of interest. On the other hand, IPCNs approved of their own IPC-led direct observational audits perhaps due to their specialist training. This provides them a deeper understanding of the principles of IPC, and how infection can develop and spread in healthcare settings. With IPCNs more likely to identify systemic and organisational factors as having an impact upon the performance of IPC practices at a ward level (Henderson et al., 2021).

The opportunity to produce accurate audit data is further complicated by the existing hierarchies and power dynamics within a ward or organisation, which can make individuals hesitant to speak-up on matters related to patient safety (Morrow, Gustavson and Jones, 2016). This can begin early in a HCW's career, with one study finding that nursing students on work placement felt unable to challenge poor IPC practices due to concerns around being penalised by those providing them with their workplace reports and wanting to fit in on the ward (Gould and Drey, 2013). This lack of power to speak up regarding poor practice could easily persist as careers progress. Particularly as candid audits could be seen as a critique of the practice of their peers, and submission of a low audit score may create further work in terms of action plans and additional scrutiny from repeated audits. Ensuring measurement of

practice is supported with a low-blame culture may encourage audit to be seen as a pathway to change and ensuring safe, high-quality care rather than a means to criticise (Armstrong et al., 2018). Where IPCNs are not based within the ward team this may allow them to transcend the power structures of the ward to provide more realistic feedback, particularly when identifying areas for improving practice.

The IPCN's perceived capability in auditing practice also influenced the way they saw the potential uptake and adoption of an EMS as to how one might fit into their role. The situating of hand hygiene practice within the ward context was something identified as lacking in EMSs by participants. This included elements such as the correct timing and quality of individual practice, as well as wider issues such as how equipment is integrated into practice. The results from Phase 1 demonstrate that an EMS can generate results similar to that of a realistic rate from direct observation of practice. This is suggestive that an EMS could be accepted as a tool to provide the quantitative data element of audit whilst IPCNs could utilise their expertise and capability to interrogate practice as it is in context.

Some HCWs are likely to have grown accustomed to seemingly meeting audit targets, giving them confidence in their current practice and no motive to change. This issue was raised by an IPCN who described times when IPC-led audits generated lower compliance rates than ward-led audits which led to confusion with HCWs as to why the results differed from one another. Using data from different audit types, either audit completed by different personnel or via electronic systems, has the potential to cause confusion or even mistrust in these audits or systems which provide a realistic view of compliance. A lack of correlation between the results of direct observational audits and an EMS is something which should be prepared for in settings where the move to electronic monitoring is being made (Conway et al., 2014). Particularly in an organisational culture where high compliance is the norm it would be important to lay the groundwork to generate trust in EMSs which are likely to show a lower compliance rate than HCWs are accustomed to. Even where EMSs generate similar compliance to observational audits, trust in electronic systems can be an ongoing concern of HCWs (Druckerman et al., 2021). Accepting realistic audit data requires preparation of not only frontline staff but also managers and key leaders to understand the potential damage of continuing to rely on unrealistic data as this creates a source of false reassurance regarding practice at all levels.

The large difference between compliance observed in this research and commonly set compliance targets also highlights the enormity of the potential improvement needed in hand hygiene practice to achieve set targets. If a vast improvement is needed this could

demotivate both HCWs and IPC practitioners as the task seems too difficult to achieve. Where large discrepancies exist, this is suggestive that inadequate hand hygiene practices are embedded at an individual, ward, or organisational level. When HCWs are receiving individual hand hygiene practice feedback during audit this is likely to be related to one specific hand hygiene moment during one episode of care delivery. On a wider level, the way in which the service overall is delivered is unlikely to be impacted by this feedback as the individual is operating within the larger ward and organisational culture. Thus, individual moments of education are unlikely to have a large impact on overall practice.

Aiming for slow and small incremental change may offer a way to approach an improvement programme aimed at hand hygiene. The WHO (2010) suggests that improvement needs to be a long-term strategy, particularly when starting from a low baseline of compliance. They state that in settings with low compliance it could take up to a year to reach 40-50% compliance, after this they suggest annual increases of 10% would be a realistic aim. Considering organisational targets of 90% and taking the observed compliance of 20% as a baseline, this would result in a timeline of five years to meet set targets. This provides a more manageable timeline of change which may motivate HCWs as targets feel obtainable and slow change may be more likely to result in sustained change. How acceptable a plan of this length would be at a senior management level in settings which require this level of improvement is unknown.

7.3.2 The role of motivation and knowledge in the application of the 5MHH in practice

Data from observation of practice showed a clear difference between compliance with the 5MHH which occurred before patient contact and those after patient contact, with moments following patient contact having higher levels of compliance. Moment 3 (after BBF exposure/risk) had the highest level of compliance at 40%, though it must be stressed that this itself is low. Whereas moment 1 and moment 2 were found to have 3% and 8% compliance respectively. The moments before patient contact can be seen as mainly being for the benefit of protecting the patient from pathogens, whereas those after patient contact are linked to protection of the HCWs themselves.

This pattern of compliance was also reported by interview participants, with IPCNs reporting that HCWs had the highest compliance with moment 3. The registered nurses stated that they would be more likely to be prompted to perform hand hygiene following patient contact, particularly following BBF exposure risk. This suggests these patterns of compliance are

likely to be widespread in practice. Handling BBF provides itself as an obvious point for hand hygiene due to the visual nature of the potential risk. This contrasts with the other moments where the potential transfer of pathogens remains invisible to the eye.

Other research has found that the moments following patient care tend to have higher compliance than those before (Knudsen et al., 2021; Iversen et al., 2020). With authors of one study suggesting this may be due to HCWs feeling like their own hands are clean upon entering a patient room and are dirty following patient care tasks (Xu et al., 2022). The present study found there was a definite sense of the patient being perceived as contaminated, or a potential source of infection, with one registered nurse describing patients as being “carriers” of “bugs”. This pattern in compliance demonstrates that it is potentially easier to apply hand hygiene when it is driven by self-interest in terms of protection of the self, and when it is linked to our innate emotions of cleanliness and disgust (Whitby, McLaws and Ross, 2006; Jackson and Griffiths, 2014).

These responses require less effort in relation to decision-making and do not necessarily require possession of the underpinning knowledge behind the 5MHH to enact the behaviour. The moments before patient contact, which are key for the protection of the patient, do not fit in with these individualistic drivers which creates an additional barrier to the consistent performance of all five moments of hand hygiene. Whether self-protection can be harnessed, and the focus diverted to the role of HCWs in being an advocate for patients with accountability for their actions during the delivery of care may be one path to undertake to encourage greater compliance (Carrico et al., 2018).

One situation in which this patient-focus has demonstrated having the potential to influence hand hygiene is during an outbreak of infection. Interview participants noted that HCWs engagement in hand hygiene practice was further motivated during such times. There was more engagement from ward managers to provide IPC practitioners with time to provide training on the ward and encouragement for HCWs to attend. Outbreaks may also pose a trigger for HCWs to reflect upon and consider their own capabilities and sense of their professional role as a patient may have developed an infection which they did not have before being admitted to hospital which could be the result of the hand hygiene practice on their ward. Indeed, one IPCN discussed how HCWs expressed a sense of guilt when an outbreak or infection did occur on their ward. Outside of this situation HCWs may assume their hand hygiene practice is up to standard as there is no overt example of the consequences of poor practice. Studies have found outbreaks can be a motivator for

practice change, however, urgency and evidence of improvements in response can diminish over longer outbreaks (Kovacs-Litman et al., 2020).

An outbreak was also likely to trigger an audit to be performed by the IPC team, this was seen as more of an interrogation of practice than a simple assurance of compliance. Allowing exploration of potential issues with both individual practice and general workflow on the ward, including how equipment was used in conjunction with hand hygiene. An enduring problem with the motivation to perform hand hygiene is that HCWs do not immediately see the impact of not cleaning their hands in terms of this leading to the occurrence, or spread, of infection. Outbreaks, if linked to inadequate hand hygiene, cannot be linked to one specific moment of missed hand hygiene and are unlikely to be attributed to one specific HCW. Nevertheless, an outbreak may trigger a general challenge to HCWs beliefs in their own capabilities which may in turn motivate them to perform hand hygiene.

Although COVID-19 may have started out similar to an outbreak situation, triggering engagement in hand hygiene and IPC practices, it appears this sort of higher engagement is not sustainable, and practice tapered off. This pattern of initial adoption of practice followed by decline is supported by literature which discusses a sense of fatigue and complacency which can occur during a pandemic regarding increased IPC practices such as wearing PPE (Rebmann et al., 2021). Participants discussed that during the COVID-19 pandemic self-protection as a motivator for hand hygiene intensified, leading to an initial increase in hand hygiene practice. Emotion was evidently driving self-protection, with a sense of fear and anxiety due to the perceived risk from the novel and potentially severe nature of COVID-19 during the first months of the pandemic. Research into respiratory disease and HCWs adherence to IPC practices has found moderate evidence of the fear of becoming infected themselves or passing the infection onto others as drivers for IPC behaviours (Houghton et al., 2020).

As literature around HCWs experiences during the COVID-19 pandemic emerges, this sense of anxiety and fear seems widespread, particularly at the start of the pandemic when patient numbers surged and guidance impacting how those on the frontline delivered patient care was subject to frequent changes (Vindrola-Padros et al., 2020; Rebmann et al., 2021). Feeding into these emotions was reporting in the media of HCWs being on the frontline of the pandemic response portraying a sense of heroism related to taking on an increased level of personal risk, this may have been unhelpful and fed into HCWs fears (Cox, 2020).

From the perspective of IPCNs, HCWs viewed patients as potential carriers of COVID-19 though this did not extend to their fellow colleagues. The awareness of, and any increase in, hand hygiene which IPCNs observed in HCWs was not necessarily related to the 5MHH or focused on the delivery of patient care. Indeed, observation of practice in this research found no impact of the pandemic on hand hygiene compliance rates. This was also very much the experience of the interview participants, with IPCNs noting that if the pandemic did have an impact on hand hygiene practice this was temporary. There was a general increase in hand hygiene equipment, such as at building entrances, and hand hygiene happening at times such as upon entering or leaving wards. This compounds the motivator of hand hygiene behaviour at this time being for self-protection rather than for protection of the patient.

Within all care situations low compliance with the 5MHH does not necessarily mean that HCWs do not possess the knowledge of the 5MHH and the capability to perform them, but there is an additional step required between possessing knowledge and applying it in everyday practice which requires both mental and physical effort. Particularly as the 5MHH need to be integrated continuously into the delivery of patient care in the dynamic ward environment. This study indicates that HCWs are unlikely to assess each task they perform through the lens of the core principles of IPC and the interruption of the spread of pathogens. This raises questions around the practicality of the 5MHH in the way they are currently understood and applied.

Whilst applying the 5MHH in practice HCWs are also required to integrate the use of many items of equipment into their delivery of patient care. Observations of practice demonstrated that integrating this equipment into practice generates many HHOs, especially when used in the patient zone and not cleaned in between each patient. In interviews IPCNs reported observing equipment being used in a way which could result in the transmission of infection. Considerations around how to integrate the use of equipment into the 5MHH were not always reported as being included in hand hygiene training by IPCNs. This leaves a potential gap in knowledge for HCWs if the 5MHH is not taught with the modern ward setting, and the digital devices commonly used, in mind.

The concepts of the patient zone and healthcare zone were not always included in training. Knowledge surrounding both the use of equipment and zoning can be linked to one of the common issues seen in the observation of practice, that is hand hygiene being performed too early or too late to be compliant to the moment when it occurred. The integration of both equipment and zoning into hand hygiene training and practice may then inform HCWs mental models and make it easier to map the 5MHH across to the dynamic ward setting.

Zoning is especially important in bays where there are multiple patient bed spaces and therefore multiple patient zones. Spaces designed in this way make it easy to move in and out of different patient zones with no overt barriers or prompts to cleanse hands at the appropriate times.

Areas of hand hygiene practice, and related issues such as zoning and equipment, in which HCWs lack knowledge or capability should be targeted with education and training. Rather than mandatory classroom-based training more specific scenario-based ward training may be a more practical way of teaching the application of the 5MHH in the setting they are applied in. Ricci and Yost (2021) envisage a move towards healthcare students needing to provide a rationale for hand hygiene practice rather than a simple tick box exercise capturing performance. In doing so this aims to encourage performance of the behaviour beyond the classroom and across to the clinical environment. Providing foundational knowledge which promotes the ability to apply IPC principles to a range of practice settings and tasks.

Integrating some practical microbiology training for nursing students covering the transmission of pathogens and demonstration of the effectiveness of hand hygiene can increase awareness of these topics (Yano et al., 2019). Whether this would affect the application of hand hygiene in clinical practice is unknown, though could be built upon throughout nurse training and an organisation's mandatory IPC training. The differences in training across organisations may also be a key factor in the variation of performance. Further standardisation of IPC training for HCWs could support consistency of practice, and in light of COVID-19, support preparedness for future pandemics (Barratt and Gilbert, 2021).

7.3.3 Influence of the environment on hand hygiene

Observations of practice allowed for the development of an average number of HHOs for HCWs, alongside informing a denominator for hand hygiene this also revealed the burden hand hygiene practice for HCWs. With nursing assistants experiencing more opportunities for hand hygiene than registered nurses. To comply with these opportunities hand hygiene needs to be encouraged to be performed at the right time and for the right reason; to interrupt the potential spread of pathogens. The environment plays a key role in terms of the location of ABHR and soap dispensers to provide HCWs with the physical opportunity to cleanse their hands at these moments.

There was recognition from IPCNs that the location of some dispensers may prompt hand hygiene to be performed in a location distant from the patient zone, such as in the corridor or bay entrance. This was also noted via observations of practice, where placement of

dispensers contributed to hand hygiene being performed too early or too late. In cases such as these, where hand hygiene was performed but then the HCW has either contaminated their hands before patient contact or contaminated a surface after patient contact, it may be that HCWs believe they are cleansing their hands appropriately. This has the potential to make it even more difficult for HCWs when confronted with low compliance rates if they feel like they have been complying with standards.

Observations also revealed that bed-end dispensers located within the patient zone at the point of care would go missing as patients in their beds were moved around the hospital. This was confirmed by IPCNs who reported this happening within their organisations. This potential lack of bed-end dispensers may mean they are not fully integrated into HCWs workflow as they cannot be relied upon to always be present. This has the potential to create other practical issues at times when equipment is brought into the patient zone, COWs for example do not have their own ABHR dispenser so frontline staff remain reliant on equipment at the point-of-care when moving around the ward.

On the wards where observations were performed gloves were stored at the entrances to multi-bedded bays. This encouraged gloves to be donned outside the patient zone and then worn for entire care episodes as there was no means to change gloves unless HCWs left the patient zone, potentially mid-task, or took additional gloves with them. Combined with the potential lack of point-of-care dispensers this could further discourage hand hygiene and compound the issue of gloves being kept on until exiting the patient zone. Previous research by Wilson, Bak and Loveday (2017) explored glove use through the Systems Engineering Initiative for Patient Safety model which focuses on how outcomes stem from systems and processes of working. They also found that glove placement tended to be away from the patient zone, creating difficulty for HCW decision-making on when to don and doff gloves, along with encouraging glove use for entire care episodes which increases the risk of cross-contamination.

When considering the increase in hand hygiene equipment prompted by the COVID-19 pandemic, it was noted by IPCNs that this was often at the entrances and exits to buildings. This increase in equipment indicates the importance of hand hygiene in the healthcare setting. However, it does not necessarily benefit the patient if hand hygiene in the patient zone itself is not easily performed. Placement of dispensers, particularly at the point-of-care, can be a key strategy to improve hand hygiene compliance though this is often implemented as part of a multi-modal strategy including support from leadership, education, reminders, and ongoing monitoring (Kendall et al., 2012). However, this is only the case if point-of-care

dispensers are integrated into the workflow and used consistently, with dispenser placement alone not necessarily enough to change practice (Giannitsioti et al., 2009). Observations in this research found that bed-end dispensers were used around 10% of the time in both wards, showing that there is a greater reliance on wall-mounted dispensers which were located outside of the patient zone.

7.4 Chapter summary

This chapter has explored the findings from both phases of this research in relation to the elements of the COM-B model. It discussed the various motivations, or lack thereof, for performing hand hygiene within the hospital environment. This touched upon how well audits currently motivate behaviour, the potential role of EMSs, and how the scale of improvement required may be a barrier to change. Alongside this motivation was influenced by outbreaks of infection, and self-protection both before and during the COVID-19 pandemic. It also explored how differing levels of perceived capability in the performance of hand hygiene audits impacted the acceptability of the data they generated. Another key element explored were the opportunities to perform hand hygiene behaviour. This encompasses the actual physical opportunities in the environment and social opportunities in terms of interpersonal dynamics such as social norms and the behaviour of peers.

7.5 Conclusions

Ward-led audits continue to be a central tenet of measuring hand hygiene practice, this currently means there is an embedded system of auditing which generates inaccurate data. This leaves HCWs without a realistic assessment of their hand hygiene practice, which is in turn likely to have no impact on their motivation to change their behaviour as they view themselves to be practising capably. An EMS may provide a more realistic assessment of compliance, though it would require a process of transition to create trust and acceptance in a system which presents compliance rates which are potentially lower than previously reported via direct observational audit data. The IPCN would have an important role in harnessing new systems and collaborating with HCWs to renew engagement with improvement of hand hygiene practice.

The specialist role of the IPCN provides them with the expertise to interrogate practice within the context it occurs. The more realistic compliance data generated by an EMS combined with this expertise may result in an audit culture which confronts the reality of compliance levels, supported by the IPC team who can engage HCWs and identify areas of practice for

improvement interventions. If HCWs are to perform audits which do provide a representative assessment of practice, they need to be capable of doing this within the wider power structures of the ward and larger organisation. This could be a particular issue where an existing audit programme commonly reports measures of high compliance. In this situation a focus on wider culture change and empowerment to support speaking out regarding potentially poor practice without fear of reprimand may be required to support change. To achieve this frontline and senior staff would benefit from seeing audit as a process to enable ongoing improvement in practice and good quality care.

Performance of hand hygiene itself is strongly motivated by self-protection. This was further demonstrated during the COVID-19 pandemic where patients were perceived as the main potential source of infection by HCWs. This negatively impacted compliance with the first two moments within the 5MHH which are directly for the protection of the patient. Seeing the consequence of the spread of infection in terms of outbreaks can trigger renewed engagement with the IPC team and task of hand hygiene. More dynamic and varied training focusing on the rationale behind the 5MHH may provide further support in building capability in terms of the core principles of IPC as a driver for practice, and to emphasize the protection of the patient as well as the self.

The practical application of the 5MHH is complicated by the active clinical environment and commonly used equipment within it. The signposting of hand hygiene through environmental design needs to support it to happen at the right time and in the right place. The placement of dispensers in the corridor encourages performance of hand hygiene which is not close to the patient, and this in combination with a lack of point-of-care dispensers this is a barrier to optimal hand hygiene at the key moments during patient care.

The next, and final, chapter will provide the overall conclusions, reflections and challenges, potential future directions, and contribution of this research.

Chapter 8 Conclusions

8.1 Chapter overview

This final chapter provides a summary of the main findings of the research along with their practical implications. It also includes personal reflections from the researcher on completing the project and the challenges experienced. Finally, the limitations of the research and potential directions for future research are discussed.

8.2 Summary of the research findings

Taking a mixed methods approach for the design of this research has supported the use of methods which fully explore hand hygiene behaviour and audit. The first phase explored hand hygiene practice in frontline care, focusing on the number of opportunities which typically arise for hand hygiene on inpatient wards in the UK. Following this, the second phase involved interviews with frontline HCWs which provided deeper interrogation as to how HCWs understand and apply hand hygiene, perceptions of existing audit practices and advances in audit technology, and reflections on hand hygiene during the COVID-19 pandemic. Bringing these datasets together has provided insight into the reality of hand hygiene in everyday practice on inpatient wards and the various factors which drive hand hygiene behaviour. Use of the COM-B framework enabled a deeper exploration into how these factors map across to the crucial components of capability, opportunity, and motivation which lead to performance of hand hygiene behaviour.

This research has developed an average number of HHOs on UK inpatient hospital wards. This not only has the potential to inform the calibration of an EMS but also reveals the significant burden arising from the requirement to apply the 5MHH in frontline practice for HCWs. In particular, for nursing assistants who experienced more opportunities for hand hygiene than registered nurses, likely due to the particular nature of their patient-facing role. This research also found low compliance rates (20%) to the 5MHH, demonstrating that this is a persistent issue and adding further strength to existing literature. Knowledge supporting specific issues with compliance was also generated, particularly that the moments following patient contact are more likely to generate performance of hand hygiene than those before patient contact (Azim, Juergens and McLaws, 2016; Xu et al., 2022).

Underpinning this finding was the strong sense of self-protection as the main driver of hand hygiene practice in HCWs, again providing support of previous literature (Smiddy, O'Connell and Creedon, 2015). Particularly interesting when exploring hand hygiene practice during

the COVID-19 pandemic was that observations revealed this had no impact on compliance levels. Though during the very initial stages of the pandemic IPCNs noted an increase in awareness and interest in hand hygiene. Further supporting the idea that the impact of even a pandemic situation upon protective behaviours may lead to an initial surge but this is likely to plateau over time, this builds on the findings of other literature in this area (Rebmann et al., 2021).

This research has found that current auditing standards are unlikely to provide HCWs with an accurate picture of compliance and therefore do not serve as a driver for hand hygiene behaviour. This stands to reinforce, and therefore potentially embed, poor practice due to its implied validation of practice via acceptable audit results. Through observation of practice alongside the installation of an EMS it was found that the EMS provided a realistic representation of hand hygiene compliance. The potential integration of EMSs was seen as an acceptable addition to the IPCN role and could allow them to focus their expertise to interrogate the quality and accuracy of practice and guide targeted improvement interventions.

The scoping review conducted as part of this research revealed the importance of constructing research informed by a theoretical framework. This has been key to underpinning this research, with the design of interview questions informed by the domains of the TDF and findings explored under the COM-B framework. The use of these kind of foundational frameworks is sometimes lacking in IPC research and would be critical for any researcher or practitioner to consider going forwards in order to ensure a thorough range of factors are considered as potentially impacting HCWs IPC behaviour. This then helps to identify key areas which can then be the focus of practical interventions in real-world practice. How the current findings may impact practice is explored in the following section.

8.3 Implications of the research

The findings of this research have implications for frontline practice and the long-established methods of measuring hand hygiene compliance in order to drive practice. The implications emanating from the development of an average number of HHOs for frontline workers has the potential to inform both innovations to EMSs and influence frontline practice. In addition, the findings from the qualitative phase suggest that particular motivations and understandings of the 5MHH may be crucial to harness in order to drive hand hygiene behaviour.

Regarding frontline practice, IPC practitioners in collaboration with HCWs may find it useful to work together and reflect upon how the 5MHH are integrated into patient care to assess whether HHOs could be reduced. This would need to include assessment of how patient shared equipment and portable medical equipment is used within the ward environment when providing direct patient care. The way these items are used currently can generate many HHOs which causes additional burden to HCWs. It may be possible to work with specific wards or specialisations to streamline patterns of working with regards to generation of HHOs, and thus result in fewer opportunities where hand hygiene would be required. This would ensure hand hygiene is focused on critical junctures within care delivery and potentially create a more pragmatic system of working. If substantial changes were brought in regarding patterns of working to reduce the number of HHOs, further research would be needed to explore whether this impacted the average number of HHOs on a significant level where an EMS was in use.

An important finding from this research is that direct audits are perceived as inaccurate and yet are relied upon as a measure of practice. There is a need to establish auditing systems which produce data that is both acceptable and valued by IPCNs and frontline staff. Audit data, whether generated from direct observational audit or EMSs, requires utilisation to drive practice. It is therefore key that audit data is an accurate representation of practice, even if this results in lower compliance scores than HCWs are accustomed to. In the short term this discrepancy may highlight the potential scope of the issue at hand, and further to this, act as an ongoing call to action to engage with the reality of hand hygiene practice. Of value, particularly for IPC practitioners, would be to reflect on their current auditing systems and processes as they currently stand in their local context. They can assess whether audits are likely to be a motivating force for staff in providing a realistic assessment of practice and encouraging improvement where required. Where it is not, this needs to be first acknowledged, and then addressed. This may also require a wider move from auditing being conceived as a demonstration of quality of care within an organisation, to an interrogation of practice which provides credible data and an opportunity for teaching and learning.

This research found that an EMS counter-based system can provide a compliance rate which is comparable to the reality of practice. Although IPCNs recognise EMSs are not able to capture granular detail on the context of hand hygiene within care delivery, this is where their expertise in terms of examination of practice would support such a system. If the reality of compliance is to be revealed by technology such as EMSs and go on to drive change, then depending on each local context, realistic benchmarks which motivate practice including reflecting and building upon sustainable changes in practice will be required.

