The impact of electronic prescribing on pharmacists' communication in UK inpatient settings: a mixed methods study

Soomal Mohsin Shaikh

University College London

School of Pharmacy

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Declaration

I, Soomal Mohsin Shaikh confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature:

Date: 24/04/2020

Abstract

Background: Electronic prescribing and medication administration (ePMA) systems are becoming widely adopted across the UK. System users, researchers and patients are now questioning the profound nature through which these systems affect the ways in which healthcare professionals (HCPs) communicate with each other.

Aim: The overall aim of this PhD was to explore the impact of ePMA systems on pharmacists' communication with other HCPs and identify areas of improvement.

Method: A systematic review explored the impact of electronic prescribing systems on HCPs' working practices. Focus groups and semi-structured interviews were conducted with hospital pharmacists, doctors and nurses to explore their perceptions of how ePMA systems have affected, or are expected to affect, the way they communicate with each other. Observations, collecting both quantitative and qualitative data, were carried out to study how pharmacists communicated with other HCPs at two sites with established ePMA systems and one with paper-based prescribing.

Results: The systematic review identified four areas of working practices affected by ePMA. The focus group and interview study suggested that ePMA systems were not being used to facilitate communication among HCPs. Doctors felt that the written and physical presence of the pharmacist had reduced since ePMA systems were introduced. Participants suggested ways their current ePMA systems could improve and streamline communication. The observational study revealed differences in pharmacists' working practices; factors included differences in pharmacy services, organisational cultures and prescribing systems. More medication charts were reviewed by the pharmacists at the ePMA sites, but a lower percentage of patients were reviewed face-to-face. This may be indicative of a potentially negative impact of ePMA on pharmacist-patient relationships.

Conclusion: Practical challenges faced by HCPs working with ePMA systems were identified. Recommendations were made for clinical practice, ePMA providers and future

researchers. A recommendation made to the hospitals was to consider updating their pharmacy clinical guidelines to incorporate ePMA into their working practice.

Impact statement

The work presented in this thesis has the potential to benefit those both inside and outside academia.

Impact on practice

This thesis has highlighted the differences in prescribing systems and contexts. The findings were fed back to the study sites so they can learn from each others' systems and organisational structures in order to improve internally. One of the sites in this study is a global digital exemplar, therefore the benefits can potentially be disseminated to the organisations associated with the trust but also with others outside of the trust.

The findings highlighted the need to update the pharmacy clinical standards within the organisations. This has been discussed with the lead pharmacists at each of the three study sites who have decided to make this a priority and disseminated to the pharmacy department at the earliest opportunity. The findings of this PhD have also been presented at education and training meetings to pharmacists and other members of the pharmacy department at all three study sites. The responses across the sites has been very positive and during the presentations the pharmacists were encouraged to provide their feedback and reflect on their practices. The paper-based site's primary motivation to take part in this research was to learn from the other organisations that have established ePMA as they were requesting tenders from ePMA system suppliers at the time of the study. The project has been presented to the senior lead pharmacists at this organisation who have noted the findings and proposed to take them into consideration when selecting and implementing an ePMA system.

The importance of studying this topic was highlighted in a priority setting partnership led by the National Institute for Health Research Imperial Patient Safety Translational Research Centre in partnership with the James Lind Alliance in 2018 (Imperial College London, 2018). One of the most important research questions identified by this group

was “how can communication be improved among the HCPs within a single organisation who are all involved in a patient’s care?”. This PhD addresses this research question, with a particular focus on pharmacists using ePMA systems. The findings were presented to a patient and public advisory group. The studies from the PhD were also presented at a symposium and workshop organised by Cerner, one of the providers of the systems studied and the funder for this research, to feed back the impact of their system on HCPs and advise them of the successes and challenges experienced by HCPs working with their ePMA system in practice. A blog post was written by the PhD student that will be published in the near future by Cerner to further disseminate the findings.

Impact within this research area and academic dissemination

The studies in this thesis have contributed to the current knowledge in the field of ePMA and will create a foundation for future academic and clinical research. The systematic review was published in a peer-reviewed journal for international dissemination. The empirical studies for this PhD are in the process of being submitted to peer-review journals. The research from this PhD has also been presented at numerous conferences (see separate list – appendix A).

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Last, but certainly not least, I would like to thank my husband, Ahmed Jamal. Your constant encouragement, incredible patience and care has allowed me to achieve this PhD. I dedicate this thesis to you all.