Reassessing the content of training to consider whether key drivers of hand hygiene are targeted is also of importance to impact behaviour. Harnessing drivers, in particular self-protection, is needed in order to encourage performance of hand hygiene at all required moments rather than selective moments. The central challenge lies with motivating HCWs to perform hand hygiene prior to patient contact. Focusing on the narrative of protection of the patient from avoidable harm to improve compliance with the moments before patient contact may renew motivation. Targeting training around concerns such as hand hygiene being performed at incorrect times and how to integrate equipment into care tasks is key, each local context will require exploration of practice to determine specific issues. It would also be important to direct training towards key groups such as nursing assistants who experience the majority of opportunities for hand hygiene, focusing on their most commonly performed tasks which may provide immediate change.

The impact of the COVID-19 pandemic on this research revealed a crucial finding related to pandemic preparedness and IPC supplies. During the early months of the pandemic there were difficulties receiving supply of ABHR from preferred suppliers, which were compatible with the hospital's existing fixtures and fittings, and potential infection control concerns around bed-end dispensers which resulted in them being removed. This raises the matter of supply chain resilience and local versus central stock management, particularly when an EMS may require specific products to be operational. It is important that an EMS would be stocked for continual usage during any outbreak or future pandemic situation, this not only allows for existing systems to continue being used by frontline staff, but also for the continual collection of data on usage and compliance. Removal of bed-end dispensers highlights the need for them to be appropriately situated and designed for ease of cleaning and restocking when they are in most demand.

8.4 Reflections on conducting the research

Before undertaking this research, I considered that hand hygiene was something which could be seen as a simple behaviour but also something which was difficult and complex to apply consistently in day-to-day practice. Despite the development and wide application of the 5MHH which aimed to standardise the application of hand hygiene, compliance is an ongoing issue. Observing frontline practice gave me some insight into factors which impact compliance. I do not have any training or experience of working as a frontline HCW, thus the preliminary phase working with an acute IPC team was key in my learning around

application of hand hygiene within the hospital setting. Coming from a psychology and research background allowed me to explore practice and auditing systems objectively.

For the most part I was welcomed on the wards where I observed practice, though sometimes viewed with suspicion. Although I have previous experience observing care delivery it remains a difficult position to hold as an 'outsider' collecting data, not being part of the care team means this position is somewhat inevitable, though can be isolating. From my observations I could see that I was focusing in on one small, yet crucial, aspect of HCWs everyday practice. Those working professionally on the wards were dealing with multiple tasks, which sometimes competed for their time. I also recognise that I was in a privileged position to be observing care from an outside perspective, this enabled me to spend time analysing the tasks performed by HCWs to identify the occurrence of the 5MHH within their care provision. Sometimes I would do this after finishing observations as it could be difficult to analyse care in terms of occurrence of the 5MHH in real-time. This also demonstrated to me the potential difficulty in needing to do this in real-time as a HCW during care provision. It is unlikely that HCWs have this kind of opportunity to step back from their work and specifically assess their own, or their peers, application of the 5MHH due to the demands on their time.

The occurrence of the COVID-19 pandemic had a huge impact on this research, this demonstrated the importance of remaining flexible and pragmatic in terms of the research process. Though at times it was frustrating with delays stemming from both government guidance and organisational issues due to the pandemic. It was important to try to develop avenues within these confines in which I could meet the original aims as closely as possible within a reasonable timescale. This also required communication and management of expectations with the research stakeholders. None of us could have anticipated a global pandemic and the adaptations which would be required to complete this research.

Interestingly when the pandemic began many people mentioned to me how timely my thesis would now be. However, I would often reflect on this, as the 5MHH were not in themselves something which should be impacted by the pandemic situation as hand hygiene practice at the 5MHH is always required whether in a pandemic situation or not. However, I was keenly aware that an increase in anxiety amongst HCWs may impact their hand hygiene behaviour and feelings towards it. Therefore, it was important to adapt the second phase of the research to include questions about the impact of the pandemic on hand hygiene practice. When observing practice during the pandemic I was initially surprised that it had not impacted compliance with the 5MHH, though interviews with the IPCNs supported this

finding. Any initial impact on hand hygiene was not sustainable as it is not feasible to stay within a highly anxious state in your everyday work setting. This was also reflected in the attitude change seen in society at general as COVID-19 became ‘business as usual’ and felt that we had to live with COVID-19 rather than eliminate the risk completely.

8.5 Limitations and future research directions

This research used the TDF to design the questions asked to interview participants, this covered 14 key domains which can drive behaviour. Although this provided a thorough exploration of many factors upon an individual’s performance of hand hygiene, one key limitation of this is that the TDF does not overtly recognise and explore the larger power structures within which behaviour is performed. A recent publication has addressed this limitation and developed a tool to be used in conjunction with the TDF which focuses on elements of intersectionality, focusing on individual’s unique social identities as they exist within wider societal power structures, which have the potential to impact individual decision-making and behaviour (Etherington et al., 2020). This may be a key focus of future research to acknowledge and further explore the impact of an individual’s lived experiences within the wider societal system and how this might impact their performance of the behaviour of interest.

Further studies which integrate EMSs into UK hospital wards would benefit the field in terms of exploration of the accuracy of EMSs, this research was unable to achieve this aim due to the impact of the COVID-19 pandemic. This means the perspective from those who have used an EMS was not captured. Integration of an EMS may be a challenge in larger acute settings, with small to medium settings offering a starting point to support proof of concept by way of a case study. Alongside the introduction of any new system, it is essential that this is done in conjunction with frontline staff to generate buy-in and trust in a system and the data it produces. Further to this, the experiences of IPC practitioners is also of interest as to how they integrate an EMS into their existing audit processes and utilise the data it produces to drive practice.

Participant recruitment was challenging, particularly for the groups of frontline HCWs who did not have specialist IPC training or experience. The group hardest to engage was nursing assistants and this turned out to be an impasse in terms of recruiting them for interview. This potentially would have been avoided had interviews been performed with HCWs from the wards where observations were completed as originally planned, however due to the pandemic this was not feasible within the research timeline. Repeated attempts to reach

these HCWs were made, with the added incentive of a gift voucher to thank participants for their time. Ultimately no nursing assistants were recruited and therefore this group continue to be underrepresented in research in this area despite the fact they provide most direct patient care.

In future other researchers may want to consider starting by initially focusing on recruitment of nursing assistants in roles such as IPC champions or similar. The relative ease of recruiting IPCNs was probably due to their specialist interest in IPC practice, giving them the confidence to be asked questions around hand hygiene as a subject. This became apparent in the interviews as IPCNs reflected with ease on the questions posed and could draw on their experiences of observing others care provision and the common problems they encountered in practice. This differed to the registered nurses who were being asked to reflect on their own practice, this is often problematic as it is difficult to do objectively and with reflexivity.

The aim of this research was not to design an intervention aimed at improving hand hygiene, however by using the COM-B model this has allowed for identification of key factors within this model which drive behaviour. These areas can be focused upon by those working in IPC to design interventions in their own settings. Further exploration in this area is required exploring how interventions might be developed which focus on protection of the patient as protection of the self is currently so clearly embedded as a strong influence on practice.

8.6 Final conclusions

Hand hygiene will continue to be central to the control and prevention of HCAI. This research provides further evidence that that hand hygiene is a significant burden for frontline HCWs, and that compliance with the 5MHH remains low. This is despite ongoing systems of audit and feedback, suggesting that innovation and targeted interventions are needed to address this pervasive issue. There is no simple way to tackle low compliance, though beginning with data which is truly representative of practice is surely an essential element. With the caveat that systems designed to monitor practice require utilisation to engage and motivate practice.

The integration of new technologies in the form of EMSs are a potential adjunct to the expertise brought by IPC practitioners. This blended approach may assist in moving beyond audit as a measure of quality via ingrained routines of data collection, to an interrogation of practice as it is embedded within the complex healthcare environment. Common patient care

tasks, including the integration of patient shared and portable medical equipment, as they are enacted within the often busy and dynamic ward setting may benefit from assessment as to how to pragmatically apply the 5MHH without creating additional burden for HCWs in terms of opportunities for hand hygiene. This practical approach could encourage practice by way of creating a feeling that compliance with hand hygiene is something attainable rather than aspirational.

The themes developed in this research present organisational, environmental, and individual elements which impact understanding and compliance with the 5MHH, and acceptance of the systems supporting its measurement. Performance of hand hygiene is often reactive and driven by innate emotional reactions to different patient care tasks and the perception of the patient as a potential carrier of infection. This finding was reinforced by the COVID-19 pandemic which demonstrated that any initial impact of a novel virus upon hand hygiene behaviour was not sustained. In conclusion, the findings of this research serve as a call to action to assess current methods of audit and their impact in presenting realistic data which drives practice, alongside the need to harness key drivers of hand hygiene behaviour to improve practice.

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Appendices

Appendix 1: World Health Organization hand hygiene observation form

Observation Form

Facility:		**Period Number*:**		**Session Number*:**	
Service:		**Date:** (dd/mm/yy)	/ /	**Observer:** (initials)	
Ward:		**Start/End time:** (hh:mm)	: / :	**Page N°:**	
Department:		**Session duration:** (mm)		**City**:**	
Country:**					

Prof.cat		Prof.cat		Prof.cat		Prof.cat	
Code		Code		Code		Code	
N°		N°		N°		N°	

Opp.	Indication	HH Action	Opp.	Indication	HH Action	Opp.	Indication	HH Action	Opp.	Indication	HH Action
1	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	1	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	1	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	1	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
2	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	2	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	2	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	2	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
3	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	3	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	3	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	3	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
4	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	4	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	4	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	4	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
5	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	5	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	5	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	5	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
6	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	6	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	6	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	6	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
7	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	7	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	7	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	7	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
8	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	8	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	8	☐ bef-pat. ☐ bef-asept ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	8	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves

* To be completed by the data manager.
** **Optional**, to be used if appropriate, according to the local needs and regulations.

General Recommendations

(refer to the Hand Hygiene Technical Reference Manual)

1. In the context of open and direct observations, the observer introduces him/herself to the health-care worker and to the patient when appropriate, explains his/her task and proposes immediate informal feed back.
2. The health-care worker, belonging to one of the main four following professional categories (see below), is observed during the delivery of health-care activities to patients.
3. Detected and observed data should be recorded with a pencil in order to be immediately corrected if needed.
4. The top of the form (header) is completed before starting data collection (excepted end time and session duration).
5. The session should last no more than 20 minutes (± 10 minutes according to the observed activity); the end time and the session duration are to be completed at the end of the observation session.
6. The observer may observe up to three health-care workers simultaneously, if the density of hand hygiene opportunities permits.
7. Each column of the grid to record hand hygiene practices is intended to be dedicated to a specific professional category. Therefore numerous health-care workers may be sequentially included during one session in the column dedicated to their category. Alternatively each column may be dedicated to a single health-care worker only of whom the professional category should be indicated.
8. As soon as you detect an indication for hand hygiene, count an opportunity in the appropriate column and cross the square corresponding to the indication(s) you detected. Then complete all the indications that apply and the related hand hygiene actions observed or missed.
9. Each opportunity refers to one line in each column; each line is independent from one column to another.
10. Cross items in squares (several may apply for one opportunity) or circles (only a single item may apply at one moment).
11. When several indications fall in one opportunity, each one must be recorded by crossing the squares.
12. Performed or missed actions must always be registered within the context of an opportunity.
13. Glove use may be recorded only when the hand hygiene action is missed while the health-care worker is wearing gloves.

Short description of items

Facility:	to complete according to the local nomenclature	
Service:	to complete according to the local nomenclature	
Ward:	to complete according to the local nomenclature	
Department:	to complete according to the following standardized nomenclature:	
	medical, including dermatology, neurology, haematology, oncology, etc.	surgery, including neurosurgery, urology, EENT, ophthalmology, etc.
	mixed (medical & surgical), including gynaecology	obstetrics, including related surgery
	paediatrics, including related surgery	intensive care & resuscitation
	emergency unit	long term care & rehabilitation
	ambulatory care, including related surgery	other (to specify)
Period N°:	1) pre- / 2) post-intervention; and then according to the institutional counter.	
Date:	day (dd) / month (mm) / year (yy)	
Start/end time:	hour (hh) / minute (mm).	
Session duration:	difference between start and end time, resulting in minutes of observation.	
Session N°:	attributed at the moment of data entry for analysis.	
Observer:	observer's initials (the observer is responsible for the data collection and for checking their accuracy before submitting the form for analysis.	
Page N°:	to write only when more than one form is used for one session.	
Prof.cat:	according to the following classification:	
	1. nurse / midwife	1.1 nurse, 1.2 midwife, 1.3 student.
	2. auxiliary	
	3. medical doctor	3.1 in internal medicine, 3.2 surgeon, 3.3 anaesthetist / resuscitator / emergency physician, 3.4 paediatrician, 3.5 gynaecologist, 3.6 consultant, 3.7 medical student.
	4. other health-care worker	4.1 therapist (physiotherapist, occupational therapist, audiologist, speech therapist), 4.2 technician (radiologist, cardiology technician, operating room technician, laboratory technician, etc), 4.3 other (dietician, dentist, social worker and any other health-related professional involved in patient care), 4.4 student.
Number:	number of observed health-care workers belonging to the same professional category (same code) as they enter the field of observation and you detect opportunities.	
Opp(ortunity):	defined by one indication at least	
Indication:	reason(s) that motivate(s) hand hygiene action; all indications that apply at one moment must be recorded	
	bef.pat: before touching a patient	aft.b.f: after body fluid exposure risk
	bef.asept: before clean/aseptic procedure	aft.pat: after touching a patient
		aft.p.surr: after touching patient surroundings
HH action:	response to the hand hygiene indication(s); it can be either a positive action by performing handrub or handwash, or a negative action by missing handrub or handwash	
	HR: hand hygiene action by handrubbing with an alcohol-based formula HW: hand hygiene action by handwashing with soap and water	Missed: no hand hygiene action performed

Observation Form – Basic Compliance Calculation

	Facility:						Period:			Setting:					
	Prof.cat.			Prof.cat.			Prof.cat.			Prof.cat.			Total per session		
Session N°	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)	Opp (n)	HW (n)	HR (n)
1															
2															
3															
4															
5															
6															
7															
8															
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10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
Total															
Calculation	Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =			Act (n) = / Opp (n) =		
Compliance															

Compliance (%) = $\frac{\text{Actions}}{\text{Opportunities}}$ x 100

Instructions for use

1. Define the setting outlining the scope for analysis and report related data according to the chosen setting.
2. Check data in the observation form. Hand hygiene actions not related to an indication should not be taken into account and vice versa.
3. Report the session number and the related observation data in the same line. This attribution of session number validates the fact that data has been taken into count for compliance calculation.
4. Results per professional category and per session (vertical):
   - 4.1 Sum up recorded opportunities (opp) in the case report form per professional category: report the sum in the corresponding cell in the calculation form.
   - 4.2 Sum up the positive hand hygiene actions related to the total of opportunities above, making difference between handwash (HW) and handrub (HR): report the sum in the corresponding cell in the calculation form.
   - 4.3 Proceed in the same way for each session (data record form).
   - 4.4 Add up all sums per each professional category and put the calculation to calculate the compliance rate (given in percent)
5. The addition of results of each line permits to get the global compliance at the end of the last right column.

Observation Form – Optional Calculation Form

(Indication-related compliance with hand hygiene)

	Facility:						Period:			Setting:					
	Before touching a patient			Before clean/ aseptic procedure			After body fluid exposure risk			After touching a patient			After touching patient surroundings		
Session N°	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)	Indic (n)	HW (n)	HR (n)
1															
2															
3															
4															
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20															
Total															
Calculation	Act (n) = Indic1 (n) =			Act (n) = Indic2 (n) =			Act (n) = Indic3 (n) =			Act (n) = Indic4 (n) =			Act (n) = Indic5 (n) =		
Ratio act / indic*															

Instructions for use

1. Define the setting outlining the scope for analysis and report related data according to the chosen setting.
2. Check data in the observation form. Hand hygiene actions not related to an indication should not be taken into account and vice versa.
3. If several indications occur within the same opportunity, each one should be considered separately as well as the related action.
4. Report the session number and the related observation data in the same line. This attribution of session number validates the fact that data has been taken into count for compliance calculation.
5. Results per indication (indic) and per session (vertical):
   - 4.1 Sum up indications per indication in the observation form: report the sum in the corresponding cell in the calculation form.
   - 4.2 Sum up positive hand hygiene actions related to the total of indications above, making the difference between handwash (HW) and handrub (HR): report the sum in the corresponding cell in the calculation form.
   - 4.3 Proceed in the same way for each session (observation form).
   - 4.4 Add up all sums per each indication and put the calculation to calculate the ratio (given in percent)

***Note:** This calculation is not exactly a compliance result, as the denominator of the calculation is an indication instead of an opportunity. Action is artificially overestimated according to each indication. However, the result gives an overall idea of health-care worker's behaviour towards each type of indication.

WHO acknowledges the Hôpitaux Universitaires de Genève (HUG), in particular the members of the Infection Control Programme, for their active participation in developing this material.

Appendix 2: Search strategies for literature review

Area of interest	Search strategy	Limits	Results (without duplicates)	Papers included	Citation searching and supplementary papers
Denominator for counter-based EMS	(hand hygiene monitoring OR electronic monitoring systems OR surveillance OR counter OR automated) AND hand hygiene denominator	2010 - 2021, English language, Academic journals, abstract available	3	3	7
Frontline HCWs perceptions and experience of EMS	(electronic monitoring system OR EMS OR EHHMS OR electronic surveillance OR sensor OR automat* OR monitor OR sensor) AND (hand hygiene OR hand cleaning OR hand washing) AND (staff experience OR thoughts OR attitudes OR opinions OR beliefs OR perceptions OR acceptance) AND (hospital OR acute healthcare)	2011 – 2021, English language, Academic journals, abstract available	47	12	9
Psychological factors which can impact hand hygiene	TI (psychological OR emotion OR drive* OR determinant) AND (hand hygiene OR hand hygiene compliance OR Hand hygiene opportunities OR Hand cleaning OR Hand washing) AND (hospital OR Acute care OR Acute setting)	2000 – 2021, English language, Academic journals, abstract available	72	11	11
Hand hygiene and glove use	TI (Gloves OR gloved hands OR glove use) AND (cross-contamination OR infection risk OR cross contamination) AND (hand hygiene OR hand hygiene compliance OR Hand hygiene opportunities OR Hand cleaning OR Hand washing) AND (hospital OR Acute care OR Acute setting)	2000 – 2021, English language, Academic journals, abstract available	12	4	1
Hand hygiene and equipment	(medical equipment OR portable equipment OR patient shared equipment OR computer on wheels OR workstation on wheels OR	2000 – 2021, English language, Academic journals, abstract	24	3	6

	"WOWs" OR "COWs" OR high-touch surfaces OR keyboard pulse OR oximeter OR blood pressure cuff OR "IV drip") AND (cross-contamination OR infection risk OR cross contamination) AND (hand hygiene OR hand hygiene compliance OR Hand hygiene opportunities OR Hand cleaning OR Hand washing) AND (hospital OR Acute care OR Acute setting)	available			
Hand hygiene and curtains	(curtain* OR patient privacy curtain*) AND (cross-contamination OR infection OR cross contamination) AND (hand hygiene OR hand hygiene compliance OR Hand hygiene opportunities OR Hand cleaning OR Hand washing) AND (hospital OR Acute care OR Acute setting)	2000 – 2021, English language, Academic journals, abstract available	11	5	4
Hand hygiene in ward environment	(multi-bedded bay OR healthcare zone OR High-touch surface* OR Patient zone) AND (cross-contamination OR infection OR cross contamination) AND (hand hygiene OR hand hygiene compliance OR Hand hygiene opportunities OR Hand cleaning OR Hand washing) AND (hospital OR Acute care OR Acute setting)	2000 – 2021, English language, Academic journals, abstract available	43	5	1
Hand hygiene audit and feedback	TI (Feedback OR drive*) AND (audit* OR measurement) AND (hand hygiene or handwashing or hand washing or hand disinfection) AND (hospital OR Acute care OR Acute setting)	2000 – 2021, English language, Academic journals, abstract available	24	7	8
Totals			236	50	47

*TI = title

Appendix 3: Copy of published scoping review, Greene and Wilson (2022)

Titled: The use of behaviour change theory for infection prevention and control practices in healthcare settings: A scoping review', *Journal of Infection Prevention*.

Reviews

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The use of behaviour change theory for infection prevention and control practices in healthcare settings: A scoping review

Carolynn Greene, BSc, MSc and Jennie Wilson, PhD

Abstract

Background: Infection prevention and control (IPC) practices performed by healthcare workers are key to the prevention and management of infections. Compliance with IPC practices is often low, they are therefore commonly the focus of improvement interventions. Designing interventions that are based on behaviour change theories may help to improve compliance to practice. The aim of this review is to synthesise the evidence on the application of behaviour change theories to interventions to improve IPC practice in healthcare settings.

Methods: A scoping review was conducted following the Joanna Briggs Institute methodological framework. The theories of focus were the Theoretical Domains Framework (TDF), Capability, Opportunity, Motivation, Behaviour (COM-B) and Behaviour Change Wheel (BCW). Studies which applied these theories to any IPC practice were included.

Results: Eleven studies were identified which met the inclusion criteria. The IPC behaviours investigated were hand hygiene (7), antimicrobial stewardship (3), and MRSA screening (1). Nine studies explored barriers and facilitators to existing IPC practice; three used their findings to design a behaviour change intervention or tool. Domains of 'beliefs about consequences', 'environmental context/resources', and 'social/professional role and identity' were identified as key across all three IPC behaviours.

Discussion: This review has demonstrated the use of behavioural theories to understand determinants of behaviour related to IPC practice. Currently, there are few published examples of interventions to improve IPC practice that have been underpinned by behavioural theory. Practitioners in IPC should consider the use of these methods to enhance the efficacy of strategies to change healthcare worker behaviour.

Keywords

behaviour change theory, infection prevention, scoping review

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Background

Healthcare associated infections (HCAI) are those which are acquired as a result of receiving treatment in, or visiting, a healthcare setting. Within care settings there are a variety of infection prevention and control (IPC) practices which aim to reduce the occurrence and spread of infection. This includes activities such as hand hygiene, use of personal protective equipment (PPE), screening patients for infection, decontamination of equipment, and antimicrobial stewardship. These practices are supported by a base of research evidence.

Evidence-based guidelines for the prevention of HCAI in acute settings were produced for the National Health Service (NHS) in 2001 (Pratt et al., 2001), and further updated in 2007 and 2014 (Pratt et al., 2007; Loveday et al., 2014). These guidelines were developed through a systematic review of evidence and provide principles of best practice which can be used to inform local procedures in healthcare facilities. The guidelines also provide a standard of practice which can be audited against in order to measure organisational adherence and quality of practice.

Despite many IPC activities being supported by evidence-based guidelines, they are not always complied

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with by staff. If not implemented effectively then IPC practices risk having little impact. Where practice is poor there may need to be a specific drive on optimising the performance of the IPC behaviour by working with staff to improve practice. Facilitating behaviour change to ensure application of best practice is one of the central roles of the IPC practitioner.

Using behaviour change theory to explore application of evidence-based practices, especially where there may be issues with poor staff performance, allows for the identification of key determinants of behaviour which can be targeted with specific interventions. A variety of behaviour change frameworks and theories have been developed which map the key factors and processes thought to influence behaviour. This tends to incorporate individual factors (e.g. motivations and beliefs), environmental factors (e.g. availability of equipment), as well as complex interactions between individuals and the social and physical contexts they operate within.

There are many different theories of behaviour change, some of which synthesise multiple theoretical components into a single framework. These offer themselves as a practical tool covering a wide scope of factors thought key to behaviour change and can be utilised to inform the development of improvement interventions. The Behaviour Change Wheel (BCW) was developed in 2011 in order to help practitioners from across disciplines to identify appropriate interventions or policies when trying to encourage adoption of a particular behaviour (Michie et al., 2011). The BCW incorporates concepts from 19 existing behaviour change theories and contains the Capability, Opportunity, Motivation, Behaviour (COM-B) model at its centre (Ojo et al., 2019). Capability refers to possessing the psychological or physical capability to perform a behaviour; that is having the knowledge and skills. Opportunity encompasses how the environment, both physical and social, around the individual can prompt behaviour. The motivation to perform behaviour can differ between individuals, this is impacted by both automatic habitual processes and reflective decision making processes. Interaction between these factors influences the performance of behaviour. The BCW also includes potential intervention functions (e.g. education or incentivisation) and policy categories (e.g. regulation or environmental planning) which indicate areas which may drive the required behaviour change.

Each of the COM-B components also map across to another framework, the Theoretical Domains Framework (TDF) (Table 1). Like COM-B the TDF combines aspects of multiple theories, it was developed to support the implementation of evidence-based practice with a focus on changing the behaviour of health professionals (Michie et al., 2005). Through consensus from a group of health psychologists and researchers one hundred constructs derived from 33 behaviour change theories were reduced into a framework of 12 domains, each thought to play a key role in behaviour change with a focus on clinical practice. The TDF was later validated for use in implementation research, at this time two domains were added giving a total of 14 domains in the framework (Cane et al., 2012). As COM-B and TDF share similar constructs they can be used in conjunction. For instance, Michie et al. (2014) suggest the COM-B can be used to identify relevant components to the behaviour of interest, from these the relevant TDF domains can be identified and used to further explore and interrogate these factors more deeply.

The BCW and TDF combine and simplify several different behaviour change theories in order to create a tool or framework which can be used by practitioners across various disciplines (Cane et al., 2012). Designing and facilitating behaviour change interventions for IPC practices is a key part of the IPC practitioner's role. Utilisation of theory to underpin interventions provides a sound theoretical base which may have an important impact on outcomes. There is some evidence that interventions which are underpinned by theory are more likely to be effective (Michie and Johnston, 2012).

The purpose of this review is to explore how behaviour change theory has been applied to IPC practices in healthcare settings, to identify common themes and consider any implications for practice. Due to their focus on clinical practice the theories of interest are the TDF, COM-B and the BCW.

Methods

In order to explore the existing literature a scoping review was conducted. Scoping reviews are a way of systematically mapping an area of research evidence and generate a descriptive overview exploring the extent, range, and characteristics of published evidence for a particular topic (Pham et al., 2014). This highlights the types of evidence available and gaps in the existing literature. As scoping reviews aim to provide a wide overview of existing studies in a particular area a formal quality assessment is not relevant (Peters et al., 2015). The objective of this scoping review was to explore how behaviour change theories have been applied to IPC practices in healthcare settings. The review followed the Joanna Briggs Institute (JBI) methodology for conducting scoping reviews. The main review question was: How have behaviour change theories been applied to IPC practices in healthcare settings?

Inclusion/exclusion criteria

Evidence from primary research, both quantitative and qualitative, was included to ensure a broad range of studies were located. This kept the scope wide and ensured the map of the literature was thorough. Grey literature was not searched. Relevant theories were TDF, BCW or COM-B and any type of IPC practice was included. The review focused on literature relating to healthcare settings, including care homes. Only studies published in the English language and

Table 1. Overview and definition of domains from COM-B and TDF (Adapted from Cane et al., 2012; Michie et al., 2014).

COM-B component	Theoretical domains framework (TDF) domain	Definitions
Capability (psychological or physical)	Knowledge	An awareness of the existence of something
	Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions
	Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment, and choose between 2 or more alternatives
	Skills	An ability or proficiency acquired through practice
Opportunity (social or physical)	Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours
	Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour
Motivation (automatic or reflective)	Beliefs about capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use
	Beliefs about consequences	Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation
	Emotions	A complex reaction pattern involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event
	Goals	Mental representations of outcomes or end states that an individual wants to achieve
	Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way
	Optimism	The confidence that things will happen for the best or that desired goals will be attained
	Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus
	Social/Professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting

published since the year 2000 were included as the relevant behaviour change theories were developed following this date. Text, review, opinion papers and letters were excluded.

Search strategy

A three-step strategy as recommended by the JBI was undertaken. This comprised (1) an initial search undertaken to identify relevant keywords and search terms. This informed (2) an individual search strategy developed for each database including mapping to relevant subject headings. Databases searched were CINAHL Complete, EMBASE and MEDLINE. Lastly, (3) the reference lists of relevant papers were screened to identify any additional studies. A search strategy for MEDLINE is detailed in Appendix 1. Limits applied to the search were: papers published in the English language, published after the year 2000, and with an abstract available.

Two reviewers assessed all titles for relevance. Relevant papers were retrieved and resifted by both reviewers. Disagreements were resolved through discussion. Information on authors, country of origin, publication year, type of theory used, methods, and key findings were extracted into a charting table (Supplementary Material 1), a brief charting table is also included (Table 2) and the findings incorporated into a narrative summary.

Results

The scoping review identified 1516 papers after removal of duplicates, of which 11 were relevant to the research question and included in the review. A PRISMA diagram is presented in Figure 1 (Page et al., 2021). These papers were published between the years 2011 - 2019 and were from two countries: United Kingdom (n = 6) and Canada (n = 5). Results are organised by the type of IPC practice the study

Table 2. Brief charting table of reviewed papers.

Authors and country of publication	Relevant theory	Overview of study
Hand hygiene (HH)		
1) Boscart et al. (2012), Canada	TDF	Identified nurses and administrators perceived barriers and facilitators to HH practices and introduction of an electronic monitoring system for HH.
2) Dyson et al. (2011), UK	TDF	Exploration of a theory-informed and non–theory-informed question schedule to assess barriers and levers to HH.
3) Dyson et al. (2013), UK	TDF	Development of an instrument to measure barriers and levers to HH.
4) Fuller et al. (2014), UK	TDF	An exploration of real-time explanations of HH noncompliance
5) McAteer et al. (2014), UK	TDF	Exploration of barriers and facilitators to implementation of HH intervention by those who delivered it
6) Smith et al. (2019), Canada	TDF	Exploration of barriers and facilitators to HH in long-term care facilities through development of a theory-informed questionnaire
7) Squires et al. (2014), Canada	TDF	Exploration of the barriers and facilitators to physician HH compliance
Antimicrobial stewardship (AMS)		
8) Chambers et al. (2019), Canada	TDF	Exploration of barriers and facilitators that contribute to overuse of antibiotics for urinary tract infection (UTI) in long-term care. Developed a theory-informed AMS programme
9) Fisher et al. (2018), Canada	TDF and COM-B	Determination of the barriers and facilitators to promotion of intravenous to oral antimicrobial stepdown by nurses
10) Jones et al. (2018), UK	TDF and COM-B	Investigation of the attitudes towards and experiences of AMS for community pharmacies in order to explore barriers and opportunities to AMS.
MRSA screening		
11) Currie et al. (2019), UK	TDF	Identification of factors which influenced staff compliance with MRSA screening policies

focused upon. Of the 11 included studies seven focused on hand hygiene, three on antimicrobial stewardship, and one on methicillin-resistant *Staphylococcus aureus* (MRSA) screening (Table 2).

Hand hygiene

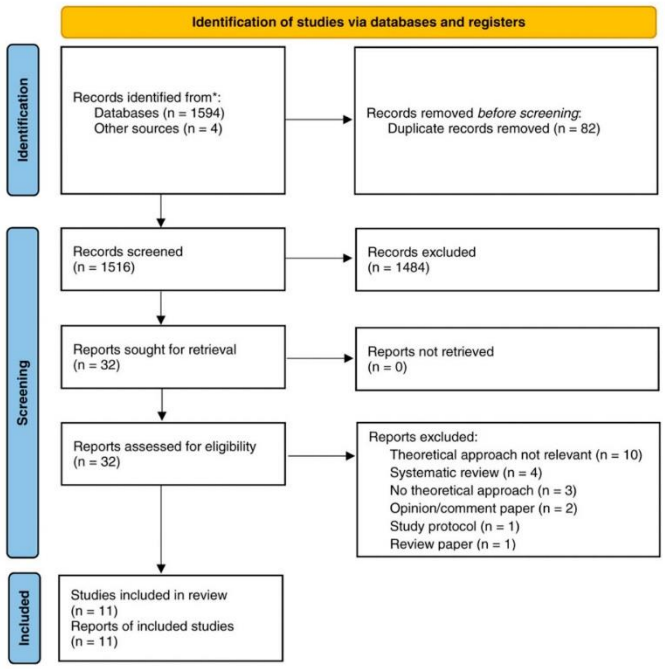
Hand hygiene is a key behaviour in the interruption of the spread of pathogens during patient care. Performance of hand hygiene by healthcare workers at specific moments during care provision aims to reduce the spread of infection between sites on one patient, between different patients, and around the healthcare environment. Seven papers were identified which had used the relevant theories to explore staff performance of hand hygiene in healthcare environments. The studies focused on three different aspects of hand hygiene: barriers and facilitators, decision making, and intervention success.

Barriers and facilitators to hand hygiene

Five studies explored the barriers and facilitators to appropriate hand hygiene behaviour. Settings included long-term care (Smith et al., 2019) and hospital (Dyson et al., 2011, 2013; Boscart et al., 2012; Squires et al., 2014). All five studies included interviews or questionnaires about the performance of hand hygiene with frontline staff as participants. All used the TDF to inform the development of question schedules and the analysis and interpretation of data.

Smith et al. (2019) aimed to identify key attitudes and barriers and facilitators to hand hygiene in the care home setting by designing a staff survey. An initial survey of 85 care workers narrowed the questions, which were based on existing surveys and literature and mapped on to the TDF domains. From this, a second survey was developed which contained 47 closed-ended questions. Analysis of the second survey focused on 342 staff whose role included providing direct care. This survey identified four main themes which mapped on to three TDF domains. The barriers to hand hygiene were related to the domain of environmental context and resources, this included time pressure, workload, and environmental controls. Hand hygiene was facilitated by two domains, that of social/professional role and identity, and beliefs about consequences to self and others. This encompassed performance of hand hygiene feeling like part of their professional duty, and its potential impact on themselves, co-workers, and patients. The authors noted that the barriers they identified were similar to those seen in hospitals. Smith et al. (2019) saw the resulting questionnaire as a useful tool for defining key factors which may restrict or encourage hand hygiene behaviour in an organisation which

Figure 1. PRISMA flow diagram for the scoping review process (Adapted from Page et al., 2021).



can then inform selection of appropriate interventions specific to that setting.

As compliance to hand hygiene may differ depending on job role, theories can support the exploration of potential determinates of behaviour for these different groups. Looking at specific job roles, Squires et al. (2014) interviewed 42 physicians, both staff and residents from surgical and medical wards, using a question schedule informed by the TDF. Nine of the 14 domains from the TDF were identified as relevant to hand hygiene practice: (i) knowledge, (ii) skills, (iii) beliefs about capabilities, (iv) beliefs about consequences, (v) goals, (vi) memory, attention, and decision processes, (vii) environmental context and resources, (viii) social professional role and identity; and (ix) social influences. The authors found that physicians reported a knowledge and skills gap related to guidelines and performance of hand hygiene. This was surprising given it would be expected these areas would be covered during training. The influence of just one domain, social influences, differed between the specialities with more surgical staff reporting their team influenced their performance of hand hygiene than the medical staff. It was noted that nearly all participants thought performance of hand hygiene was a conscious process, thus may benefit from reminders in the environment.

Dyson et al. (2011) explored barriers and facilitators to hand hygiene whilst comparing data elicited from two types of questionnaire. One questionnaire was developed using the TDF, with questions covering 12 domains. The other questionnaire was based on existing literature and probed existing factors which have been found to influence hand hygiene including social and organisational; individual differences; and knowledge. Questions were delivered via focus groups, interviews, and paper questionnaires with a total of 70 healthcare workers. The authors found that the theory-based questions prompted significantly more discussion of three domains in particular: emotion, habit/routine, and incentives. The authors suggest that these domains may have an unconscious influence upon behaviour, thus by asking participants about them outright their influence is considered and discussed.

The TDF has also been used to underpin the design of an instrument to explore barriers and facilitators to hand hygiene which can be administered to large groups. Through use of Delphi survey and pilot testing Dyson et al. (2013) developed an instrument which consisted of 33 questions

spanning 10 TDF domains. Testing with healthcare workers showed that those who reported higher numbers of barriers had lower self-reported compliance to hand hygiene. The authors propose that development of such instruments allows for large scale assessment of healthcare staff in an organisation as opposed to potentially lengthy interview processes. This also allows for tailored interventions to be developed based on local results.

As theory can help to explore influences on performance of evidence-based practice it can be used to explore potential barriers to practice before interventions are implemented. Boscart et al. (2012) aimed to explore barriers and facilitators to the introduction of a new electronic monitoring system (EMS) for hand hygiene as well as to existing hand hygiene practice in a hospital setting. 10 interviews, with questions informed by the TDF, were conducted with nursing staff and administrative staff (IPC nurse, unit manager, and director of care). The authors found differences between the responses from the nurses and administrators. In general, nurses felt they had sufficient knowledge, skills and capabilities to perform hand hygiene, and discussed the routine nature of hand hygiene to their practice. Administrators thought nurses potentially lacked in knowledge and decision making and identified potential environmental barriers nurses may encounter to performance of hand hygiene. Discussing hand hygiene practice and the EMS enabled the authors to pinpoint specific areas they could target when implementing the EMS in order to aid its success. Interviews also highlighted differences in views dependent on job role which could be considered when planning implementation strategies.

Staff decision making

The decision for individuals to perform hand hygiene is influenced by both automatic and conscious processes. To explore how healthcare staff decided when to clean their hands during practice Fuller et al. (2014) observed care provision and asked staff about their noncompliance to hand hygiene immediately following the event. The TDF was used to code and analyse the reasons given for noncompliance. Just over two thirds (142/207, 67%) of coding related to two domains of the TDF; (1) memory, attention and decision processes and (2) knowledge. Fuller et al. (2014) surmised that this indicated that both automatic and conscious process need to be targeted when designing interventions due to the dynamic nature of behavioural influences.

Interventions to improve hand hygiene

Hand hygiene is often the focus of improvement interventions. McAteer et al. (2014) explored why an intervention may succeed in some settings but not others. They assessed the implementation of an intervention to improve hand hygiene which was trialled using a stepped wedge cluster randomised controlled trial in 16 NHS trusts. The intervention itself was based on goal setting and control theory, involving observation of staff, feedback and goal setting. Ward coordinators, who delivered the intervention, from 17/33 (52%) of the wards involved were interviewed to explore experienced successes and challenges. Interview questions were based on nine TDF domains thought most relevant to the topic, answers related to these domains were coded with a number which represented how likely it was to contribute to intervention success. McAteer et al. (2014) found that domains most related to successful implementation were linked to professional identity in that the tasks were already part of the ward coordinator role, knowledge of the intervention, skills around implementation, motivation to deliver the intervention, and behavioural regulation with regard to prioritising goals.

Antimicrobial stewardship

Antimicrobial stewardship focuses on optimising the use of antibiotics in order to minimise unnecessary use, or overuse. This is considered to be critical in reducing and controlling the emergence of antimicrobial resistant pathogens. Three studies were found which focused on perceived barriers and facilitators to antimicrobial stewardship. All were based in different settings covering long-term care (Chambers et al., 2019), hospital (Fisher et al., 2018) and community pharmacy (Jones et al., 2018). In all studies, the TDF was used to inform a question schedule or analyse data collected via interviews or surveys. Two studies (Fisher et al., 2018; Jones et al., 2018) went on to map the identified domains onto the COM-B to ascertain the relevant behaviour change techniques.

Fisher et al. (2018) used semi-structured interviews with 15 nurses at one hospital to explore the barriers and facilitators to stepdown from intravenous (IV) to oral antibiotics on hospital wards. Interview schedules were developed using the TDF and responses analysed using content analysis focusing on the TDF domains. All TDF domains, except that of emotion were represented in the data. More than half of the coded responses represented just four domains: beliefs about consequences, knowledge, environmental context and resources, and social/professional role and identity. Domains were mapped onto the COM-B system in order to identify the potential development of interventions to promote the stepdown to oral antibiotics.

Jones et al. (2018) focused on current and potential use of antimicrobial stewardship in the community pharmacy setting. This was explored through interviews and focus groups with 58 participants working within community pharmacies and GP surgeries. The question schedule was informed by the TDF, with responses showing comments coded into all 14 domains. Identified domains were mapped onto COM-B to identify relevant interventions, and this led to recommendations as to how practice could be improved. Recommendations were focused on four key TDF domains:

environmental context and resources, beliefs about consequences, memory, attention and decision making, and professional role and identity.

One study developed a theory-informed antimicrobial stewardship programme. Chambers et al. (2019) explored the barriers and facilitators to management and treatment of urinary tract infections by surveying 381 people working in long-term care. Responses were coded and mapped onto the TDF domains; this identified eight domains as relevant to appropriate prescribing practice. Relevant domains were then mapped onto a specialised database which suggested interventions to improve drug prescribing practice. Interventions were chosen which had the potential to address the TDF constructs identified. Focus groups with staff from two long-term care facilities were held to explore acceptability and feasibility of proposed interventions in the care setting.

MRSA screening

The routine screening of patients for MRSA helps to appropriately manage those colonised and reduce the risk to other patients. One study used a mixed methods approach to explore the MRSA screening behaviours of UK hospital staff (Currie et al., 2019). The TDF was used to design a question schedule and analyse the results of interviews and focus groups with 49 nurses and clinical staff. This identified key barriers and enablers to screening behaviour which were used to design a national survey to explore the issue. Three-quarters of survey respondents (76%, 343/450) reported their compliance with MRSA screening procedures as >90%, this was considered optimum compliance according to local standards. Logistic regression found three predictors for >90% compliance: (1) screening as part of admission process (it was seen as easy to complete due to admission routine); (2) feedback regarding compliance levels to screening (staff were aware of their performance); and (3) clinical area (the influence of ward culture). The authors recommend targeting these areas in order to influence and embed screening behaviour.

Discussion

This scoping review has shown how behaviour change theories have been used to explore the application of evidence-based IPC practices in relation to hand hygiene, antimicrobial stewardship, and MRSA screening. The reviewed studies encompassed a range of settings and staff roles with most exploring perceived barriers and facilitators to existing IPC practices by healthcare staff. This can help to explore determinants of engrained practice and identify potential interventions specific to the setting. Only three of the studies (Dyson et al., 2013; Chambers et al., 2019; Smith et al., 2019) described an intervention or development of a tool which targeted the behavioural determinants identified.

Use of a theoretical framework within the studies ensured a wide range of behavioural determinants were explored, including ones which were not previously reported to be of influence on the particular behaviour. This is demonstrated by Dyson et al.'s (2011) finding that theory-informed questions elicited discussion from participants of a wider scope of behavioural determinants than questions based on published literature. This broader assessment of the range of barriers and facilitators identifies potentially unknown influences on IPC behaviours which can be targeted in the design of interventions.

Some domains were frequently identified across all three IPC behaviours: beliefs about consequences, environmental context and resources, and social/professional role and identity (Table 3). These may be key areas to consider when planning interventions in IPC practice. Awareness of the consequences of an infection occurring or its potential spread to other patients or the healthcare worker themselves was a facilitator for performance of hand hygiene (Smith et al., 2019). However, attribution of the occurrence of infection to behaviour is problematic due to the period of intermission between the two events. Due to this delay in consequences, encouraging IPC behaviour may require greater focus on the formation of habitual behaviour and developing emotion-based motivations to perform behaviour (Cioffi and Cioffi, 2014). Where a specific behaviour was to be avoided, e.g. prescribing antimicrobial agents, some healthcare workers worried that if a patient was not treated they may develop an infection (Chambers et al., 2019). This perception of a potentially negative consequence can be addressed by providing support and education to promote recognition of the balance between the appropriate use of antibiotics and potential harm from over usage.

In order for staff to adhere to preferred IPC behaviours they require an environment that supports these actions. For hand hygiene the location of alcohol-based hand rub at the point-of-care enables healthcare workers to decontaminate their hands close to where contamination occurs. This point-of-care location has been found to increase compliance to hand hygiene (Traore et al., 2007). This sort of environmental or resource change may require the introduction of new systems and processes or adapting something which is already in place. The idea of an enabling environment also links to the concept of making IPC behaviours an essential part of the professional role. Creating an environment which encourages IPC behaviours makes it easier for them to be performed as a core part of everyday practice and create a strong link to a sense of professionalism.

Other domains featured in some studies but not in others, although sometimes this was due to questionnaire design and whether they included all domains in the questions. The differences between the findings of the studies also demonstrates the importance of exploring determinants of behaviour within individual settings rather than assuming we understand why a behaviour is, or is not, performed

Table 3. The TDF domains identified in reviewed studies*.

Theoretical domains framework (TDF) domain	Domains identified in each study		
	Hand hygiene	Antimicrobial stewardship	MRSA screening
Behavioural regulation	1, 2, 3, 4, 5, 6	9, 10	11
Beliefs about capabilities	1, 3, 5, 6, 7	9, 10	—
Beliefs about consequences	1, 2, 3, 4, 6, 7	8, 9, 10	11
Emotions	1, 2, 3, 4, 5	8, 10	—
Environmental context and resources	1, 2, 3, 4, 5, 6, 7	8, 9, 10	11
Goals	1, 7	9, 10	—
Intentions	1	9, 10	—
Knowledge	1, 2, 3, 4, 5, 7	8, 9, 10	—
Memory, attention and decision processes	1, 2, 3, 4, 6, 7	9, 10	—
Optimism	1	9, 10	—
Reinforcement	1, 2	8, 10	11
Skills	1, 2, 3, 4, 5, 7	8, 9, 10	—
Social influences	1, 2, 3, 4, 5, 6, 7	8, 9, 10	—
Social/Professional role and identity	1, 2, 3, 5, 6, 7	8, 9, 10	11

*Studies identified by numbers used in Table 2.

consistently. Identification of these specific barriers and facilitators is vital before designing or introducing interventions. Engaging staff in this process may also demonstrate to them that any intervention to be introduced will consider issues specific to their experience and context.

The influence of different factors on behaviour was shown to vary according to occupational group (Boscart et al., 2012; Dyson et al., 2013; Squires et al., 2014). This is of importance when thinking about improving IPC practice in a ward setting where different team members may benefit from tailored support or different approaches to training. Squires et al. (2014) found a lack of knowledge and skills around hand hygiene among physicians even though it would be part of their basic training. Assumptions may commonly be made about level of knowledge and skills in relation to IPC practices, therefore additional ward-based training and feedback may benefit staff (Tavolacci et al., 2008).

Most studies in this review involved interviews with staff, these can be time consuming to complete and analyse. The survey instrument developed by Dyson et al. (2013) demonstrates an approach for assessing determinants of behaviour at scale across an organisation, obviating the need for interviews. By developing such theory-based instruments, IPC practitioners can target larger cohorts of staff across different settings to define the specific factors influencing behaviour at a local level. Ensuring these tools have an underlying theoretical base also allows for relevant behaviour change techniques to be identified and included in the design of interventions.

The successful implementation of behaviour change strategies is key to the effectiveness of interventions. Using behaviour change theory to explore potential barriers and facilitators prior to the design, or implementation, of an intervention allows for it to be tailored to each specific context. In addition, after an intervention has been implemented the reasons behind its success or failure can be explored using the same framework (McAteer et al., 2014). This can highlight key areas to address or support when implementing interventions in similar settings, or to inform adaptions to improve the intervention.

Limitations

The scope of the identified studies is currently fairly narrow and focused on exploring three IPC practices. Some papers relied on self-reported compliance to IPC behaviour, this could have led to social desirability bias where participants report they perform behaviour more than they do in reality. Combining staff interviews with observation of care delivery or reviewing audit data may present a more accurate picture of compliance where this is important. The studies

identified for inclusion in this review were only conducted in two countries, the UK and Canada, thus behavioural determinants may vary further depending on the country the research is conducted in. Future research should aim to extend the scope of theory-based analysis of behaviour related to a wider range of IPC practices. Areas of interest could include use of PPE including glove use, implementation of care pathways and bundles, and adherence to isolation precautions.

Conclusions

Use of behaviour change theories to explore IPC practices has helped to establish a range of determinants involved in the performance of behaviour. Identifying these factors means they can be targeted in order to support the translation of evidence into practice, ensuring it meets recommended standards and guidelines. It would be of benefit for IPC practitioners to utilise these methods to explore practice and support behaviour change. The small number of published studies and IPC behaviours explored indicate more research in this area is required which is underpinned by theoretical frameworks.

Declaration of conflict of interest statement

The authors declare that there is no conflict of interest.

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Supplemental Material

Supplemental material for this article is available online.

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Appendix 1

Search strategy for MEDLINE

Exp Models, Theoretical/OR exp Psychological Theory/OR Theoretical Domains Framework.mp. OR COM-B.mp. OR Behaviour change wheel.mp. AND exp Antimicrobial Stewardship/OR exp Hand Disinfection/OR exp Disease Transmission, Infectious/pc (Prevention & Control) OR infection prevention.mp. OR exp Cross Infection/pc (Prevention & Control) AND exp "Quality of Health Care"/OR exp Program Development/OR improvement.mp Limit to (abstracts and English language and yr="2000 -Current").

Appendix 4: Search strategies for scoping review

CINHAL Complete (via EBSCOhost)

Search strategy	Limits
(MH "Conceptual Framework") OR (MH "Behavioral Changes") OR (MH "Models, Theoretical+") OR (MH "Psychological Theory+") OR "Theoretical Domains Framework" OR "COM-B" OR "Behaviour change wheel" AND (MH "Antimicrobial Stewardship+") OR (MH "Handwashing+") OR (MH "Disease Transmission, Professional-to-Patient") OR (MH "Infection Control+") OR (MH "Infection/PC/PF/ED/NU/TM") OR (MH "Cross Infection/PC/ED/NU/ST/PF") AND (MH "Quality of Health Care+") OR (MH "Organizational Compliance") OR (MH "Program Development+")	2000-2019, English Language, Abstract Available

EMBASE (via Ovid)

Search strategy	Limits
exp theoretical model/ or exp conceptual framework/ OR exp behavior change/ OR exp psychological theory/ OR Theoretical Domains Framework.mp. OR COM-B.mp. OR Behaviour change wheel.mp. AND exp antimicrobial stewardship/ OR exp hand washing/ OR exp disease transmission/pc [Prevention] OR exp infection control/ OR exp infection prevention/ OR cross infection/pc [Prevention] AND exp health care quality/ OR exp program development/	abstracts and english language and yr="2000 - Current"

MEDLINE (via Ovid)

Search strategy	Limits
exp Models, Theoretical/ OR exp Psychological Theory/ OR Theoretical Domains Framework.mp. OR COM-B.mp. OR Behaviour change wheel.mp. AND exp Antimicrobial Stewardship/ OR exp Hand Disinfection/ OR exp Disease Transmission, Infectious/pc [Prevention & Control] OR infection prevention.mp. OR exp Cross Infection/pc [Prevention & Control] AND exp "Quality of Health Care"/ OR exp Program Development/ OR improvement.mp	abstracts and english language and yr="2000 - Current"

Appendix 5: Ethical approval for Phase 1

UNIVERSITY OF WEST LONDON
The Career University

College of Nursing, Midwifery and Healthcare
Research Ethics Panel
Paragon House
Boston Manor Road
Brentford TW8 9GA
Tel: +44 (0)20 8209 4110/4145
email: cnmh.ethics@uwl.ac.uk

Carolynn Greene
21392581
5th March 2019

Dear Carolynn

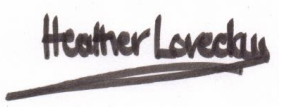
Re: Application for Ethical Approval No. UWL/REC/CNMH-00517
Development and exploration of an electronic monitoring system for hand hygiene in hospitals

Thank you for sending in your application for approval. The Panel has considered this and approved the research without major amendment.

If the research does not progress, or if you make any changes to your research proposal or methodology can you please inform the Panel in writing as this may entail the need for additional review. It is your responsibility, as the principal investigator, to submit a report on the progress/completion of the research twelve months from the date of this letter. Please find attached a blank report form to be completed by 01 January 2020.

The Panel wish you well with your research and look forward to your report.

Yours sincerely



Professor Heather Loveday
Director of Research
Chair, College Research Ethics Panel

Appendix 6: Phase 1 information sheet for ward staff

June 2019

Information sheet for ward staff

Research project title:
Establishment and exploration of an electronic monitoring system for hand hygiene in hospitals

Who is organising this research?
This project is part of a professional doctorate being undertaken by Carolynn Greene at the University of West London (UWL), College of Nursing, Midwifery and Healthcare (CNMH). Ethical approval has been received from the UWL CNMH Research Ethics Committee. The project is funded by SC Johnson (previously Deb Group).

What is the purpose of the project?
This project is looking into the use of electronic monitoring systems for monitoring hand hygiene activity in hospitals. The project aims to develop frequencies of hand hygiene opportunities for healthcare workers on hospital wards and explore the accuracy of an electronic monitoring system. During a second phase of the project the researcher will be seeking the thoughts and experiences of staff regarding hand hygiene practice, auditing, and electronic monitoring.

What will the researcher be doing on the ward?
The researcher will be completing observations of staff during normal working practice in order to explore the frequency of hand hygiene opportunities according to the World Health Organisation's *My 5 Moments for Hand Hygiene*. These observations will cover weekdays, weekends, day shifts and night shifts. Observations will include different staff roles to explore their work loading and how this impacts the number of hand hygiene opportunities.

What data will be collected?
No personally identifiable information will be collected, data collected will include job role only.

What will happen to the data which is collected?
The findings from these observations will be used to inform a denominator for an electronic monitoring system for hand hygiene. Observations will also inform the development of questions for use in staff interviews in the second phase of the project.

If you have any questions or further information please contact:

- Researcher: Carolynn Greene, UWL, Carolynn.Greene@uwl.ac.uk
- Principal supervisor: Professor Jennie Wilson, UWL, Jennie.Wilson@uwl.ac.uk

Appendix 7: Phase 1 data collection form

Observer initials: _____

Data collection form	
Date:	Observation duration:
Ward:	Observation period start:
Shift: Day / Night	Observation period end:
Number of staff on shift:	Number of patients:
Staff type: Nursing Assistant / Staff Nurse / Doctor / Allied Health Professional Other:	
Comments:	

Page ___ of ___

Opportunities for hand hygiene			
Time	Activity/Procedure	Indicate if not observed	WHO Moment indicated

Appendix 8: Amendment to ethical approval for Phase 2

UNIVERSITY OF WEST LONDON
The Career University

College of Nursing, Midwifery and Healthcare
Research Ethics Panel
Paragon House
Boston Manor Road
Brentford TW8 9GA
Tel: +44 (0)20 8209 4110/4154
Email: cnmh.ethics@uwl.ac.uk

Name: Carolynn Greene
Student No: 21392581
Date: 21st July 2021

Dear Carolynn

Re: Minor Amendment for Ethical Approval No. 00884

Thank you for sending in your amendment for Ethics approval. Chair's Action has considered this and approved the amendment unconditionally.

If the research does not progress, or if you make any changes to your research proposal or methodology can you please inform the Panel in writing as this may entail the need for additional review. It is your responsibility, as the principal investigator, to submit a report on the progress/completion of the research twelve months from the date of this letter.

The Panel wish you well with your research.

Yours sincerely

Professor Heather Loveday
Director of Research
Chair, College Research Ethics Panel

Appendix 9: Phase 2 participant information sheet

Short study title: Healthcare workers perspectives on hand hygiene performance and audit

Participant Information Sheet V2.0

Introduction

My name is Carolynn, I am a PhD student at the University of West London (UWL). I am working on a research study that aims to explore healthcare workers experiences and perceptions of hand hygiene in everyday practice. In order to do this, we would like to interview healthcare practitioners such as yourself.

Why have I been invited to take part in an interview?

We wish to seek your views in relation to your role as a healthcare professional, to talk about your daily work and how you apply hand hygiene during your day-to-day practice.

Do I have to take part?

No, taking part is voluntary. If you would prefer not to take part, you do not have to give a reason and no pressure will be put on you to try and change your mind.

What would taking part involve?

If you agree, you will take part in a one-to-one interview with the researcher which can be done face-to-face or virtually via Microsoft Teams. You will be asked questions about your everyday practice and experiences of performing hand hygiene; your experiences and thoughts about audit of hand hygiene; the potential use of electronic systems for hand hygiene audit; and the potential impact of COVID-19 upon your practice. You will be asked to sign a consent form which means you agree to take part. You are free to withdraw from the research at any time without providing a reason. You can ask the interviewer to pause recording at any point, and you are welcome to ask us if you have any questions.

How will we use information about you?

We will need to use information from you for this research project, this includes your:

- Name and contact details

This information will be used to manage your participation in the research and will be deleted following the completion of the study. We will keep all information about you safe and secure. We will write our reports in a way that will not allow any individual participants to be identified. Once the study is completed, we will keep some of the data for a period of 5 years so we can check the results.

If I agree to take part, what happens to the information?

The information you give us will be kept confidential. The research student, Carolynn, will conduct, record, and transcribe the interview. The recording will be destroyed when data analysis is complete. Any paper copies of interview data (e.g. consent form and interview transcript) will be kept in locked cabinets in a secure room at UWL. This will be kept for 5 years following the completion of the project for audit purposes, after this the physical data will be securely destroyed. Electronic copies of interview transcripts will be password protected and will be stored on secure drives on password protected university computers in line with UWL policy. You can find out more about how we use your information by asking one of the research team.

drives on password protected university computers in line with UWL policy. You can find out more about how we use your information by asking one of the research team.

What will happen with the results of the research study?
It is hoped that the results of this study will be used to build a picture of the way in which hand hygiene is integrated into daily working practice. The research will be written up as a doctoral thesis and results published in peer reviewed academic research journals. Any quotations from interviews used in these documents will be anonymised meaning you will not be identified.

Who is organising this project?
This study is part of a PhD project being undertaken by Carolynn Greene at the University of West London (UWL), College of Nursing, Midwifery and Healthcare (CNMH). The project has received ethical approval from the UWL CNMH Research Ethics Committee.

How will taking part in an interview affect me?
We do not think any harm will occur from taking part in the interview. Taking part will help to inform knowledge around hand hygiene as it is applied in practice.

What if there is a problem?
It is unlikely that anything will go wrong, but if there is a problem or you have a concern about any aspect of this study, please contact:
Carolynn Greene, UWL, Carolynn.Greene@uwl.ac.uk (Doctoral Researcher)
Professor Jennie Wilson, UWL, Jennie.Wilson@uwl.ac.uk (Principal Supervisor)

What do I do now?
Before you decide whether to take part it is important that you understand the research and what this study will involve. Please take time to read the information carefully. Ask us if there is anything that is not clear or if you would like more information. You will be asked to sign a consent form which means you agree to participate in an interview. Please also ask if you have any questions about the consent form.

If you are happy to take part in this study, please sign the consent sheet attached.

Thank you.

Carolynn Greene
Doctoral Researcher
University of West London
Carolynn.Greene@uwl.ac.uk

Appendix 10: Phase 2 participant consent form

UNIVERSITY OF WEST LONDON

Short study title: Healthcare workers perspectives on hand hygiene performance and audit

Participant Consent Form V3.0

Thank you for considering taking part in this research. The person organising the research should have explained the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide to take part. You will be given a copy of this Participant Consent Form to keep and refer to at any time.

If you agree, please tick each box

1. I confirm that I have read and understand the Participant Information Sheet dated 06.07.21 V3.0 for the above study.	
2. I have had the opportunity to consider the study information and ask questions about the study which have been answered to my satisfaction.	
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my work or legal rights being affected.	
4. I consent to my session being audio recorded.	
5. I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the General Data Protection Regulation (GDPR).	
6. I consent to the use of anonymised direct quotes in the research write up and any academic publications.	
7. I understand that a summary of the study findings will be made available to me.	
8. I understand that following completion of the interview I will be emailed a £10 Amazon eGift Voucher.	
9. I understand that some parts of the data collected for the study may be looked at by representatives of regulatory authorities and by authorised people to check that the study is being carried out correctly. All will have a duty of confidentiality under the General Data Protection Regulation (GDPR).	
10. I agree to take part in the above study.	

Name of Participant	Date	Signature (Please use an electronic signature or type your name)

Name of person taking consent	Date	Signature

When completed: 1 copy for participant; 1 copy for researcher

UWL REC ref: UWL/REC/CNMH-00884
Participant Consent Form 06/07/2021 V3.0 Page **1** of **1**

Appendix 11: Question schedule for registered nurses and nursing assistants

Introduction

Thank you for agreeing to take part in this study. (Check consent form, did you have any questions?) Just a reminder that I am now audio recording the interview. Today I am going to ask you some questions about your experience of hand hygiene in your everyday practice. There are no right or wrong answers, I just want to know about your thoughts and experiences. As stated in the consent form your answers will be anonymised so you can be open and honest in your answers. If you do not want to answer a question, then please let me know and I will move onto the next one.

To begin could I ask you about your current role:

- What is your job title?
- What band are you employed at?
- Where do you work? What size of hospital?
- How many years' experience have you had in your current role?
- Do you have any special role in infection prevention and control at your workplace? (e.g. Infection Control or Hand Hygiene Champion)

Initial question

To begin with I would like to get you to think about the World Health Organization's Five Moments for Hand Hygiene as you apply it in your everyday practice.

- Can you describe to me a step-by-step scenario of patient care when you would clean your hands more than once? (If unsure: suggest scenario of taking patient observations) (Prompt: WHO image of 5MHH)

Discussion of scenario

- Can you talk me through why you cleaned your hands at those times?
- How do you decide to clean your hands at those times?

- How do you find the use of portable medical equipment (such as computer on wheels or observation carts) impacts your application of hand hygiene as you perform a task?
- How do you understand the concepts of the patient zone and healthcare zone in relation to HH?
    - Do you view the patient privacy curtains as part of the patient zone or healthcare zone?
- When you think about your hand hygiene practice do you think you tend to use the bed-end or wall-mounted dispensers more? Prompt: Does the location of dispenser impact your hand hygiene practice? For instance, point-of-care bottles located at the bed-end/treatment area compared to wall-mounted.

I would like to ask you some more general questions about the WHO 5MHH.

5MHH

- What training have you received about the 5MHH?
- How well do you feel the training you have received about the 5MHH related to your

day-to-day practice on the ward? Prompt: Is it easy to apply to 5MHH in real practice?

- Do you feel the 5MHH are all as important as each other?
    - Would you say one moment is the most important?

- Do some activities result in you cleaning your hands more than others? (Prompt: Type of care activity? Type of patient?)
- What problems do you encounter which mean you are less likely to perform the 5MHH? (Prompt: competing tasks, time constraints, resources)
- Do you feel that the hand hygiene behaviour of others on your team influences your own hand hygiene?
- Who do you feel able to ask about hand hygiene practice if you are unsure whether it is required at a particular time during care provision?

I now have some questions which are more focused on auditing practices.

Audits

- Can you briefly explain how is hand hygiene audited where you work?
- How do ward staff feel when a hand hygiene audit is taking place?
- Do you think the data collected during audits represents typical hand hygiene activity on the ward?
- Do you think that hand hygiene audits are important? Why/why not?
- What happens if the hand hygiene compliance score from an audit is very high or very low?
- When does feedback have the most impact on you, when do you really take notice? (Prompt: Individual or group feedback?)
- When audits are performed, do you interact with the auditor? (Prompt: Asking the IPCN questions or advice)

EMS

My next questions are about the potential of electronic monitoring systems for auditing hand hygiene compliance. I don't know if you have ever had experience of any electronic systems for monitoring hand hygiene, but I have been exploring one which generates a compliance rate by capturing dispenser usage by using a counter within the dispenser units – this includes all soap and sanitizer dispensers, including point-of-care dispensers. The counter records a hand hygiene event and compares this to the number of expected hand hygiene opportunities for the ward which is based on research and reflects the number of staff and patients on the ward. This system collects data 24/7 and can then provide an overall compliance rate for the ward, it cannot provide compliance rates for individuals or specific cohorts based on job role for instance. The compliance rate can be presented as a daily rate and can be further broken down to shift level or even hourly compliance.

- What do you think the advantages of a system like this could be?
- What do you think the disadvantages of a system like this might be?
- What do you think about a system which focuses on overall ward compliance rather than individual staff members compliance?
- Would you see a role for direct audit alongside a system such as this?
- Would you see any challenges or barriers to the acceptance of an electronic

monitoring system for hand hygiene by staff? Do you have any personal thoughts about an electronic system?

COVID-19

I am going to ask a few questions about COVID-19 and hand hygiene, are you happy to continue?

- How did you feel about cleaning your hands at work during the pandemic?
    - Were these feelings temporary or ongoing?
- Has the pandemic impacted how effective you think hand hygiene can be?
- Did you receive any additional hand hygiene training following COVID-19?
    - If yes, did you have any questions or concerns about hand hygiene which you were able to ask about?
    - If no, who could you ask if you had any questions or concerns about hand hygiene?
- How did you utilise the IPC team during the pandemic?
- Do you feel that increased use of PPE impacted your ability to perform the 5MHH?
- How did it feel to see the importance of hand hygiene (something you do in your everyday work) talked about in wider society, for instance on television and in public health messaging?

Close

That is all my questions, thank you for your time today. Do you have anything further you would like to add or any questions? Please contact me if you think of anything following the interview.

Appendix 12: Question schedule for IPC practitioners

Introduction

Thank you for agreeing to take part in this study. (Check consent form, did you have any questions?) Just a reminder that I am now audio recording the interview. Today I am going to ask you some questions about your experience of hand hygiene in your everyday practice. There are no right or wrong answers, I just want to know about your thoughts and experiences. As stated in the consent form your answers will be anonymised so you can be open and honest in your answers. If you do not want to answer a question, then please let me know and I will move onto the next one.

To begin could I ask you about your current role:

- What is your job title?
- What band are you employed at?
- Where do you work?
- How many years' experience have you had in your current role?

To begin with I would like to ask you some questions about the World Health Organization's Five Moments for Hand Hygiene.

5MHH

- What training have you received about the 5MHH over your career?
- What do you understand about the concept of the patient zone?
- What do you understand about the concept of the healthcare zone?
- When thinking about the healthcare zone and patient zone where do you see the patient privacy curtains fitting into those zones?
    - How are these concepts included in staff training on hand hygiene?
- How much do you consider portable medical equipment (such as computer on wheels or observation carts) to be a potential risk for infection transmission?
    - Prompt: Do you see these items used on the wards in a way where they could lead to cross-contamination?
    - How far is the role of portable medical equipment integrated into staff training on hand hygiene?
- How do you find teaching staff about the 5MHH?
    - Are there any concepts which they find difficult to apply to their everyday practice?

I now have some questions which are more focused on auditing practices.

Audits

- Can you briefly explain how you collect hand hygiene audit data in your organisation?
- How much do you think that the compliance data collected during audits represents typical everyday hand hygiene activity on a ward?
    - (If direct observation used) Prompt: How do you think direct observation affects practice of HH?
- What approach do you take in feeding back audit data to staff?
- How do staff generally respond to feedback? Prompt: Do they take feedback on board?/Are they receptive to what you tell them?
- How do you feel the data from audits impacts the hand hygiene behaviour of staff in the long term?
- Are there certain moments of the 5MHH which staff struggle to adhere to and why do you think this is?

- What is your impression of healthcare workers understanding of the 5MHH? Are some easier to apply in practice than others?
- What sort of issues arise which staff say makes it difficult to apply hand hygiene in practice? Prompt: Being busy, forgetting, location of equipment
- How do you find glove use affects hand hygiene compliance?
- How much do healthcare workers interact with you when you are auditing? Do they ask you about hand hygiene?

My next questions are about the potential of electronic monitoring systems for auditing hand hygiene compliance. I don't know if you have ever had experience of any electronic systems for monitoring hand hygiene, but I have been exploring one which generates a compliance rate by capturing dispenser usage by using a counter within the dispenser units – this includes all soap and sanitizer dispensers, including point-of-care dispensers. The counter records a hand hygiene event and compares this to the number of expected hand hygiene opportunities for the ward which is based on research and reflects the number of staff and patients on the ward. This system collects data 24/7 and can then provide an overall compliance rate for the ward, it cannot provide compliance rates for individuals or cohorts based on job role. The compliance rate can be presented as a daily rate and can be further broken down to shift level or even hourly compliance.

EMS

- What do you think the advantages of a system like this could be?
- What do you think the disadvantages of a system like this might be?
- What do you think about a system which focuses on overall ward compliance rather than individual compliance?
- Would you see a role for direct audit alongside a system such as this?
- If a hand hygiene compliance rate were generated electronically, potentially freeing up the time you now use for audits, what could you use that time for?
    - Prompt: How might an electronic system be integrated into your IPC role?
- Would you see any challenges or barriers to the acceptance of an electronic monitoring system for hand hygiene by staff and IPC staff?

COVID-19

I am going to ask a few questions about COVID-19 and hand hygiene, are you happy to continue?

- How do you feel healthcare workers hand hygiene behaviour has changed over the course of the pandemic?
    - Prompt: Has any change been lasting?
- Did you deliver additional hand hygiene training during the pandemic?
    - If yes, what were the staff's main concerns or questions?
    - If no, did staff contact you to ask questions about hand hygiene?
- How did increased PPE use impact the performance of the 5MHH?
- How did it feel to see the importance of hand hygiene (something integral to IPC) talked about in wider society, for instance on television and in public health messaging?

Appendix 13: Table of codes for each participant demonstrating each theme

Participant: IPCN01		
1. The 5 moments for hand hygiene in practice		
Challenges in HH (hand hygiene)		
Common misconceptions	4	"…just sort of being really clear in the defining of it because the curtains are always the one that will catch people out." "that's always a sort of conversation of debate people will just chat through erm, and that's a way for us to kind of highlight that touching curtains with gloves on and things as well so just saying what you're doing now you need to clean your hands please take those gloves off, they're contaminated or potentially contaminated"
Complexity of integrating HH into practice	1	"I think that's quite tricky, isn't it, when you've got to be able to put the apron on, close your curtains, put your gloves on, do your hand hygiene at the right times, and they might not feel confident to do those things or they might not have been shown to do it that way, or they just might think that that's the right way to do it."
Not recognising each patient zone	5	"I think it's quite natural for staff members to do that because they are in one room together essentially so they might not see the kind of each individual patient zones whereas if they're in a side room, or they have individually allocated equipment it's much clearer I think, the boundaries or the definition of that individual use, and they're less likely to transfer over." "I think it's probably from like bay activity so they'll go from one to the other, might get lost in the moment and forget to do it at the particular sort of moments that they need to."
Not seeing the patient zone as a source of contamination	1	"…so sort of them sort of fiddling around and moving tables and things, they don't, I think that's quite difficult for them, to think well we're not touching the actual patient, so it's just getting them to understand, erm like simple skin flora, they're gonna [inaudible] their contaminated environment of the patient's own organisms and then that being on their fingers and where that goes next"
Translating theory into practice	2	"I think whilst they're working in their clinical practice, I think they get quite a bit more um, whilst doing it in their day to day working and I think it embeds slightly differently. Rather than just showing them a diagram with the five moments and they go "Okay, yeah", and then they didn't do any of it [laughs]."
HH as embedded into daily practice		

Use of soap and water or hand sanitiser	1	"…to keep the alcohol hand gel close erm, the only difference would be if they're visibly dirty, or you're dealing with sort of, particular organisms that's when soap and water is a must…"
Motivations to perform HH		
5MHH as protection for patients	1	"…sort of aim it in a way that you're trying to keep them and their patients safe"
5MHH as protection for the self	2	"…and also what they take to lunch, that's a big point that I kind of make to them I'm like if you don't clean your hands, you're taking it to yourself to lunch so and I get some thinking "Oh, my gosh." [laughs]"
Patient status impacting practice	1	"…so items of equipment it depends on what infection or if there is an infection status for the patient"
Potential for cross-contamination in workflow		
How gloves are used or misused	4	"…the use of gloves, people not changing those gloves and like- more so like looking at COWs and WOWs how they'll go from the patient with the gloves on then back to the COW or the WOW and then just doing this all the time you're just like "no stop, no no gloves" [laughs]" "…placing gloves on can make some practitioners feel that they don't need to change their gloves in between each patient, or they just forget that they need to do that because I don't see hand hygiene needs to take place because they've got gloves on."
The role of equipment in potential spread of infection	4	"…so like the magic COW or the WOW like that isn't a part of the patient so if you are going from patient to patient you must clean your hands with that too cause that's a nightmare" "…we're lucky if people clean in between kind of the conversation about sort of stats probes and blood pressure cuffs it would be ideal for them to be cleaned between but the likelihood is that they'll go from patient to patient to patient it's just sort of highlighting that risk even though that in a bay together for example they're still individual bed spaces and individual people with their own flora or potential infection control elements…"
Understanding the role of curtains in potential spread of infection	3	"that's always a sort of conversation of debate people will just chat through erm, and that's a way for us to kind of highlight that touching curtains with gloves on and things as well so just saying what you're doing now you need to clean your hands" "it is quite difficult to describe erm, to individuals so they don't realise things like curtains are part of the patient zone…when you're stepping in beyond there and you're going into the patient environment that's when you need to be doing moment one or stepping away

		that's when you need to be doing moment 5”
Training in 5MHH		
Embedding 5MHH into other training	2	“…that’s been implemented in other training so if I've done like IV erm, courses then they’ll always have an infection control part within that of which then the 5 moments is very present. So it's kind of interjected in other parts”
Self-directed learning around HH and the 5MHH	2	“…then on the job, it's probably prompted that isn't official teaching, so I think is probably gently instructed by sort of mentors that I've had.”
Situating the 5MHH in practice	6	“definitely when I've done clinical skills it's very present and about the timing of when to do hand hygiene as well.” “…for practitioners that value is there, I think whilst they're working in their clinical practice, I think they get quite a bit more um, whilst doing it in their day to day working and I think it embeds slightly differently. Rather than just showing them a diagram with the five moments and they go “Okay, yeah”, and then they didn't do any of it [laughs].”
Using visual methods in HH training	1	“So initially we double gloved and we were trying to step it down for ages, but it took quite some time and having to go with like light boxes and stuff, just emphasising like their technique of hand hygiene and then showing them with their gloves on and then with their gloves off and just sort of making sure that they cleaned their hands properly.”
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	4	“…we do get “I was going to call you but now you’re here…” sort of questions as well, which is great. Yeah, or walking down the corridors we don't necessarily have to go to the wards like walking through corridors or through buildings we can get stopped as well, which is fine, it's great.”
Revealing the reality of practice	6	“…actually working with the staff you can see what they’re doing and support them and if there’s any adjustments that need to be sort of made or even just sort of finding out what is truly happening.” “And actually we’ve found that when the results are not 90% but set at 40% it's probably a good reflection that they've managed to do without being spotted.”
Staff reaction to low compliance	3	“I kindly said to her I'm not interested in your 90%, I'm interested in your 40% and I gave her the reasons why, and just sort of allowed her to feel supported within that dialogue, saying you haven't done anything wrong, nor has your staff, this is a true reflection of what really happens and this is a time to kind of really highlight that it’s, it’s really important that

		education needs to happen, we still need to gently remind each other erm, so yeah it was a good experience, even though she felt mortified." "I went back to the ward a week later, I could see the difference, it wasn't pretend it wasn't something, "oh yeah I just need to do this", it was real life and it was happening- change was happening, and it was coming within."
Compliance with the 5MHH		
Reasons for non-compliance	3	"…it's probably from like bay activity so they'll go from one to the other, might get lost in the moment and forget to do it at the particular sort of moments that they need to. Or they're so focussed on what they need to do that they forget that they need to clean their hands in order to do that thing." "…the normal things, "I'm busy", "I've got a lot to do", erm, "I didn't think it was a moment" erm, or "I hadn't realised" so there just it's a momentary lapse erm, they're kind of caught up in the moment erm, or "is that really is that really a moment? Do I really need to do it now? Why?" so understanding, understanding really."
Difficulties of direct observation of practice		
Areas missed by direct observation	1	"I'm not 100% sure that they do it at night-time. It would be quite interesting to see them do that."
Audit data not representative of true practice	3	"…when you're seeing sort of 90% across the board and then I can stand on a ward withing half an hour I can see clearly that hand hygiene isn't happening at the said times I really do question the 90%." "I think within hand hygiene auditors, if people rotated or they did them at different times I think they'd probably more end up with sort of 40-50s than anything else, I reckon."
Box ticking exercise	1	"And I guess that impact's not there, it's just a task and it's being ticked off."
Hostility towards IPC	2	"…it can be a mixture actually, so before, walking on the wards it's like cats they just disappear…"
Trying to avoid being noticed	2	"They try their best to kind of do it in stealth mode, but it's quite tricky for them to do that. And actually we've found that when the results are not 90% but set at 40% it's probably a good reflection that they've managed to do without being spotted." "And it's really tricky when you've got a massive badge on your uniform that says 'Infection Control' and then you're sat there like, "Hi, how are you?" and they're like literally like bathing themselves in hand gel, "am I that obvious?"."
Providing practice feedback		

Approach to delivering feedback	1	“I think it's about timing and also awareness of what's going on. So if you go in there all guns blazing and they’re caught up with something, it's just not appropriate but if you're sort of, sort of aim it in a way that you're trying to keep them and their patients safe, time it in a way they're you can’t- they’re not running around or something horrendous is happening erm, and also if you think it's not quite approachable, kind of mention it someone that they know more and just say, “I just need to give you this information are you able to feed it back to them?” erm, to support them.”
Audit as a time for providing education	3	“that's a way for us to kind of highlight that touching curtains with gloves on and things as well so just saying what you're doing now you need to clean your hands” “So as I was auditing, I noticed somebody do something and I needed to stop them because they had gone from the bed space to bed space, didn't clean their hands, had PPE on, took the PPE off and about to walk out of the bay and I went “I need to stop you, because you're about to do something that isn't in line. You need to wash your hands.” And they were horrified, they hadn't realised, and I said, “this isn't about embarrassing you, I just need to keep you and your patients safe.” and actually, it was okay, they weren’t cross with me, I didn't get the whole kind of mask or the ‘hand police’ comments. They were like, “Oh gosh, I didn’t even realise”, because they just so busy in caught up in the moment.”
Giving positive feedback	1	“also not just focus on things when they don't happen but to highlight good practice as well. So I've done that the same on the ward and just said “your hand hygiene is spot-on, I just need to let you know that” um, because I don't- I think it's easy to give constructive feedback but sometimes the kind of positive feedback might be lacking sometimes, and that's about relationship building.”
Ways in which HH practice might be changed	5	“we do try and find examples of common used items to try and um link it to the practitioner rather than just going “you must do this”, ok so how can I work this into your daily working in order for them to feel like they own it or they feel like they can, what difference can be made if any at all” “just- yeah having positive role modelling erm, is quite important to break those kind of norms, I think.”
3. Electronic monitoring systems		
Potential benefits of EMS		
Measure of reality of practice	4	“…it’d be quite enriched data because you’re actually seeing how much people are

		actually using." "Data wise, I guess it gives a baseline for sort of ward managers of what's actually happening, and if individual observations need to occur" "it's doing it all the time so you're not going to get that Hawthorne effect"
Time could be spent on other IPC activities	2	"…they can just purely focus on hand hygiene moments then and then provide education of the five moments erm, when in clinical practice" "…education of use of like donning and doffing and PPE appropriately within the hand hygiene moments, cleaning down equipment at the right times"
Practical implications		
Combining multiple monitoring streams	3	"…it's almost like having a sort of a multifocal, so if you've got that, with something else it'd be quite enriched data because you're actually seeing how much people are actually using." "…yeah I think to have a multi-level, multi-focal will definitely help for lots of different reasons."
Understanding practice on the wards to generate data	8	"Initially, if something gets erm introduced, there might be an emphasis of people doing it more so, but I guess the system will allow for that initial increase and then it will start to plateau and you'll see what routine data's like anyway…" "…you can have like an average or an expectation of how many times hand hygiene might happen within, I should say, like the hour, the shift, the day but if you have two patients that become very unwell, or do something different, then they'll need more contact and vice versa, if they become well again, that contact goes down, doesn't it? They're getting ready for discharge, etc., so that- you wouldn't be able to pick up that kind of peak and trough this is going to occur- I don't think that easily."
Where appropriate to use	3	"…that would be quite interesting for areas that aren't- possibly aren't high risk so like clinics and outpatients and things…" "And hand care, like we don't focus on that enough, actually, we'll mention it but also like it might be interesting to see how much staff like access like the Medicare lotion … how to look after their hands whilst in clinical practice, to keep their hands healthy, that would be good."
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
Increase in awareness of HH	3	"I think everybody's become more aware about cleaning their hands and erm using

		alcohol hand gel more so erm, both in and out of clinical environments." "…actually there's been a big, I think, shift for everybody to be able to want to clean their hands at a particular points they may not have done before um, by people going in and out, so coming into hospital, like going to and from home um, and just sort of making it- like awareness of cleaning your hands is better than wearing gloves and making- allowing people to feel comfortable with the reasonings why…"
IPCN activities during pandemic		
Providing support and reassurance	6	"…just listening, listening to their concerns and worries, rather just going "no, no, no it'll be fine, this what the government says", like, "tell me why you're worried and I'll chat it through with you"" "…sometimes we had- people were scared, but they were also feeling quite angry as well, so we just sort of processing that with them…" "…it's just trying to do that relationship building and um guide- guidance as well to just point them to the guidance as much as possible but again, they're just overloaded. They couldn't read it and whatever they read it just literally [goes over head] so…"
Provision of training	3	"we actually went to quite a lot of face-to-face but on the ward so almost like practice educators sort of delivery of education cos it's in smaller groups, it's in their environment"
The IPC concerns of staff	1	"I think- getting COVID. They really didn't want it, erm and they were trying to sort of limit their risk erm whilst working on the wards or in the healthcare environments."
Staff motivations to perform HH		
Community prevalence impacts anxiety and practice	2	"I think when the prevalence is higher people are much more inclined to clean their hands, even touching sort of pieces of paper around the nurse's station erm in comparison to not, erm but again it depends on the emotions and what's happening." "I think there's lots of variables isn't there? Like what the prevalence is like, what- where the nation is as regards is it full-blown lockdown are we stepping down, how the patient- how the staff feel so are they get fatigued with it erm and what's happening on the ward."
Personal anxiety and self-protection	5	"…also what's happening to them as an individual, so sometimes staff can get- can feel really anxious about things so they might be doing more and then staff might be more comfortable, so they might be just sticking to what they think that they're doing right as regards to the five moments. And we have had staff that have had really sore skin because they have overly cleaned, because they're just so scared um, and that creates another risk."

Presence of COVID patients impacting practice	1	“So if they've got patients that have particular sort of IC alerts or there’s a potential COVID positive patient or outbreak that's happening, they might be more inclined to clean their hands more…”

Participant: IPCN02		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Common misconceptions	2	"…they've got that perception that I haven't really touched a patient yet, so my hands are clean." "…even consultants would say that "I was wearing gloves", "that were- there were no direct contacts between my hand and the patient or the environment, so I think my hands are clean", in fact we get the contaminated when they get to remove the gloves and everything, sometimes there are tiny holes that you won't see so yeah."
Not recognising each patient zone	1	"If I'm going to contextualise that a little bit, at least from when I went to an area where there are bays. In terms of zoning, I think the healthcare worker zone and the patient zone is pretty much mixed up."
Motivations to perform HH		
Patient status impacting practice	1	"…how I consider there's a potential risk of transmission, it actually depends from case to case basis…I'd say that the other hospital that I'm managing has less er infectious patients and we only pretty much treat surgical patients which are you know, less infectious as we get to screen them. So I'd say that that the risk would be low. So there are a lot of factors involved in it. But the other one that I'm managing, it involves a lot of medical patients and there are a lot of infections involved erm, and obviously we get to screen them and we get to know what type of infections they have."
HH as fundamental IPC practice		
HH as fundamental IPC practice	2	"It's really interesting for me, hand hygiene, I mean it's one of the most basic things erm for healthcare professionals, healthcare workers and for infection control nurses like me." "…what I have been saying since the beginning of this interview is that one of the basic things- basic but one of the most important things to break a transmission of infection…"
Potential for cross-contamination in workflow		
How gloves are used or misused	1	"…even consultants would say that "I was wearing gloves", "that were- there were no direct contacts between my hand and the patient or the environment, so I think my hands are clean", in fact we get the contaminated when they get to remove the gloves and everything, sometimes there are tiny holes that you won't see so yeah."
Importance of the housekeeping role	2	"…as part of the training process for staff members, not just with the clinical ones, but also for our housekeeping because we're very particular of their role as well into the

		transmission of microorganisms in the environment."
The role of equipment in potential spread of infection	4	"…obviously, medical devices going in and out of the patient's room do bring a lot of erm risks, especially if the staff members are not really practicing good hand hygiene and use of PPE." "I've used UV light and I've marked several medical devices that are, you know, they're expected to be cleaned in between patients. Well, in fact, I did that 24-48 hours, I marked it and then I came back. Obviously, those medical devices were clean- I mean we're used, but upon checking my UV markings were still there."
Training in 5MHH		
Mandatory training covering HH	2	"…our mandatory training we do have some e-learning that we have to go through erm, which actually includes the five moments of hand hygiene."
Situating the 5MHH in practice	1	"…obviously with infection control then having all these principles behind what we do, erm we have to work with them to translate it into a more practical approach, particularly each area is different from one another, say endoscopy's different from the wards, same goes with outpatients. So they get to work with them in terms of that one and find a more, a more appropriate approach."
Using visual methods in HH training	3	"…we're actually looking into developing this UV light thing as part of the training process for staff members, not just with the clinical ones, but also for our housekeeping…" "…apart from the visual aspect of the UV light, um it's also a bit more engaging because you- somehow you forget the science behind what you're doing and there's evidence as opposed to, "oops, I think the desk you were working on, it was a little bit dusty" but how can you prove it? So yeah, so that's that bit of engagement there that makes it a little bit more interesting as well when you look at it."
Understanding zoning		
Division of the patient and healthcare zone	3	"If I'm going to contextualise that a little bit, at least from when I went to an area where there are bays. In terms of zoning, I think the healthcare worker zone and the patient zone is pretty much mixed up."
Training in zoning	2	"Ah that's a good one, erm, I don't think so, at least from the general training being provided in our organisation."
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"I believe that working alongside with them, getting to know them and building

		relationships actually impacts the work that you do, um at least from my perspective, I get to see a lot of people ask me questions about hand hygiene and why we need to do it and what's the science behind it, because when you get to gain their trust and you get to build that the relationship with them, you would often see that they would take the lead and you're basically just there guiding them…"
Compliance with the 5MHH		
Reasons for commonly missing M1	1	"…they've got that perception that I haven't really touched a patient yet, so my hands are clean."
Reasons for non-compliance	1	"…so number one would be workload, then availability of resources would be second, for example, some of them would tell me that "the hand hygiene sink is too far", "I have got a lot of things to do on my list", "I was wearing my gloves, um so I don't think my hands are dirty", "I didn't double- double glove", if you go to ICU they're very into double gloving and everything, um "I didn't really touch the patient I was just you know writing down on this note", something like that…"
Detail around auditing		
Audit triggered by infection rate or performance	1	"From an IPC perspective, we do get to audit them as well, like we carry out an independent audit apart from the ones that they do, especially if we know- we also look at different factors as to where we're going to I mean, which departments we're going to scrutinise a little bit more depending on the infections that they have, the infection rate, um if there are any complaints coming from the patients regarding practices that they see"
Auditing programme description	1	"...we follow an audit programme, and a part of that audit programme would be sets of audit all about infection control, and part of that is hand hygiene. Each area is assigned two sets of audits, and it's actually the infection control link and ward managers and some of the- some of their colleagues within that department who does the hand hygiene audit. From an IPC perspective, we do get to audit them as well, like we carry out an independent audit apart from the ones that they do…"
Continuous audit programme	1	"…if you've started with an improvement project, say improving hand hygiene compliance of a particular area, like I said, it has the potential to improve the behaviour on a long-term basis, but it needs to be a continuous cycle. You need to always have someone there to monitor what's happening and probably once the Hawthorne effect somehow diminishes, we need to introduce other measures to you know keep it going, probably a peer review…"
Engaging with ward staff	1	"…that pretty much depends on the person who's doing the audit, so each infection control

		nurse as an individual has their own aura or personality, I'm a bubbly person because I really like people, because I believe that working alongside with them, getting to know them and building relationships actually impacts the work that you do, um at least from my perspective…"
IPCN verification audit	2	"…we carry out an independent audit apart from the ones that they do, especially if we know- we also look at different factors as to where we're going to I mean, which departments we're going to scrutinise a little bit more depending on the infections that they have, the infection rate, um if there are any complaints coming from the patients regarding practices that they see…" "…in fact when we do our independent audit because we've got that critical eye for IPC, we get to see practices that are not supposed to be how it is you know for guidance."
Ward skills for completing own audit	1	"…I mean, there are factors that affect the audit being done by the infection control links and the ward nurses. Number one would be their knowledge and skills, how they do or conduct a proper hand hygiene audit. Number two would be their workload, which has always been one of the issues, I think, not just within the independent health sector side of things, but also in the NHS."
Difficulties of direct observation of practice		
Audit data not representative of true practice	4	"What we often find is that the hand hygiene results are in a pristine condition like a hundred percent, 99 percent, 95 percent, when in fact when we do our independent audit because we've got that critical eye for IPC, we get to see practices that are not supposed to be how it is you know for guidance." "…what often, often happens is that erm yes, we do get the results of hand hygiene audits from the wards, however it's all 100% so there's a problem there." "…I mean we're all humans we're prone to errors, mistakes, and everything, and seeing one hundred percent for an IPC nurse especially hand hygiene just makes you question things."
Providing practice feedback		
Approach to delivering feedback	3	"…we're very engaging and we like feeding back results in a nice way um if it's just a staff member who we're actually familiar with or we know like, for example, a HCA or a staff nurse we get to feed them back erm what we observe immediately." "…if we are looking at a bigger audience, say for example, staff members of the whole unit or perhaps consultants, um and there would be a bit more of a challenging behaviour, we

		go through um the proper um- not escalation, but line management go through the clinical manager, involve other stakeholders…"
Audit as a time for providing education	1	"…we do get to teach them how to do the proper hand hygiene is also part of our internal audits erm so it's a continuous process."
Data to support feedback	2	"…then we get to process the data so at least they get to see what we've been doing, how we've been doing it but they can understand the gaps where their practices probably, you know hopefully they get to improve it based on the recommendations." "So obviously for us, at least for me, to get to test the waters first and then see how it goes, if it's a bit more difficult then we go through proper line of communication, I guess. And I think the thing that I find useful would be to use data to challenge their poor practice."
Feedback as a means of changing behaviour	1	"if you've started with an improvement project, say improving hand hygiene compliance of a particular area, like I said, it has the potential to improve the behaviour on a long-term basis, but it needs to be a continuous cycle."
Power dynamics between staff	1	"I was a staff nurse as well before and whenever I get to see infection control nurse, I get to see them in a way where in fact there's some sort of power over you, something like that, which works especially if we work side by side with them. However, there those say, clinical managers, consultants, or those who are like here [actions higher up] who would be a bit difficult to, you know, discuss things with."
3. Electronic monitoring systems		
Potential benefits of EMS		
Provide ward level performance data	1	"…if you're going to present general data to a group of people obviously, it's a good thing they get to see how the whole unit is performing and everything…"
Time could be spent on other IPC activities	1	"…I've got a lot of work to do and maybe I can allocate that particular time that I do with intense scrutiny with that particular ward, to something else. Number two, be able to develop interventions for specific perhaps hand hygiene compliance based on the results generated by that system at least that would make my life easier."
Working in the background collecting data	1	"I've already got data being collected by a system, that can actually influence practice."
Potential drawbacks of EMS		
Issues around privacy and monitoring	1	"From my perspective I think one of the things that may- that they may challenge this kind of system would be I mean, the reason would be privacy, something like that? Could be. What else? They may feel uncomfortable because somebody is like watching them,

		watching their moves all the time.”
Unable to specify HH practice issues in context	1	“…I think what they need to know would be the specific problems that is existing and because with that one at least they would know how to probably tackle it through different types of interventions. So it depends if that general data would actually give you information as to what the problems are, then it would be worth it.”
Practical implications		
Acceptability by IPC and ward staff	1	“…from an IPC perspective, I think it's really a good thing for us.”
Combining multiple monitoring streams	1	“At least we can audit how that specific thing or system is doing alongside with how we're doing, like a direct audit to compare results probably.”
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
A temporary change	3	“…I mean, now it's starting to wear off based on the observations that we've been doing…” “…during the COVID-19 pandemic erm, up until January, February 2021 erm, I think hand hygiene was still on point at that time, but now it seems to be going back to normal again.”
Increase in awareness of HH	2	“So in terms of changes particularly during the onset of the pandemic and through the first-second wave, they were cleaning their hands as much as they could, they became obsessed with hand hygiene measures, soaps, disinfectants, not just that, even with disinfecting their workspaces and everything erm yeah something like that. So, definitely hand hygiene measures or the hand hygiene practices really shoot up like never before.”
Patients prompting HH	3	“…also with patients and it actually empowers them to challenge behaviours that even for IPC nurses like me are difficult to challenge, say for consultants or other people out there.”
Implications of PPE use		
Staff reducing adherence to PPE use	1	“We're finding it difficult to make the staff members adhere to the appropriate use of PPE at the appropriate time now when in fact, two, three, four, five, six months ago they all wanted to wear FFP3s, they wanted to wear gloves. But now, like I said, it's starting to wear off and they just find it uncomfortable. They just find it too much, they're tired and they're fatigued with all of these crazy COVID things that they've gone through for the past year.”
IPCN activities during pandemic		
Provision of training	1	“We organised link training sessions wherein we actually invited other colleagues as well, not just IPS links and part of that training or promoting awareness about the transmission of infections, particularly COVID, would be hand hygiene.”

The IPC concerns of staff	1	"…there were questions around does water temperature affect the effectivity of your hand washing, erm does the type of soap that you use actually effect the effectivity of your hand washing, erm what's the science behind the 20 seconds? [laughs]"
Public messaging		
Importance of messaging from the top	1	"…it just, just amazing how I mean, what the effect it has if it's not just coming from us, if it's coming from the prime minister, the health ministers and every- and everyone up there blasting out the importance of hand hygiene, it makes a lot of difference not just with the staff members that we're working with, but also with patients and it actually empowers them to challenge behaviours that even for IPC nurses like me are difficult to challenge, say for consultants or other people out there."
Staff motivations to perform HH		
Personal anxiety and self-protection	1	"…in fact, two, three, four, five, six months ago they all wanted to wear FFP3s, they wanted to wear gloves."

Participant: IPCN03		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Not seeing the patient zone as a source of contamination	1	"However they've been in patient surrounding, you ask them that 'oh you've been with the patient, you've put your paper on the patient desk and you write on it and coming from there you have to gel your hands', they say 'oh OK because I didn't touch the patient I was thinking that-', I said no, I said 'you didn't touch your patient I agree, but the environment is also part of the patient that you can transmit infection from one patient to another."
Motivations to perform HH		
HH as a show for patient benefit	1	"…healthcare is being accountable, the accountability in healthcare, that's why sometimes people tend to forget you are accountable to your colleagues you are accountable to your patients. So even though you've washed your hand outside forget about that, that patients inside didn't see you when you washed your hands, come in there wash your hands again and then- before you touch them…"
Role of patient in prompting HH	2	"…I'm really in favour of- I know it's a big burden for patients, I'm really in favour of patients asking the nurse or healthcare people 'oh, gel your hands' or 'have you gelled your hands?'"
Potential for cross-contamination in workflow		
How gloves are used or misused	4	"…they wash their hands outside patient zone- in the healthcare zone they will wash their hands and things and then gather their things and then in their mind they think that that's the hand hygiene done already for them because they've already done that and then then putting on the gloves, they tend to miss that one when they are doing the observation." "…the person that you see when they don't use gloves, they're coming from the patient bedspace they normally tend to gel their hands, well if it's the same person doing a task using gloves they will do a lot of tasks for that one patient with the one gloves and they won't change it."
Importance of the housekeeping role	3	"…especially with cleaners I really, really want to work with them to see their understanding of what they're meant to do and to see I really want to go with them to see how they go about in terms cleaning their microfibre equipment, the glove that they're using, where do they clean it, I really want to see that process- how that process goes."

		"…we have all these outbreak meetings…I really don't want to ask the ward 'are you happy with your cleaning?' I want to know how that cleaning in that ward is being done and because it's not only the ward should be happy with the cleaning, me myself are visiting the ward I should be able to be happy with that cleaning"
The consequences of outbreaks	4	"But if they have outbreak then you see a lot of engagement and I think, I think although it's a shame for us to be more reactive- reacting to those kind of things, but that's the reality of things." "So because the outbreak situation, they feel like they've given patients infection and they feel that sense of- sense of guilt that they've given to patient this infection and maybe it's because they don't understand their hand hygiene and maybe they're not adhering to appropriate cleaning and things…the morale normally tends to be low when they have outbreaks, so I think yes, it's more a likeliness of them feeling like they've given the patient the infection."
The role of equipment in potential spread of infection	4	"…we expect you, when the equipment is leaving the room you're meant to clean them but we've seen that sometimes when you observe practice that's not being done so, so yes, it can act as a means of transmission." "…one that that we normally tend to forget but for me, I've observed it a lot is the blood sugar machine, the one that is used, sometimes you have like a- three or four bays that you have each patient- maybe one patient in the different bays that have diabetes that they want to check their blood sugar, they have only one machine. I've never seen them cleaned in between patients, so that's another thing that I've observed also…"
Understanding the role of curtains in potential spread of infection	3	"…it comes up frequently moment one…in their mind they wash it already and they come and touch the curtain they touch their equipment so in their mind they've already washed their hands in the corridor that's all."
Training in 5MHH		
A lack of training received	1	"So not here, but in NHS we used to just do the, you know, training regularly. So not any specific training, not really."
Embedding 5MHH into other training	1	"So part of the ANTT, hand hygiene and the five moment are also discussed and also observed."
Mandatory training covering HH	2	"…in terms of the infection control teaching of new starters or new starters- specially newly qualified people we don't really have a good, a good basic for infection control training all they will have is online training…"

Self-directed learning around HH and the 5MHH	1	"…once in the infection control because of the main part of my role I have to do a lot of reading on my own and with an understanding of the five moments but to have formal training, I never had no formal training in the five moments."
Situating the 5MHH in practice	1	"…I tell them that your five moments start on your patient zone, forget about the healthcare zone because the healthcare zone you have your corridor, you have your nursing station, all those things because most times they've forgotten that when they're doing hand hygiene but because of the training I'll go there and say your zone- the zone of your patient that's where we are more concerned about and that's why we base our five moments on, so it does help a lot with them with their understanding."
Understanding zoning		
Division of the patient and healthcare zone	3	"…to be honest with you the concept of patient zone- doing this course now it makes understand that different trusts have different ways of how they interpret it, even amongst us as infection control nurses." "…my understanding of the patient zone is that it's all that what we have in the patient bedspace, the patient's space, and then the healthcare zone is everything beyond the curtains…"
Lack of understanding of PZ and HCZ	1	2…which is why I'm really really focusing on the patient zone, they don't understand- the healthcare people don't understand- the ward don't understand the patient zone that much. Patient zone, that's where your five moments is…"
Training in zoning	2	"…because of the training I'll go there and say your zone- the zone of your patient that's where we are more concerned about and that's why we base our five moments on, so it does help a lot with them with their understanding."
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"…if they know you on the ward and they will let you- go 'oh sister, what are you doing to us today?' then they will just pass, and if they don't know you they will come and interrupt you 'oh, how can we help you?', I say 'oh no, I'm infection control', 'oh yes, OK'…"
Compliance with the 5MHH		
5MHH which are more consistently complied with	3	"…moment five is easy, easy peasy. Moment five I'll observe five people in moment five maybe four of them will wash their hands and will gel their hands after the environment." "…moment three also it's easy for them because it's body fluid exposure, after body fluid exposure so it's so, so easy for them to more likely to wash or gel their hands."

		"…moment two because meant to- the concept of aseptic technique they know the concept is there the ANTT concept helping them to do moment two."
Reasons for commonly missing M1	4	"…this is always always 'oh I've just washed my hands' then you tell them that yes- which is why I'm really really focusing on the patient zone, they don't understand- the healthcare people don't understand- the ward don't understand the patient zone that much." "…in their mind they've already washed their hands in the corridor that's all."
Reasons for commonly missing M5	1	"…they- allied professional, like the dietitians and the speech and language therapist, because those are the ones that- they are not delivering that care that much that personal care to the patients. However they've been in patient surrounding, you ask them that 'oh you've been with the patient, you've put your paper on the patient desk and you write on it and coming from there you have to gel your hands', they say 'oh OK because I didn't touch the patient I was thinking that-', I said no, I said 'you didn't touch your patient I agree, but the environment is also part of the patient that you can transmit infection from one patient to another."
Reasons for non-compliance	3	"…they would say, 'oh, OK sister then will I have to go and wash my hands' and I say 'well you can use your gel by your bedspace', it's 'oh no sister my hands, I'm allergic to gel' or 'the gel will make my hands dry', 'I don't like to use gel'" "…some of them would say 'oh OK I was I was thinking that because I've washed my hands now I'm coming to the patient I didn't think that touching this thing- I'll decontaminate my hands'." "…most of them like the nursing staff they normally tend to say, 'I didn't know', 'I don't want to use the gel because it makes my hands dry' and things."
Detail around auditing		
Audit triggered by infection rate or performance	4	"…sometimes we have an outbreak, we have a problematic ward, that we think that their hand hygiene is not too good when I'm going around I'm doing teaching if they're not too good then I'll do an audit for them…" "…when we have outbreak and we have the audits then it's that time that you can also- it will also affect them because you will find out, they will engage with you more…if they have outbreak then you see a lot of engagement and I think, I think although it's a shame for us to be more reactive- reacting to those kind of things, but that's the reality of things."
Continuous audit programme	1	"…two yearly audits for the trust that's the most and then we have- the ward have their

		own monthly audits and then we have huddle audit in between that time."
Engaging with ward staff	1	"…when they have outbreak on the ward and you have audit, hand hygiene audit, which is below seventy they tend to engage with you more to- when you offer teaching they will pull people around to do the teaching, they will give you a space in their handover to do that so I think it depends on when you- what is happening on the ward, more of outbreak they will engage with you more. If you don't have outbreak, they will just feel like as if your audit is not really reflecting for what they are thinking."
IPCN verification audit	2	"…the data collected by the ward itself does not represent it all it's like mismatch between what we are seeing on the ward... I think that's just for them, for their ward and to see what they are doing but mostly when we do our own audits it's shocking to them when we do our own audits as compared to what they are doing. So I think our own audits, the IPCN's audits it's more closer to what is really happening on the ward… So I would say more or less the IPCN's audit is more closer to the reality of what's happening in the ward."
Ownership of audit to ward	1	"…I think that's just for them, for their ward and to see what they are doing but mostly when we do our own audits it's shocking to them when we do our own audits as compared to what they are doing."
Ward skills for completing own audit	1	"…they tend to miss that one when they are doing the observation… So they tend to miss that. It's only when you tell them that…"
Difficulties of direct observation of practice		
Audit data not representative of true practice	4	"…most times the ward hand hygiene is 90 percent, one hundred percent - that's not realistic. We- what we are seeing we know that it's not realistic and it's not reflecting their practice, their current practice. So we normally do that and then we have the results." "…so the data collected by the ward itself does not represent it all it's like mismatch between what we are seeing on the ward and what they're doing on the ward…" "…when you tell them it's hand hygiene then they will leave you but they will start washing their hands every moment, every side, everywhere you go…" "…especially with the Hawthorne effect even though, to be honest with the Hawthorne effect it doesn't distort our audit at all because the healthcare, the nurses, or the clinician on the ward the Hawthorne effect it's only affecting them when they see you they will wash their hands in the wrong places pretty much only. But where you expect them to wash their hands, they won't do it. So, which is why the Hawthorne effect is there, but I

		would say it's not there also because they are not doing this in the right places."
Trying to avoid being noticed	1	"…the nurses normally tends to interact with you and see 'oh sister, how can we help?'…"
Providing practice feedback		
Approach to delivering feedback	2	"…when we're on the ward doing audits we normally tend to feedback to the ward manager or if the ward manager is not in to the nurse in charge… "
Consequences of audit	1	"…most time when you have it they have that immediate effect because the divisional leads, they don't like to see it, they feel like, they feel really let down by their staff and they feel frustrated and they feel like you're picking on them also, every other emotion is coming through when you have them, especially when it's like below seventy five…"
Data to support feedback	1	"…then they put it on their ward too and display it on their ward."
Feedback as a means of changing behaviour	1	"…when they have outbreak on the ward and you have audit, hand hygiene audit, which is below seventy they tend to engage with you more to- when you offer teaching they will pull people around to do the teaching, they will give you a space in their handover to do that so I think it depends on when you- what is happening on the ward, more of outbreak they will engage with you more."
Power dynamics between staff	1	"…yeah, the nursing staff 'how can we help you?' doctors won't ask 'how can we help you?' instead they will give you some other task 'oh nurse, you know this patient..' whilst you are doing your- so yes it depends on the staff group…"
Staff awareness and reaction to feedback	3	"…some of them would say, 'oh, we've done badly' and then some of them say, 'OK, it's this person' or 'it's the doctors' the nurses would say 'oh if the doctor's been around' and most of them, to be honest with you, they know that we're not making up something and then some will ask you 'well sister look at- what about this our 98%, why is it different?' so then I'll tell them that 'because you guys are doing a lot of handwashing in the healthcare zone'…" "And then, and then they don't feel- they really don't feel happy about it so they tend to react to it and see- and some will ask you 'well what do you want us to do? Do you want to be part of- come to the teaching? Do you want to do teaching? Do you want to come to the huddle?'"
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		
Measure of reality of practice	1	"…people are aware that they're monitoring them, they are part of this monitoring system

		and they are aware that at the end of the each month or whichever timeframe they're gonna pull that data for them to see themselves. And this is- nobody that they will say, 'oh, this person doing this' they blame the others or something…"
Time could be spent on other IPC activities	3	"…I'd focus on teaching because teaching- I like teaching and I'll focus on the environmental auditing and I'll focus also on the equipment cleaning…" "…I'll focus my time on the staff especially in terms- especially with cleaners I really, really want to work with them to see their understanding of what they're meant to do and to see I really want to go with them to see how they go about in terms cleaning their microfibre equipment, the glove that they're using, where do they clean it, I really want to see that process… I would focus my time with the cleaning part of things to see how the cleaning is being done and the understanding of it…"
Working in the background collecting data	1	"…able to monitor hand hygiene compliance without using IPCNs because if you for example, want to do your weekly audit you can do it- you can do your own weekly audit on that and then you can derive the data from that so that's another advantage without using IPCNs."
Potential drawbacks of EMS		
Does not highlight individual practice	1	"…when it's covering the whole ward it tends to not to be more effective because people don't think that's- people, individual people don't own it but when it- place it in different bays individual nurses are responsible for the bays feel like they own it- it's our- it's me, my, my practice they are measuring."
Issues around privacy and monitoring	2	"…then for the staff they feel being pressured by their lead nurses or their matron for them to use it. So that also will conduct 'oh we need- we have to use this'…"
Staff may perform HH to game the system	4	"…so later when we are not there- nobody's there to observe then they might gel, gel, gel, gel, gel their hands…"
Unable to specify HH practice issues in context	1	"…the compliance of nurses on the different bays, some bays that are dependent patients you don't have maybe- you don't have more of healthcare activities in those bays. You might not necessarily use them there."
Practical implications		
Combining multiple monitoring streams	2	"…because of those barriers that we don't know when staff are going to be using this hand hygiene, for that reason alone, I would say we still have a role, a bigger role for observational audits to take place side by side to be honest, anything that can help disseminate information about hand hygiene in a clinical setting is good, it's nothing bad."

Senior staff on ward would promote EMS	2	"When it's on the ward you have only one person that would be responsible for that, which is the ward manager or the ward matron because they feel, they feel like it's their ward and this is their ward being judged based on this. So they are more likely to, to push it for staff, they are more likely to sell it in their handover, they're more likely to push the nurse in charge to encourage people to use it because they know that data is going to come out soon."
Understanding practice on the wards to generate data	2	"So I think there is a bit of sort of a bit of a bias in there because you never know how many people on shift in the first place but sometimes you might know you're own number of people in the shift but your visitors are coming also, you have the specialist nurses maybe all visiting the ward today but might not necessarily visiting that ward tomorrow. Maybe you have four, five specialist nurses come to the ward today, they use it maybe tomorrow you might not have that same."
Where appropriate to use	1	"…some bays that are dependent patients you don't have maybe- you don't have more of healthcare activities in those bays. You might not necessarily use them there."
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
A temporary change	2	"…I don't know whether the value of it was taken out from it and I don't know whether it makes people feel like, 'oh no, we've heard it all', 'well, we're tired' or exhaustion from this part or something and then, yeah, the second wave I didn't see that, I didn't see that that impact much in terms, of in terms of they thinking about the hand hygiene…"
Increased HH not always linked to 5MHH	2	"To be honest, nothing much changed. It just striking the idea me, I, and myself. Myself, myself, myself, myself, myself so that's what's come across in terms of their hand hygiene, nothing changes in terms of the patient zone. There's nothing change there, nothing I'll tell you now, nothing changed that that moment when we have to do the moment in terms of spreading the transmission of COVID from one patient to another, it's nothing changed in there. There's no improvement in that one…"
Implications of PPE use		
Increase seen in other infections	2	"…I mean that's either people are not doing their hand hygiene properly or they're not cleaning the equipment their using properly. So we've seen- there was a lot of contaminants, a lot of bloodstream infection, a lot of skin infection also we observed but we didn't do like a formal audit on that."
PPE leading to IPC issues	2	"So it does impact a lot because like I said, the donning centre is away from the patient

		bed space so they will put on everything, the visor, mask, apron, or long-sleeved gown if they are in a COVID bay and then they put on the gloves on top and some of them sometimes yeah, so they go there and then they've missed the moment, moment 1…"
IPCN activities during pandemic		
Impact on regular auditing	1	"…during the pandemic it was difficult, the trust stopped all hand hygiene audits, they stopped us doing hand hygiene audits because of these reasons and because of staff- they were very anxious and the division they will kill you go and show them. Literally, they won't be happy with you if you go and show them 'oh this is my- this is your audits for this' so we stopped all of the audits and hand hygiene audits. So we were just going there supporting them…"
Providing support and reassurance	1	"So we were just going there supporting them, that's all, when you are wearing these don't forget to take it off and gel your hands. Just that support that we're giving them."
Provision of training	1	"…we had the PPE training in terms of donning and doffing and to reduce self-contamination, and then we had that on a lot because they were very, very, very scared and very uncertain amongst them…"
The IPC concerns of staff	3	"…they were concerned more about- they were not, the trust the surgical mask, they wanted to use the FFP3 mask and then we tried to explain science behind the COVID…" "…protect themselves from the COVID, protect themselves from the COVID and protect themselves from the COVID. Their patients- 'I couldn't care less, I just want to protect myself'… they forget that staff we are humans, just like our patients, but they see their patient like the reservoir of the COVID."
Public messaging		
Importance of messaging from the top	1	"…I feel elated during the first week and that- when I'm going on the ward I said yes, we have somebody that that's not doing my job and really making people- but as time goes on, I think the [laughs] the value of it just faded away…"
Staff motivations to perform HH		
Personal anxiety and self-protection	2	"…it does strengthen in them the idea about me, me, I, and myself. To be honest, nothing much changed. It just striking the idea me, I, and myself." "…yeah it makes the COVID pandemic- makes it even worse for me, as infection control nurse, it makes it worse in terms of us seeing our patient as the key part in terms of preventing infection to them, we just- we just- now it's even worse, now we just want to protect ourselves."

Participant: IPCN04		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Complexity of integrating HH into practice	1	"…it's not really that practical, I would say. I mean, in terms of it- I just don't think that the staff or- it's really effective in terms of reminding staff when they should be washing their hands because they won't care whether it's moment one, moment two, or moment three what they need to know when exactly they need to wash their hands."
Translating theory into practice	5	"…even working on the wards, I would say it wouldn't necessarily- I wasn't necessarily thinking, 'oh, is this moment one?', 'do I wash my-', moment one obviously is quite easy to, to remember it's before patient contact, but other moments you won't be critically analysing things like that and 'is this moment two? Is this moment three? Am I entering moment four now?'"
Motivations to perform HH		
5MHH as protection for patients	2	"I've heard comments from staff saying that they need to save time, like they've got -like, let's say 12 patients to look after and they can't be decontaminating their hands every time and they keep telling them that 'yeah, I know, like it's your time, but what about the patient's time? They've got families waiting for them at home, but if they pick up hospital acquired infections because we didn't wash your hands, it's not fair on them'."
5MHH as protection for the self	2	"…staff are really, really good in decontaminating their hands after contact with patients or after contact with bodily fluids. It's before because they think that I need to protect myself, they've got this perception that I might get something from the patient without realising that the patients are more susceptible to whatever it is that's- that might be on their hands."
Part of the profession		
HH as fundamental IPC practice	1	"It's- it's our bread and butter, isn't it? We go around to the different areas of the trust every day and observe what other people are doing and making sure that they're performing hand hygiene when they should."
Potential for cross-contamination in workflow		
How gloves are used or misused	3	"…they would put gloves on their dirty hands without decontaminating it, wear gloves, go to the patient, do whatever they need to do with a patient. They would wash their hands after they removed gloves, sometimes, but more often than not, they won't decontaminate their hands before."

		"…they think that it's like a big shield that protects them from everything."
The role of equipment in potential spread of infection	2	"So it would just be healthcare staff and their hands going from one patient to another or going from one room to another room…"
Understanding the role of curtains in potential spread of infection	1	"The curtain is quite controversial, isn't it, because it can be touched by the patient but obviously it's not something that- if there are people who would be touching the curtains, it's more of the healthcare staff and the people outside rather than the patients…"
Training in 5MHH		
Mandatory training covering HH	2	"During induction when they first started in this trust, we had an induction and it was just basically a set of slides where they showed us this is the five moments of hand hygiene and the definition like should be before a patient contact, blah, blah, blah, no examples or anything like that."
Self-directed learning around HH and the 5MHH	1	"There's no formal training or anything like that, but it's going to be part of your job. It's- it's our bread and butter, isn't it? We go around to the different areas of the trust every day and observe what other people are doing and making sure that they're performing hand hygiene when they should. So I got more familiar with it, like the technicalities around it…"
Situating the 5MHH in practice	2	"…it's not really that practical, I would say. I mean, in terms of it- I just don't think that the staff or- it's really effective in terms of reminding staff when they should be washing their hands because they won't care whether it's moment one, moment two, or moment three what they need to know when exactly they need to wash their hands."
Unknown training level of agency staff	2	"…agency staff is a problem as well, because they may not be necessarily aware of the trust policies and, you know, if you're agency- this may sound really judgemental, but I think we are not really sure about the training that they've had… we haven't got any assurance." "…they don't take as much responsibility and ownership of what they do, which is also a challenge."
Understanding zoning		
Division of the patient and healthcare zone	2	"there's been a lot of debate around this hasn't it? [laughs] it's very controversial what one considers is the patient zone, so personally I would think that the patient zone is everything that the patient touches or gets in contact with, like the bed, the chair, the bedside table of the patient."
Training in zoning	1	"And those concepts sort of included in staff training for the ward staff? IPCN04: No, I don't think so."

2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"…to be honest, I've never had a question about hand hygiene unless I initiate the conversation and ask them 'oh why are you wearing your gloves?' or 'can you tell me, you know, why you didn't wash your hands and' but the staff coming to me for- to ask me about hand hygiene, I've never had an experience."
Revealing the reality of practice	1	"I think because they know that they are being audited externally. So they're quite- they're more careful of the- how they rate themselves, because before they used to overrate their compliance."
Compliance with the 5MHH		
5MHH which are more consistently complied with	1	"…staff are really, really good in decontaminating their hands after contact with patients or after contact with bodily fluids. It's before because they think that I need to protect myself…"
Reasons for commonly missing M1	2	"It's before because they think that I need to protect myself, they've got this perception that I might get something from the patient without realising that the patients are more susceptible to whatever it is that's- that might be on their hands. So even our audit shows that there is really poor compliance with moment one." "…they're thinking that I'm the healthcare provider. You know, they don't realise that they could be vectors of infection and organisms, they just think that 'oh, I don't know what this patient has, I need to protect myself' so I should wash my hands or gel my hands after the procedure or even- even with PPE, they would wear gloves- they would put gloves on their dirty hands without decontaminating it, wear gloves, go to the patient, do whatever they need to do with a patient. They would wash their hands after they removed gloves, sometimes, but more often than not, they won't decontaminate their hands before."
Reasons for non-compliance	5	"…it's not that they don't know that they should- they're supposed to do that because they hide or they say sorry, sometimes when I when I approach them, I haven't even said anything and it'd be like, 'oh, I'm really sorry', because they know I'm an infection control nurse and I was like 'oh, my God, so she knows that she shouldn't have done that but she still did do it'." "…the experience of people on the ward because nobody wants to harm patients intentionally, they- when they know that they're going to be transmitting infections or organisms, they're not going to do that, they don't do it intentionally. And sometimes

		they're on a rush, like with the amount of workload they have it's difficult for them to actually do what they should be doing." "I've heard comments from staff saying that they need to save time, like they've got -like, let's say 12 patients to look after and they can't be decontaminating their hands every time…"
Detail around auditing		
Audit triggered by infection rate or performance	3	"…we would normally pick those- those issues up when we've got outbreaks or when we've identified unusual increase in the number of cases of an organism on the ward, like MRSA, for example, or C. diff, that's when we start looking at 'oh have they been sharing equipment between the space?'"
Auditing programme description	1	"So every area, both inpatient wards and outpatient services and other departments, every area is required to submit to a hand hygiene audit every month… it's a set of twenty observations per month per area…"
Ownership of audit to ward	1	"…ward A would be auditing ward B and ward B would be auditing ward A but it's not really that effective, I would say"
Ward skills for completing own audit	3	"…we've got PPE champions who are doing the hand hygiene observations for us, and I don't think they're picking those issues up." "So unless you give them specific instructions that you need to go to this ward and do an observation of practice around use of equipment and use of this and that, it won't be picked up necessarily."
Difficulties of direct observation of practice		
Areas missed by direct observation	1	"…normally it's the audit tool that they use as well and sometimes people can be very fixated on the tool that they're using. If it just says gloves, hand washing, hand gelling… it sort of feels like sometimes you've got to give them another audit tool to check whether equipment is crossing between patients or something like that but that's not something that is normally done."
Audit data not representative of true practice	3	"…sometimes the auditor would go to the ward and announce that 'I'm doing hand hygiene audit!' so there's that Hawthorne effect and so it's not giving us a true picture." "…its always 99 percent, 100 percent most of the time, so it's an observation that wards tend to overrate themselves. They overrate their compliance and the way we found out is because during the pandemic, we've introduced the PPE champion teams… we compare the audit results from the ward self-audit and from the audits undertaken by our PPE

		champions and there is massive, massive discrepancy between the results, like the wards result would be ninety-nine or a hundred percent and the PPE champion audit results would be as low as sixty five percent, 60 percent."
Box ticking exercise	3	"…she was honest with me, and she said- and I said, 'what about hand hygiene audit? What do we do with them?' and she said, 'I just get them done because I have to submit them' and she said 'it's like a tick box exercise, like when it's like near the end of the month, I will ask someone, oh, we need to do this, and they would be sitting probably in one corner just ticking the boxes'"
Providing practice feedback		
Approach to delivering feedback	3	"…with the audits undertaken by our PPE champions, they would give the feedback right there and then, they would speak and challenge the staff. They would speak to the staff and challenge that the practice, and they would document it and inform the nurse in charge on that shift…"
Consequences of audit	1	"…with the audit results of all the wards, it gets- they all get compiled and we've got a monthly infection control committee meeting which is attended by the head of nursing, so every month they would give us a report of this is what's going on, this is our scores and give us action plans of what they're doing with those scores and how they're addressing it and give us assurances that they've taken it to the ward level."
Feedback as a means of changing behaviour	2	"…'I just get them done because I have to submit them' and she said 'it's like a tick box exercise…'… That's why you always get ninety-nine percent, hundred percent, so it's not really, we're not really getting the essence of auditing and feeding back, we're not getting the most out of it because it's not improving practice, it's not changing anything."
Power dynamics between staff	2	"…we've had reports from our champions to say that 'oh staff on this ward I didn't really respond very well when we challenged them. They were not happy that we challenged them', particularly doctors…" "So there is really that gap between senior management and what the assurances they give are and the experience of people on the ward because nobody wants to harm patients intentionally, they- when they know that they're going to be transmitting infections or organisms, they're not going to do that, they don't do it intentionally. And sometimes they're on a rush, like with the amount of workload they have it's difficult for them to actually do what they should be doing."
Staff awareness and reaction to feedback	2	"…they don't feel that confident to challenge and doctors would be asking, 'well, what's

		your evidence? Well, can you explain to me why you need to do this and not do that?' and, you know, so it kind of affects them." "…I think it depends on the personality of the person challenging the person being challenged as well because there are nurses and healthcare assistants who also have the wrong attitude when they're being challenged, they would be, you know, they won't be very happy, and they would just walk away, not be bothered but there are some that are- that will take it on board."
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		
Inclusion of time periods not normally audited	1	"I don't think anyone is doing auditing at night so it's good to know as well because when we've got outbreaks, we would be looking at hand hygiene scores and, you know, but those audits are happening during the day. So what if those transmissions are actually happening during the night when nobody's watching? So I think it's good to have that as well, and obviously people aren't going to do hand hygiene observations overnight."
Measure of reality of practice	1	"…it would really be good because it's going to get rid of the Hawthorne effect won't it, because people won't know that they're actually- that what they do is actually being recorded and that someone's actually counting the number, it's- it's very quantitative…"
Time could be spent on other IPC activities	1	"…it's a good addition, but I don't think it's going to free up a lot of time for the IPC practitioners."
Potential drawbacks of EMS		
Does not highlight individual practice	1	"I think it would be quite a challenge because on a very busy ward, you've got multidisciplinary teams working on the ward and it- for you to tackle the problem you know, you should know who the culprits are, you know what I mean like, because with our current audits we break it down, the different professions, like we've got for the nurses, healthcare assistants so that we know who to take it up to… in order for you to address the problem and to know who you need to take it up to, you need to find out who are not, you know, doing what they should be doing."
Unable to specify HH practice issues in context	2	"…it would be limited to the- just the quantitative side of things like how many, but you won't necessarily see why or what was the circumstances surrounding the failure, the failed hand hygiene…"
Practical implications		
Acceptability by IPC and ward staff	1	"They might be- they might challenge it if they don't want the result, it is giving them but I

		think it should be- it should be fine.”
Combining multiple monitoring streams	4	“…but there's something there that's causing them to fail but I think it's really good in terms of measuring the compliance, but I think if it's used in conjunction with a traditional audit or traditional observation, it would be fantastic.” “If you’ve got an electronic system, it will be a really good adjunct to the already existing auditing process in place.”
Understanding practice on the wards to generate data	1	“…you can like check it per hour and correlate it maybe with what's happening during that time of the day but again, it's not always the same thing happening, especially on a very busy ward, there's no template that from eight to nine, this is what's going to happen from nine to ten this is what's going to happen.”
4. Impact of COVID-19 on hand hygiene practice		
Implications of PPE use		
PPE leading to IPC issues	2	“…I think in some ways hand hygiene has become less in some of the areas because of the pandemic, and not- it's not because- it's counterintuitive isn't you’d think that because of the pandemic, they would be washing their hands more but the problem is the gloves because of the pandemic, they're so scared they're going to be wearing gloves for everything that they're going to do and that stops them from washing their hands or from gelling their hands.”
Wearing gloves has become habitual	3	“We’ve got problems with that at the moment, especially on our ward on a ward that has been a COVID ward for such a long time and people just got into the habit of wearing gloves for everything…”
IPCN activities during pandemic		
Provision of training	1	“We've been doing. PPE training and stuff like that, but we haven't really focussed about hand hygiene…”
The IPC concerns of staff	1	“It will be the use of FFP3 and masks and I- hand hygiene has never really been an issue for staff. I've never encountered a staff member asking me about hand hygiene. I think people think that they're under the impression that ‘it’s just hand hygiene’ like, but they don't know what the implications are.”
Public messaging		
Greater focus on HH required	1	“…the microorganisms are everywhere, whatever we touch, whatever we- but this- we cannot avoid, that's inevitable they will always be there, but the thing is, if you wash your hands, you wouldn't have any problem. You wouldn't be passing anything to anyone and

		that's, I think, something that needs to be, you know, more communicated out there that you know, we should be washing our hands more."
Staff motivations to perform HH		
Personal anxiety and self-protection	1	"…especially after the pandemic- not after but during the pandemic because staff look at PPE as- they translate it directly through just for their protection, you know, like they use it primarily for COVID exposure risk and they don't realise that it's got tiny defects in them, that they would still have to wash their hands, and they think that it's like a big shield that protects them from everything."
Presence of COVID patients impacting practice	1	"…people just got into the habit of wearing gloves for everything, because in the COVID ward, if you've got suspected and confirmed cases, you've got to wear them regardless of what you're doing. So they got into that habit. At the moment, they're no longer a COVID ward they would wear gloves for, taking observations, for feeding patients even, and I'm like, 'no, you shouldn't'."

Participant: IPCN05		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Common misconceptions	2	“So it’s something- those two I think they're very- although I think they’re not, they're very kind of subjective to people and what their own interpretation is and although cleaning your hands before you enter a bay or a room is probably good because it looks very good- reassuring for the patient and, you know, it's a good reminder to clean your hands, but it's not at that before patient contact kind of thing.”
Not seeing the patient zone as a source of contamination	1	“…after contact with patient surroundings, as I mentioned, particularly when it's just like handing someone something or, you know, pulling their duvet back over their legs or something like that erm, people just don't realise.”
Translating theory into practice	1	“…obviously when you look after someone whose got vomiting and diarrhoea you swap to soap and water. So I think that anecdotally going around the ward, you can see people are using the alcohol gel but not thinking about other forms of hand hygiene and when and how to do those.”
Potential for cross-contamination in workflow		
How gloves are used or misused	5	“Surprisingly, I do see people empty catheters and bed pans with a pair of gloves on, take their gloves off and just walk off, which is to me, if you can't remember that one, I'm like, ‘oh, my goodness’, because you're touching- you're basically touching something that as a human, you feel is dirty. So even those innate reminders are not there, so that's quite concerning.” “…I do see people just putting a pair of gloves on and going and taking them off and feeling that they're protected, erm so still those reminders to people are required.”
The role of equipment in potential spread of infection	3	“…I've been unfortunately involved in outbreaks where commodes have been a potential source of infection because they've been really soiled underneath and not cleaned properly.” “Particularly in areas where it's bays, I see it less when it comes out of side room because I think generally people think because someone’s in a side room their- you know, it's more of a reminder that they’re leaving that area…”
Training in 5MHH		
Embedding 5MHH into other training	1	“I learnt very quickly in IPC that talking about just hand hygiene as a separate component people don't really want that training but if I said to you, ‘well I'm going to do- can I come

		and do some training on CPE or multi drug resistant organisms' and they're like, 'oh yes, please' then you sneak in the hand hygiene and you do the glow box or you do, you know how to clean your hands or you talk about it then erm, people don't know that it's a hand hygiene talk, but it is."
Putting self in the place of patients	1	"…and I ask the question, 'would you appreciate it being used on the person next to you and then on to you?' erm, so it's something that yeah, I do focus on that quite a lot."
Self-directed learning around HH and the 5MHH	1	"No, not specific training, it's independently- apart from erm, kind of within my university it was touch upon very briefly when I did my undergrad but apart from that no."
Using visual methods in HH training	2	"So I tend to use pictures and also, so you use the glow powder to show how things can spread off the blood pressure cuff…"
Understanding zoning		
Division of the patient and healthcare zone	4	"I think I see as the inside of those curtains and the inside the door would be the patient zone and the outside would be the hospital to the rest of the ward or hospital zone so- kind of it's a physical barrier I suppose to enclose that patient."
Training in zoning	3	"I know that that patient zone is very er, jaded in regards to what's what but I do tend to explain it to people to try and think about all the things that patient's been in contact with, what you've been in contact with after you touched the patient in that area…"
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"…sometimes people will see you and ask you like other stuff about IPC which is quite nice because you can have a conversation whilst actually still auditing but people aren't noticing that."
Compliance with the 5MHH		
5MHH which are more consistently complied with	1	"…after patient contact people generally are quite good…"
Reasons for commonly missing M1	3	"…a lot of people will say, oh, before I enter to the bay or before I enter the room. So I think a lot of people think that that first moment is- but they don't think about then I need to get my handover sheet out of my pocket, I then need to get my pen out, and I'm not- it's not that before, so I think a lot of people get confused with that, that particular one."
Reasons for commonly missing M2	1	"…in areas that use a lot of IVs as well, and particularly again in bay areas that you can really notice that people will clean their hands before they go in, put their gloves on- if they're going to do- they've got their blue tray they go straight to the patient and then- so

		that before aseptic technique as well is something people forget as they feel they've already clean their hands."
Reasons for commonly missing M5	4	"…after contact with patient surroundings, as I mentioned, particularly when it's just like handing someone something or, you know, pulling their duvet back over their legs or something like that erm, people just don't realise."
Reasons for non-compliance	5	"…they'll say, 'oh, sorry, yes, oh, I forgot' or 'I just about to do it' or 'oh, sorry I'm really busy'." "…'oh, sorry, I'm really busy' it something, 'oh, sorry, you know I've got- I've got to do this and I've got to do that' people see it as oh if I've got time I'll clean my hands there's that sort of mentality." "Sometimes as well you can see the physical things of like actually there isn't an alcohol pump at the end of that bed because they're surgical ward and every time the bed goes off they come back on a different bed…" "And people do forget- not having it in the right place, the right time…"
Detail around auditing		
Auditing programme description	2	"…it comes up with a five moments picture, you select the moment, you select if they clean their hands, and you can either select if they can do alcohol gel or soap and water, you can even do how long they clean their hands for."
Ownership of audit to ward	1	"…they have to report them to the board every year- every month, sorry- and then every year we'll do at least one validation audit."
Ward skills for completing own audit	2	"I think sometimes as well the ward delegates these sorts of audits to people that perhaps haven't had any training, they don't really know what they're looking for, they're just asked to do a hand hygiene audit and people just think, OK, I'll tick how many times I see someone cleaning their hands. So I think, they're not particularly very accurate, but it depends who's doing the audit." "…the amount of time it gets through as a hundred percent and you can only see two or three as well opportunities… So I think as well is people think that, you know, I've just watched five minutes I've seen three people, that's not really accurate. So, again, it's knowing how long to audit for, what to look for, I think there's lots of components to hand hygiene audits that people forget."
Difficulties of direct observation of practice		
Audit data not representative of true	2	"I think they're probably about 60 percent accurate, to be honest, particularly when you

practice		when, you know, even anecdotally without auditing, you can just go to a ward and you can generally get a feel for their kind of compliance because you can see 'OK I saw four people not clean their hands in a row' so that's not good, and then they send through the hundred percent."
Trying to avoid being noticed	1	"…sometimes people do- thing is people are always asking 'are you OK, can I help?' is the main thing that people do ask, and I'm like 'oh I'm just here, just not doing anything, just watching practice' erm, I usually say so that people don't- are not- I'm not going to be undercover but I'm just here to observe practice…"
Providing practice feedback		
Approach to delivering feedback	3	"…any score will get reported back to the ward sister any link practitioners we would send an email with the scores, what we observed, if I've got the graphs I'd send the graphs too, erm I then send them to also the divisional lead, the matron, include all of our infection control team in as well…" "…in the areas that I personally cover, and I know the people they're much friendlier…"
Audit as a time for providing education	2	"…if I'm doing audit as well and I've just finished, if I'm on the ward and there are people around I will show the score, just go around and show the score and say, 'you know, this is something that- this is what you've got this is the main thing, just trying to remember about these things, because this is you know, this is your score at the moment and that's what I'm going to report'. So next time, hopefully they'll remember that…"
Consequences of audit	1	"…so we also tried to do an action plan. So it went to our kind of hospital infection control committee and to the board and it was just like a flowchart so if anything was scored below 80 percent, we would- an action plan would need to put in place, we would come back and reaudit within two weeks and then if it was still not any better, they would have to come up with a- even more rigorous action plan."
Data to support feedback	2	"…because it can create reports and you can create graphs that show how many moments were missed, which moment was missed more, and then you can send that back to the area to give them some physical data." "…if I've got the graphs I'd send the graphs too…"
Feedback as a means of changing behaviour	1	"…an action plan would need to put in place, we would come back and reaudit within two weeks and then if it was still not any better, they would have to come up with a- even more rigorous action plan."
Giving positive feedback	1	"…I also include something positive as well because there's usually somebody who was

		quite good and so I'll include- and if I know the name of that person, I'll also CC that person to the email so that they've got that for revalidation or whatever they want to use it for."
Staff awareness and reaction to feedback	2	"…I know the people they're much friendlier, they'll say, 'oh, sorry, yes, oh, I forgot' or 'I just about to do it' or 'oh, sorry I'm really busy'. In areas that don't the same answers still come up 'oh I'm really busy' but they do feel like they're being really slated, I feel that they- it's seen as a negative experience…" "…because of COVID I think people are much more susceptible to erm, you know, wanting to improve that score and thinking, 'OK, I made a mistake, but next time I'll make sure'."
Ways in which HH practice might be changed	2	"…if you know that it's because gloves 'it's OK I need to support this area in their glove use' or 'I need to sort them out with some more dispensers so they can clean their hands at the right time'. So I mean, some areas it's because the gloves are on the wall but there's no sanitiser next to it so you just put the gloves on and you walk straight in so it's like little things like that that you can actually make improvements…" "…because they might say, 'well, it's because my hands are really sore, so I don't want to use the alcohol foam' and it's like 'well, you know, have you seen Occupational Health?', 'oh, I didn't know I could do that' so it's like even as I meet little separate people and interactions they do make a difference."
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		
Inclusion of time periods not normally audited	1	"I think as well, night shifts and weekends is obviously something that people don't really audit erm, because we're not a 24-hour service, whether that will change going forward I'm not sure, but it is good because I've been on night shifts and I know that people tend to work very differently than they do in the day, so that would be good to get that data."
Measure of reality of practice	1	"I think obviously an advantage is that it may not have that Hawthorne effect someone's not stood there with a clipboard or with a iPad clearly doing something erm, so people will be more, you know, people will just be more natural…"
Provide ward level performance data	1	"I don't think that people would find it an issue on the ward because it can't be traced back to individuals with this one- I don't think people would find it as a personal- because it would be like you, this ward as a whole is using 20 percent less hand gel this week, let's say, so obviously compliance has gone down."

Working in the background collecting data	3	"…it's not just that 20-minute period it's creating more levels of data so you can get more results from that." "…I think it is a good way of getting a rough idea of how often people are cleaning their hands, be good to look at trends."
Potential drawbacks of EMS		
Does not highlight individual practice	1	"…it's not fair to penalise always everybody when actually some people are doing a really good job but it's certain members of the disciplinary team that are causing it down. "
Unable to specify HH practice issues in context	5	"…I think that would be a disadvantage and not knowing which moment, or which- which barriers there are for people when they're not complying it obviously makes it difficult to then do anything about it." "…if it's because, you know, after patient contact you then don't have a dispenser near you, because if you're not watching that you wouldn't know, you can't have those conversations with people because someone's not going to remember yesterday on the night shift why they didn't clean their hands when you go back and ask them if you can see that compliance is down."
Practical implications		
A way of pinpointing areas to further investigate	1	"…it's very difficult to go places all the time so it will give a general kind of general understanding of what's going on out there and actually, it might help to streamline where we go and do our validation audits, because if you see that there's an area that's now decreased or increased their uptake, all of a sudden it's OK, let's see what's going on here…"
Acceptability by IPC and ward staff	2	"I think they would in conjunction- that it wasn't the only measure. I think it would need to be as a kind of another tool in the kind of, in the toolkit really."
Combining multiple monitoring streams	2	"…definitely having both would be the gold standard because you could- the more data and understanding, the more input you have, you can obviously hopefully make better improvements."
Understanding practice on the wards to generate data	1	"Although it doesn't take into account that, you know, you could have had someone could have spilt the bottle, had to change it halfway through or it could be lots of visitors have come in, you know, an influx of cleaning their hands…"
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
A temporary change	2	"I think they did initially, definitely, people were getting cleaning hands much more."

Increase in awareness of HH	3	"…it's definitely on people's minds, people are much more aware of it." "…it never used to be actually as many dispensers there but people are thinking about just hand hygiene more."
Increased HH not always linked to 5MHH	1	"…you can see people just they are cleaning their hands more but whether or not they're attached to specific moments…"
Changes in ward routines		
Caring for multiple patients	1	"…it was the fact that you've got critical care nurses caring for more than one patient who is very sick and you're stood in the middle of them, dealing with one patient with your gloves, your long sleeves gowns on and then the other patient's deteriorating and you quickly help them…"
Implications of PPE use		
Increase in HH equipment	2	"…it's just been an increase in hand hygiene, particularly in the beginning, we were having a lot of people like, 'oh, we need more dispensers' and now just dispensers up everywhere or like freestanding bottles just put everywhere…" "…people were more interested and wanted to, like I said, wanted to have more dispensers, wanted to have more moisturisers to look after the hands…"
Increase seen in other infections	1	"…particularly in ICU settings erm, we did have an increase in MRSA bacteraemia and other bloodstream infections."
PPE leading to IPC issues	5	"…there's been a definite increase in over reliance on gloves, so people still don't always have the understanding that actually gloves are just there as a barrier for that specific moment…" "…people didn't quite understand hand hygiene is actually as important as the physical PPE that you're wearing."
IPCN activities during pandemic		
Impact on regular auditing	1	"…in the last few months we've not been doing as many hand hygiene audits because of COVID we've added hand hygiene audit to our PPE safety audit, so it's been an extra component…"
Provision of training	4	"…we made videos of how to don, how to doff, and we had hand hygiene in there…" "…in our step by step guide we did gloves and then- take the gloves off, clean your hands and then apron erm, but people didn't want to touch the apron without their gloves on so we swapped it around…"
The IPC concerns of staff	1	"The one thing was, it's just obviously people don't let it dry and they try to get the gloves

		on… so then there's the worry that people don't do it because, you know, it's frustrating when you're trying to don and doff and then you're, you know, getting a glove on and it rips when you put it on…"
Public messaging		
Importance of messaging from the top	1	"…a lot of people think IPC are the hand hygiene police, so it was nice to see other people talking about hand hygiene… I think that was really, really good to see because lots of people just think it's us banging on about, you know, you need to clean your hands here and you need to do this because of this but, erm yeah, having that hands-face-space really helped people to see that it is important and people were more interested…"
Staff motivations to perform HH		
Community prevalence impacts anxiety and practice	1	"I think as the threat in some areas, I don't know if that's the right word, decreased so people, you know, were more used to knowing what COVID was, they weren't seeing as many cases or actually I'm in a green kind of pathway area and things then decreased."
Personal anxiety and self-protection	2	"…I think that mentality, people would rather protect themselves with a piece of plastic than they would actually clean their hands." "…when you go into Tesco, they were expecting you to clean your hands before you go in and people were starting to see that actually yeah, this is important and this is going to protect me erm, so people wanted to protect themselves."
Presence of COVID patients impacting practice	1	"…I think it depends- it's very dependent on where you go, who- what patients-demographic people are looking after in those areas erm, but it's definitely on people's minds, people are much more aware of it."

Participant: RN01		
1. The 5 moments for hand hygiene in practice		
HH as embedded into daily practice		
Advice to patients about HH	1	"…then we'll go and wash our hands. That is not for any hygiene purpose, but to show the patient that they should do that… We tell the patient as well, if you do that- or there's a carer or someone else injecting for you as well you must do these things or they must to do it, do those hand hygiene technique."
HH as a blanket approach	1	"…if you perform a hand hygiene, that doesn't harm you, you know, that's that's my my answer to that. You don't need to doubt whether "should I wash my hands or not", just wash it so that, you know, that's over because if- it is more trouble if you don't wash but if you wash, take off the colony whether it doesn't need or need, take off the colony and you can carry on with, you know, that's in your mind that you've done something."
HH after direct patient contact	1	"And in the meantime, if we touch anywhere unnecessary, like if you care about hair or between you are showing the body areas where you can inject if you touch the patient's body or we just shown our body part like tummy or hand or something, in that case also. After that, before we do the next procedure, we wash our hands just to make sure that it's not contaminated to any other areas."
HH after leaving patient zone	1	"…it is our duty to wash our hands after every patient… So it will come as before and after the patient, but generally in five minutes, ten minutes then you get to the next patient. So we wash our hands after the patient so that things are clean, and the hands can be clean and dry."
HH before and after glove use	1	"…then before putting gloves, wash hands, dry hands, gloves on, syringe taken, show the injection or this is the medicine taking off, disposing things with the same gloves, then gloves off and hand wash and come back."
HH before patient contact	1	"…once the patient comes in, this is the clinic room settings, it is our duty to wash our hands after every patient. And if there is a delay in, say a half hour delay, then we need to wash our hands before the next patient comes in as well. So it will come as before and after the patient…"
Use of soap and water or hand sanitiser	1	"…basically if you're going for a for a tea break, you don't need to wash your hands before entering the other zone, they can use the hand rub, just you can drop and clean your hands. But if you are getting into the healthcare zone from say for the treatment room or somebody you need to see, a lab specimen or anything or certain things that

		you must hand wash."
5MHH as protection for patients	2	"…when you come on a private you know public transport, you don't know what- the bugs you are bringing in and you're going to, especially in an elderly ward, immunocompromised patients, you don't know what bugs you're going to hand to them, when you simply shake hands or something because you don't know."
5MHH as protection for the self	5	"They keep us safe. So it's not really the patient, it keeps us safe as well." "…basically we only see patients from the community, so we always stick with that hand hygiene because we don't know where they come from, what they come- and even visiting before or our clinic, whether they visit the patient in the ward or hospital, you know that that is really they're from an unknown zone so we consider them as really the carriers of some sort of bugs so we always do that." "…the fact is that this is what keeping us safe, and this is what keeping- you know, at the end of the shift you're going home healthy because you are wash your hands."
HH as a show for patient benefit	2	"That's the basic- so probably we may wash then between three times, four times between the procedure and that is- our hands will be clean you know but that's- we need twice hand washing but we will do that two or three times extra just to show the patient, this is very important."
Importance of the 5MHH	1	"I think all of them are important because, the thing is if you skip one that maybe we are giving, we are compromising there, which can be the cause of spread of infection so we- I think five moments are important, they are important."
Patient status impacting practice	1	"…whether they visit the patient in the ward or hospital, you know that that is really they're from an unknown zone so we consider them as really the carriers of some sort of bugs so we always do that."
Part of the profession		
HH as part of RN role	2	"…being the senior person, I should be looking after our staff where we stand with the hand hygiene and infection control. It's not a dedicated- it's not a designated role but, you know, this comes as part of our job." "…it is our duty to wash our hands after every patient."
Potential for cross-contamination in workflow		
Cleaning computers - office based	2	"…because of COVID we wipe the screen and the key parts and we will make sure if you're going to use a new computer, or going to use a new office, then we wash our hands before that…"

The consequences of outbreaks	1	"…even in times of the winter season and everything our hospital really have a good record on infection control basically with the norovirus and all sort of things. So we really appreciate them for what they're doing it is really good because sometimes if the infection gets worse, then, you know, some of our areas would be taken by additional bed capacity and everything, so we don't want that as well."
Training in 5MHH		
A lack of training received	1	"I can't remember any special training on hand hygiene, no."
Understanding zoning		
Changing zones as an indication for HH	2	"When we coming to the healthcare zone from patient zone, we must wash our hands as per the protocol…"
Division of the patient and healthcare zone	1	"…when you pull the curtain on that is a compartment for the patient zone, it is not a healthcare zone, it is a patient zone…"
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"…we don't really interact with them on that basis. When you see them, you think 'ok anyway, this will come through, they'll come through with their annual report or bi-monthly report' and when the report comes in, see, OK, well, this is- infection control is getting better, er they're doing well, that's it. Sometimes they do that through the annual infection control training, some of them just display one graph, just to show how it is."
Detail around auditing		
Auditing programme description	1	"…so they generally come around, in- once in six months or less than that, we often see them around our areas so they, they stand sometimes in our door to see- make sure we do hand washings."
Difficulties of direct observation of practice		
Audit data not representative of true practice	1	"…the process will make us to do hand hygiene unnecessary. Sometimes you feel like 'oh because they're standing there let's do one more washing' just to make sure you know, they're auditing us [laughs] even, even without them we wash you know, the necessary times when hand washing should be done, we do but maybe we may do a couple more washing when they're there."
Providing practice feedback		
Consequences of audit	1	"I never got any correspondence on such basis that our department- they did an audit and our department falls below or, you know, or doing great or anything particular

		comment, which I mean, I think we are moderately or compliant with their practices."
Debates in HH and IPC	1	"…we don't have a clinical area, so we generally wear wristwatches and there's a little bit of, you know, argument- it's a debate basically just because of nurse's uniform and a wristwatch, it is a bit of a debate most of the time."
Feedback as a means of changing behaviour	1	"…I mean, I think we are moderately or compliant with their practices. So, which I need to carry on the same, I don't you know, I don't need to be stressed about that."
Staff awareness and reaction to feedback	3	"I haven't seen a unit, there are notices, there are so many here to read through on a daily basis or weekly basis, there are some findings and auditing results and everything comes out and there will be a general statement, what is the rate, how is your managing things…"
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		
Knowing there is constant monitoring could improve practice	1	"…if they know that the numbers going to the machine, it is a self-responsibility that somebody's keeping an eye on me straight away… so everybody will be alert about that, it is more, more I think people will be more compliant than if somebody's standing at the door with the diary or ticking the boxes."
Potential drawbacks of EMS		
Does not highlight individual practice	3	"…maybe one person, multiple people may not be doing adequate washing or hand hygiene, but maybe others, maybe somebody who is anxious staff somebody maybe to the extent that we cover everyone, you know."
Issues around privacy and monitoring	1	"…everybody likes to wash their hands and to keep safe from infections, but nobody wanted to be monitored or kept eye on them, even I don't like somebody watching me."
Practical implications		
Understanding practice on the wards to generate data	2	"So, yeah, if you get calibrated and electronically, just everything, it's a quite complex, you know, thing, really, because you cannot- you cannot bring one machine to another area to monitor it."
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
A temporary change	2	"At the moment, it is a temporary feeling, you know, we must do when we are COVID free until then we must do this practice…" "..so at the moment we feel like it's a temporary, but this is hand hygiene, and the distancing is sort of embedded in our brains now."

Increase in awareness of HH	1	“Basically the hand hygiene is more and more concerned at the moment because of COVID impact…”
Increased HH not always linked to 5MHH	1	“…it was so, so important that really enhanced- anywhere you touch you wash your hands, you keep yourself- your body away from any surface and because you don't know who walked before in the same place you went, so you're going now so it is- it's- it's- it's really scared us so that, you know, only method is wear mask and wash your hands, so we did really yeah.”
Changes in ward routines		
Reduction in patients during COVID	1	“…we reduced the number of patients coming to our department or visiting hospitals during this time because of the COVID situation.”
IPCN activities during pandemic		
Provision of training	1	“…our hand hygiene and the mask was emphasised but because we were not working in the wards in that particular- we were not in direct contact with patients. I think we never invited for any training session, but we've been given mask fitting training.”
Public messaging		
Greater focus on HH required	1	“…it comes to the responsibility of every public- public serving person to make aware to the public that, you know, that this is a- we are dealing with a particular condition, and this is the way forward and keep yourself and others safe.”
Importance of messaging from the top	1	“They always say in the briefings, the evening briefings, they always say that, you know, this is the way, the way forward to keep distance and wear masks and wash their hands. So that is really resonating everywhere- even if you go to public or private.”
Staff motivations to perform HH		
Evidence of effectiveness of IPC measures	1	“I haven’t caught COVID at all, it’s almost getting two years now not getting it. Kind of myself and my family is safe, nobody got COVID. So even though I work every day in the hospital since 2020 March…”
Personal anxiety and self-protection	1	“…it's really scared us so that, you know, only method is wear mask and wash your hands, so we did really yeah.”

Participant: RN02		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Not seeing the patient zone as a source of contamination	1	"…I'm probably better with the hand hygiene than if I've just within the bed space and done something quickly or maybe got something, or just pushing something in and out or you know things like that it's probably not as implanted…"
HH as embedded into daily practice		
Assessing task for appropriate PPE	2	"…if I'm likely to touch anything that has body fluids or blood or, you know, I might have to clean a patient I would always put gloves on…" "…any body fluids you handle you put glove on also if you have a patient that is MRSA or any other infections I would put gloves on."
HH after direct patient contact	1	"…what we probably do quite well is like if we're doing something directly on the patient and with the handling fluids or we're taking bloods or I'm examining the patient I think I'm more so- I'm probably better with the hand hygiene…"
HH after leaving patient zone	1	"…obviously then you then leave the bed space you would have to take your gloves off if you have some on or- and then wash your hands."
HH on way into patient bed space	1	"…so before I enter the bedspace and have any contact with the patient I put an apron on and would wash my hands, so that is the first thing…"
Use of soap and water or hand sanitiser	1	"I personally prefer to wash my hands but sometimes might not be possible then you would also gel your hands, you would gel your hands before you go into the bedspace if there's no washing facilities or you would equally when you come out of the bedspace would do that after any patient contact really…"
Potential for cross-contamination in workflow		
Automatic ways of working could lead to cross-contamination	3	"…sometimes someone looks into the curtain or shout something out for you and it's like a reflex you're touching the curtain with gloves on, I have done it, I have to say and I know I should not do it but it's just more like a reflex- you're in the middle of cleaning the patient, doing something to the patient and then you- you're being distracted and yeah, you should not do it but I think it happens and I think the curtains are full of mucky stuff, yeah." "…it's very difficult to sometimes not just go for it, just to collect yourself and you literally need to be on alert all the time and I think we're all human beings and we tend to- sometimes another task overtakes the task you're doing." "…sometimes you just simply can't maintain all the basic hand hygiene you sometimes

		rush from one bed space to the other…"
How gloves are used or misused	1	"No gloves on the computer when you use or you know, look at medications for example or blood results so you would not wear gloves for using computer equipment or portable equipment, we prefer to leave it out."
The role of equipment in potential spread of infection	1	"…we would always try to avoid taking anything into the bed space like when we go from patient to patient and leave the COW or the portable- you know- computer outside that is not always possible, especially in intensive care. So sometimes we have a portable computer inside the bed space but that is patient specific, and you know, we use it within the bed space and equally wash our hands after the contact and before we use the computer."
Understanding the role of curtains in potential spread of infection	2	"I personally don't really like the curtains because you tend to touch the curtains and sometimes not think about you having gloves on, you should not touch it with gloves on, um at certain situations around the bed space I think the curtains are the worst um, because you always- sometimes someone looks into the curtain or shout something out for you and it's like a reflex you're touching the curtain with gloves on…"
Training in 5MHH		
Using visual methods in HH training	1	"…our infection control champion goes around and you wash your hands, or you gel your hands and then you can check under ultraviolet light of how effective you actually have been so I found that quite helpful so we do that like I don't know, maybe twice a year and we're being assessed on how well we actually wash our hands and it's always the fingertips or between your fingers or some parts that are not washed that well or gelled that well."
Understanding zoning		
Lack of understanding of PZ and HCZ	1	"…I'm not sure about the healthcare zone, but the patient zone definitely."
Risk assessment when entering PZ	1	"…anything that comes close to the patient you need you need to consider what protective equipment you personally need, and I think that's probably why you say your personal zone it's not only to protect the patient from whatever you bring in, it's also the other way around, protect yourself from whatever you could pick up at the patient side or zone, I guess."
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
How ward staff utilise IPCN during audits	1	"The champion on the ward and the nurse in charge on the ward, or you could also- we're

		small hospital so I think equally you could contact infection control if you're not certain about certain things…"
Revealing the reality of practice	1	"I think I don't know how you could do it any different or much better I would say, I think it's- it is reflecting what's going on in the busy time- during the busy time yeah."
Compliance with the 5MHH		
5MHH which are more consistently complied with	1	"..what we probably do quite well is like if we're doing something directly on the patient and with the handling fluids or we're taking bloods or I'm examining the patient…"
Reasons for non-compliance	1	"I think the staffing as I said is an issue, distraction, you're being asked so many questions about your patient, your bed space, you know it's very easy if you're medication you're doing medications and you're being distracted by something else…"
Detail around auditing		
Continuous audit programme	1	"Yeah, it is audited I think once a month at least and if we don't do well and there is- I think, I can't quite remember the percentage we need to reach, but I think it's about 90% that we need to reach during the hand hygiene audits and if we don't reach that we then repeat each day until we reach the percentage that's required to pass."
Difficulties of direct observation of practice		
Audit data not representative of true practice	1	"I think if there is a channel of more strict observing behaviour, nurse in charge or the hand hygiene champion or whoever is in charge of the bed space itself, you do then monitor a bit more strict, I think, it reflects on the behaviour of your own, yeah I would definitely say so."
Providing practice feedback		
Audit as a time for providing education	2	"…if you all pass but if there is a failure, that person is going to be spoken to one by the nurse the charge, or whoever does the audit yeah, I think it's good practice to get to people straight away so they know and remember it's very close to when the audit was done, so I think it's most effective if you speak with people straight away." "I think you get the feedback that is important, and you learn from it. I mean, it's about learning it's not about punishing people it's about learning I think it's important."
Consequences of audit	1	"I can't quite remember the percentage we need to reach, but I think it's about 90% that we need to reach during the hand hygiene audits and if we don't reach that we then repeat each day until we reach the percentage that's required to pass."
Feedback as a means of changing behaviour	1	"…I think you get the feedback that is important, and you learn from it. I mean, it's about learning it's not about punishing people it's about learning I think it's important."

Staff are not always aware of being observed	1	"…some might do, but this only happens if it would be the same person doing it, that's doing it all the time. Usually the people change, you know, it's not always the same person that's doing it…I don't think it is that visible or people always notice. Some might, I think the thing is knowing that you can't entirely make sure no one knows about it."
Staff awareness and reaction to feedback	1	"I think it's good practice to get to people straight away so they know and remember it's very close to when the audit was done, so I think it's most effective if you speak with people straight away."
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		
No change in practice required to use system	1	"I mean, teaching would probably be very easy, it just would mention it, there wouldn't be any other teaching involved I think you would probably just have to mention it and cascade it down."
Potential drawbacks of EMS		
Cost and maintenance	1	"I don't know how expensive that system would be in terms of sensors, and you need some kind sensors that feed it back electronically, I guess right and how breakage would be, the maintenance you know all those things."
Staff may perform HH to game the system	1	"I think as any system that's electronic I think it can be cheated so that comes first to mind, so if someone wants to look good on their shift, they might just press the button so that comes to mind."
Unable to specify HH practice issues in context	1	"It doesn't really tell you how well you do it, it only tells you that you do it, that's maybe another one."
Practical implications		
Acceptability by IPC and ward staff	3	"…It doesn't really tell you how well you do it, it only tells you that you do it, that's maybe another one." "…something new generally always hit some resistance for whatever reason. It's new I think people are a bit reserved I guess when something new comes in."
Combining multiple monitoring streams	1	"I think trialling it would probably unearth you know, some concerns. It doesn't have many but, you know, I would be happy to try it out it would be maybe a good support to in addition to the audit."
4. Impact of COVID-19 on hand hygiene practice		
Changes in ward routines		
Caring for multiple patients	2	"…the patient nurse ratio is not as it should be. So we're having to look after more patients

		during the COVID situation at the moment than we usually would, and if you double up, for example, two intubated intensive care patients, it is very difficult to- you have to control your movements between your two patients..." "…we have not the normal staffing in ICU at the moment, there is often double ups of ventilated patients and it's just the nature of the busyness. And then sometimes you just simply can't maintain all the basic hand hygiene you sometimes rush from one bed space to the other…"
Implications of PPE use		
Increase seen in other infections	1	"…you have to go from one bed space very quickly to the other bed space and you might not be able- even if you wanted to do proper hand washing and taking gloves off you know, taking your apron off wash your hands before you go in the next bed space. And I think that has also led to a lot of infectious spread between patients and it was quite an issue in our unit, where also because of the long sleeves that we were wearing at the time, the gowns, we were tracking along, you know, germs from one bed space to the next because of long sleeve issues."
PPE leading to IPC issues	5	"…you might not be able- even if you wanted to do proper hand washing and taking gloves off you know, taking your apron off wash your hands before you go in the next bed space." "…initially I think we made lots of- all sorts of mistakes and actually gelled our gloves hands very initially I think it was during the first wave, but obviously that was entirely wrong…" "…the long sleeves I mentioned you know with the gowns that was not helpful because, especially when proning patients you go with a long sleeve really under the patient and then because you're an enclosed COVID environment, would then go to the next patient with the same gown on."
IPCN activities during pandemic		
Impact on regular auditing	1	"The infection control team I think they were totally overworked, they're usually a smaller kind of team but suddenly became the heart of the hospital and they were totally overwhelmed by what was needed of them. And I think maybe the hand hygiene you know, it just stopped off the wagon because they had a lot of, I don't know, other pressing issues to deal with, including protecting their staff from COVID, I think that was the main thing."

Increase in IPC staff	1	“I think me and my hospital have employed two more infection control nurses so there is movement there is thinking about to move things and there’s- yeah, I think hospital has realised, management has realised, that it wasn't enough that they did at the time.”
Provision of training	1	“At the start of the pandemic everyone was busy with the correct donning and doffing, and correct placement of the mask and the assessment of the mask. Not so much specific hand hygiene, I think it was just general hand hygiene.”
The IPC concerns of staff	1	“I think equally you could contact infection control if you're not certain about certain things and we've done so quite frequently, especially during COVID where it was a bit unsure in certain moments what- how things should be handled and there's definitely the advice coming from them how you should handle certain situations or risk assess certain situations.”
Public messaging		
Wider impact of IPC measures in society	1	“It is quite interesting how the public actually took on a lot of the advice, and I think we were seeing low numbers in respect flu and other illnesses as well that are usually around that actually have disappeared like there was no flu wave for the last one and a half year because of distancing, hand hygiene and the general advice for the public. It is an interesting point and that has had a good effect I think on other illnesses.”
Staff motivations to perform HH		
Evidence of effectiveness of IPC measures	1	“…we've learned more and more research has come out, but at the beginning there was hardly any research. Everything was just simulated and not really based on the real scenarios. So, I think that really helped, that there is more studies out that, you know, that advice of what to do. In the beginning no one really knew and we advised in things, and I think scientifically it was not proven entirely…”
Lack of trust in messaging cascaded down	1	“…these things get cascaded down from above and you on the floor you have to follow whatever gets cascaded down and that is sometimes in itself, well it’s not trusted by the staff because these people are not on the floor, they're not exposed to the same risks so I totally understood some of the nurses reaction.”
Personal anxiety and self-protection	1	“…I think people were so paranoid and so scared that they wanted to protect themselves more so than the patient.”

Participant: RN03		
1. The 5 moments for hand hygiene in practice		
Challenges in HH		
Complexity of integrating HH into practice	1	"…if you want to wash your hands, you can wash your hands."
Translating theory into practice	1	"…it's very descriptive and it's very thorough and very succinct, like, I know who to do, what to do…"
HH as embedded into daily practice		
HH as a blanket approach	1	"…in case of doubt you know like every time I've touched the patient and I'm going to touch the notes, I have to always consider universal precautions, always wash your hands or gel them."
HH after BF risk	2	"…if I have touched any really obviously dirty linen or blood products or anything, that's when we wash our hands." "…the one where you kind of, you touch some unsterile thing, blood products or anything, which is really infectious, that's very important."
HH after direct patient contact	2	"…once you've touched the patient, a patient area, that's definitely- because now you have a sick person that you've touched you do not know exactly what bacteria, what viruses he's brought in. So that's definitely the most important…"
HH after leaving patient zone	2	"…if I've used you know touched any area around them, so the environment…"
HH before patient contact	2	"…then when I go wash my hands before touching…"
HH before sterile procedure	1	"…if I'm going to give vaccines, injections, if I'm going to make antibiotics, I'm going to make prepare a vaccine…if I'm going to give blood or blood products, which will be absolutely sterile procedure I'm giving IV medication, we are dealing with anything with the respiratory, you know, if they have a [inaudible] I'm going to suction them, or a tracheostomy, so absolutely sterile area I make sure it's a very good hand washing properly up until my elbows."
Use of soap and water or hand sanitiser	2	"…we always try and wash with soap and water only in between sometimes we use hand sanitizers or if there's absolutely no room available to wash your hands at then we have hand sanitisers at the desktops."
Motivations to perform HH		
5MHH as protection for the self	1	"…once you've touched the patient, a patient area, that's definitely- because now you have a sick person that you've touched you do not know exactly what bacteria, what

		viruses he's brought in. So that's definitely the most important I feel, or maybe the one where you kind of, you touch some unsterile thing, blood products or anything, which is really infectious, that's very important."
HH as a show for patient benefit	1	"…we always say, 'okay, so we've washed our hands', we'll say this to the patient quite loudly in fact when the patient comes in and the doors close, that's when we say 'now, have you washed- when was the last time you washed your hands?'"
Importance of the 5MHH	1	"Do you feel like the five moments are all as important as each other? RN03: Yeah. Yeah."
Patient status impacting practice	1	"…once you've touched the patient, a patient area, that's definitely- because now you have a sick person that you've touched you do not know exactly what bacteria, what viruses he's brought in."
Prompting colleagues	1	"…that's when we say 'now, have you washed- when was the last time you washed your hands?' and they said, 'oh, in the lobby' but now you open your door, whatever, 'so why don't you just wash your hands now?', so we kind of influence each other."
Role of patient in prompting HH	1	"…I would feel more patient- like patient approach would be better than this, you know, like if you ask every single patient… you know when you orient the patient you know this is your ward, this is where I've come in, can you please also make sure every time the patient- these are the five times the nurses or anybody coming in your area should be washing their hands…"
Potential for cross-contamination in workflow		
Cleaning computers - office based	1	"…we have own desktops and yes so I clean every time, so it's my own computer but I clean my desk area once I've come in to work…"
The role of equipment in potential spread of infection	2	"…we wipe them yes. Only very rarely would these equipments be washed or anything but we always we would clean them with the wipes."
Training in 5MHH		
Mandatory training covering HH	1	"So not here, but in NHS we used to just do the, you know, training regularly. So not any specific training, not really."
Understanding zoning		
Changing zones as an indication for HH	1	"So let's say I'm going to give this child a vaccine then I would pull out all my stuff before and I've cleaned my area, put it all on the trolley. So one, only there's an emergency would I go into my zone because now I've touched the patient, my hands are obviously dirty and then if I have to go to my zone again, then I'm going to wash my hands and go to

		that zone so it's very helpful.”
Division of the patient and healthcare zone	1	“So the patient zone would be anything that they would be touching using- so their cupboards, their bed, so we have patients coming with the push chairs that would be the patient zone kind of, and also there would be everything that I'm going to use, my stethoscope wherever I keep my equipment and everything.”
2. Hand hygiene auditing practices		
Benefits of direct observation of practice		
Revealing the reality of practice	1	“…so when we started this, like as a surprise, the scores were not very low, but there were certain areas where this started so it wasn't showing like hand hygiene 100% or whatever, but there were specific areas, like when people left the room, nobody was using a hand gel or after you close the curtain, they were not using hand gel, whereas when they were entering, they were using, when they left seeing the patient, they were washing. So there were specific areas which we kind of were lacking but as we moved on, we got to 100% in each area…”
Staff reaction to low compliance	1	“So there were specific areas which we kind of were lacking but as we moved on, we got to 100% in each area because people picked up like, ‘oh this is where I'm missing’, and now have to.”
Compliance with the 5MHH		
5MHH which are more consistently complied with	1	“once you've touched the patient, a patient area, that's definitely- because now you have a sick person that you've touched you do not know exactly what bacteria, what viruses he’s brought in. So that's definitely the most important I feel, or maybe the one where you kind of, you touch some unsterile thing, blood products or anything, which is really infectious, that's very important.”
Reasons for non-compliance	3	“I mean if it gets busy or something, you try to, but we always have- I mean if you can't obviously wash your hands, you always have the sanitiser.” “…it's always there, it’s at every station, it’s at every bed side, even in the wards. So if they are not filled, then that's another issue…”
Detail around auditing		
Auditing programme description	1	“…at previous wards we would always do one weekly audit of hand hygiene. We had a hand hygiene champion, and so we- she would always randomly just ask someone to just show me a hand hygiene practices… annually we all have our infection control like policy to be ticked off and so part of it is doing a demonstration and a manager will normally ask

		us to show hand hygiene, you know like all the seven steps of doing a hand hygiene and when you would do the five moments."
Continuous audit programme	2	"…you'll be randomly audited, but there's no specific date, time and then people show their best behaviour it was mostly a surprise."
Ward skills for completing own audit	1	"…I would be told by the hand hygiene champion that 'okay, this night shift, make sure you watch everybody who's washing their hands and just mark it and have they done it every single time and just randomly watch them and give me the percentile like did they do with this every single time', if not, she would calculate the percentages and then we would display it on our board yeah."
Difficulties of direct observation of practice		
Hostility towards IPC	1	"…initially everybody felt a bit like alert and were not very happy, whatever but we all realised why it's been done you know, the objectives were kind of put out, it wasn't been pointing to a particular person or one particular task so people got the idea that okay this is research based. So people kind of got adjusted to it and approved for it and then kind of started using it in their day-to-day practice."
Providing practice feedback		
Audit as a time for providing education	1	"For that specific saying, 'oh, we were doing only 60% on this particular area we want to encourage people to do more we want to reduce more hospital related infections because of poor hand hygiene techniques' yes, it was- education was given, email was sent out to all the nurses, staff, everybody and yeah, it was encouraged."
Feedback as a means of changing behaviour	2	"…when people left the room, nobody was using a hand gel or after you close the curtain, they were not using hand gel, whereas when they were entering, they were using, when they left seeing the patient, they were washing. So there were specific areas which we kind of were lacking but as we moved on, we got to 100% in each area because people picked up like, 'oh this is where I'm missing', and now have to."
Staff are not always aware of being observed	1	"No most of the time people would not know that there was an audit happening."
Staff awareness and reaction to feedback	2	"…she would calculate the percentages and then we would display it on our board yeah." "…as we moved on, we got to 100% in each area because people picked up like, 'oh this is where I'm missing'…"
3. Electronic monitoring systems for hand hygiene		
Potential benefits of EMS		

Provide ward level performance data	1	"…will help to kind of say if the ward is really doing the job and if not, what are the areas we could, you know, let's say, okay, this is particular area when you're going in make sure."
Potential drawbacks of EMS		
Cost and maintenance	1	"If there's failures, I mean the electricity goes off, that's not a system that's going to stay you're going more concentrate on your ventilators or your- that to stay whereas not audit based system."
Issues around privacy and monitoring	1	"…it does enter into your privacy, confidentiality, because, you know, any system where there's a technology in ward it kind of put patient's data at risk, so I would all the spams and stuff so I would worry about that."
Staff may perform HH to game the system	2	"…if people are just, oh, we're getting a wrong percentage so just make sure the night shift, make sure you just go there every few, you know, like, maybe every 15 minutes just wash your hands…" "As to like, oh, now the patient- the nurse has actually touched the patient's bed has she come out and wash your hands or it's just like, a little ping every few minutes for night shift like, well, actually we haven't seen the patient, but just to get a good rate, we have made sure we washed our hands."
Unable to specify HH practice issues in context	2	"…it's more just a monitoring system the system may not understand when to do it, when you're leaving the area, you're coming in…" "…it's smart but it doesn't have a sense as to where it has to be done. I mean, if that's inculcated in it, then it's different."
Practical implications		
Combining multiple monitoring streams	1	"There would definitely need to be a visual audit because the whole medical system is more patient oriented and yeah, I would definitely want to have another audit along with this, a person watching if this is being done when it has to be done."
4. Impact of COVID-19 on hand hygiene practice		
Change in HH behaviour		
Increased HH not always linked to 5MHH	1	"…initially used to you know just wash your hands before every patient and then, like the regular practice but I think COVID kind of alerted us a bit more like not touching the 'T facial area', making sure every time you're going to do that, wash your hands, to not touch your body, touch the equipment, touch the patient, so we kind of concentrated when it started it did take a big role, hand hygiene took a big role…"

Promoting HH with patients	1	"…not just us, but for the patients they had a lot of information boards and had pamphlets going around because we did get a little pushback from 'oh, I've just washed my hands outside', 'oh, I've just been from the cafeteria' but yeah you've touched all the door knobs all throughout so you know handing over that leaflet, putting all those signs, kind of like was a reminder, 'ok, we here to protect each other', so you know, why don't you wash your hands again?"
Changes in ward routines		
Impact on cleaning routine	1	"…we clean the room after every patient and before they come in so just so that it's like a double check, we always let the air- room air ventilate a little bit because our air flow is like every ten minutes so we give like a 10 to 15 minutes gap between each patient appointment so we can switch, we have like five rooms so patient A goes in room A, then patient B goes into room B…"
Implications of PPE use		
Increase in HH equipment	1	"…every single place we have a little sanitisers wherever you can and washing stations you know there's various- one with the non-touch, one with just a sensor, one for the little kids…"
PPE leading to IPC issues	1	"…we do not wash our hands we remove our gloves and wash our hands, a lot of places that have been to GPs or hospital settings with the gloves, they would use a sanitiser, which is not the best practice because it really doesn't- it's not effective. So we make sure if you're gloved, you know, remove your gloves, wash your hands before and after donning a glove or wearing your mask or using the eyeglasses yeah before and after, yeah."
Public messaging		
Greater focus on HH required	1	"I don't think it was as much said about by the public or the government officials as much as like how much the mask use was encouraged."
Wider impact of IPC measures in society	1	"…even in the trains and stuff I don't see there's, like, one place that you could have the buses is absolutely no place the kids touch everywhere and so you just worry that you know, we're exposing everybody…"
Staff motivations to perform HH		
Evidence of effectiveness of IPC measures	1	"We kind of all stayed well because of a proper hygiene practices, we saw a lot of COVID patients, we gave a lot of COVID vaccines, we gave a lot of- we did a lot of COVID PCR tests, we all stayed healthy. And yes, hand hygiene paid a lot of a role in protecting us."

Personal anxiety and self-protection	2	"…so we kind of concentrated when it started it did take a big role, hand hygiene took a big role, especially now that okay, we have a COVID patient how are we going to protect ourselves, yeah."

Appendix 14: Images showing the 5MHH tailored to different patient care scenarios from Allegranzi et al. (2022)