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Abbreviations

CAG	Confidentiality advisory group
CCG	Clinical commissioning groups
CDS	Clinical decision support
CDSS	Clinical decision support systems
COW	Computer on wheels
CPOE	Computerised physician order entry
EHR	Electronic health record
eP	Electronic prescribing
ePMA	Electronic prescribing and medication administration
ESRC	Economic and social research council
GDE	Global digital exemplars
GP	General practitioner
HCP	Healthcare professional
HRA	Human research authority
ICHNT	Imperial College Healthcare NHS Trust
IRAS	Integrated research application system
IT	Information technology
LDR	Local digital roadmap
MMAT	Mixed methods appraisal tool
MMPT	Medication management pharmacy technician
NHS	National health service
NIB	National information board
NPfIT	National programme for information technology
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
SCR	Summary care records
SOP	School of pharmacy
STP	Sustainability and transformation plans
UCL	University College London
UK	United Kingdom
US	United States of America
USA	United States of America

Chapter 1: PhD overview

This thesis explores the impact of electronic prescribing and medication administration (ePMA) systems on pharmacists' communication in an inpatient setting. The thesis is presented in eight chapters; the studies have been summarised in Figure 1 and the chapters then described briefly below.

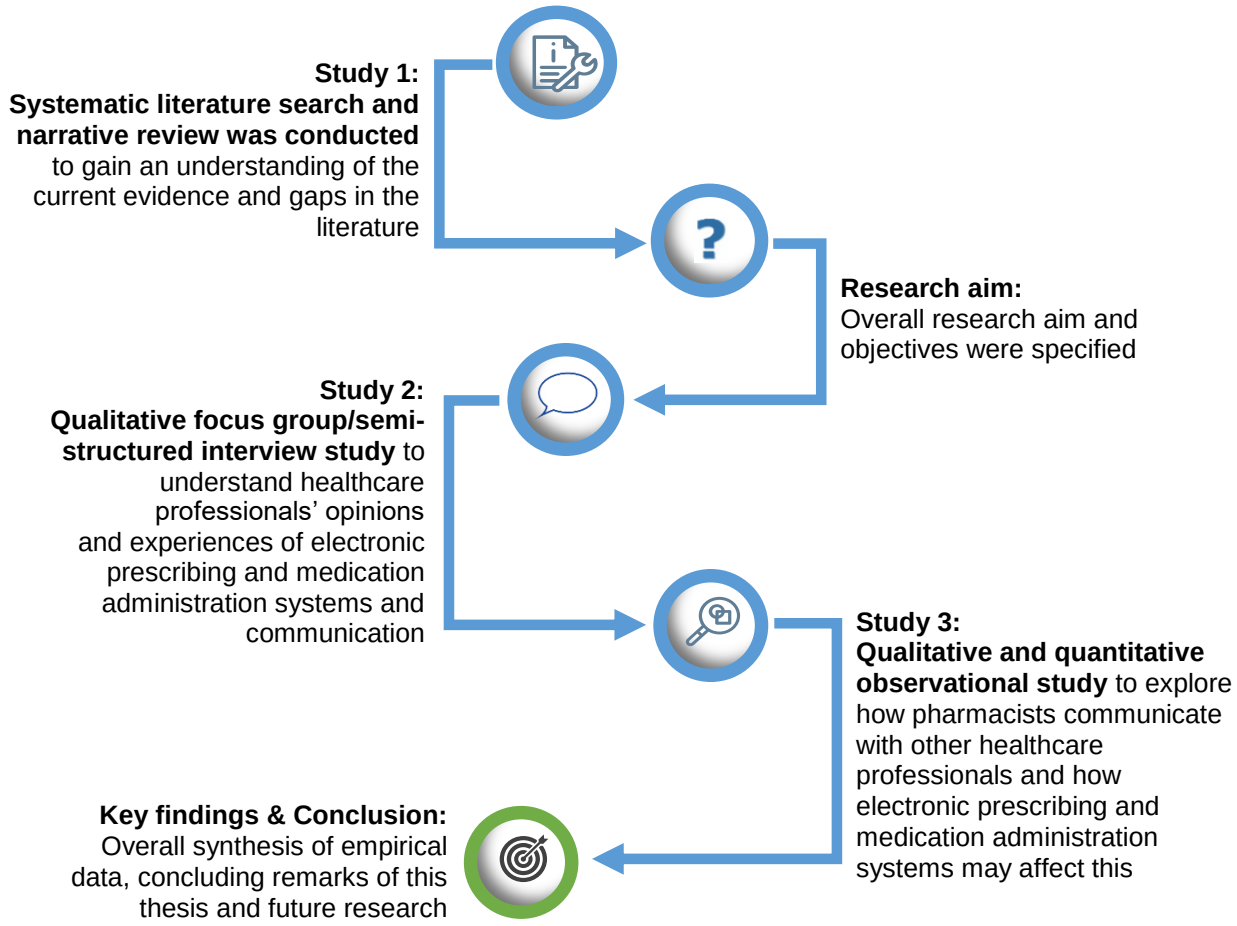

Figure 1: An outline of the PhD thesis

Chapter 1 – Overview

This present chapter comprises a brief summary of the chapters in the thesis.

Chapter 2 – Background

The background chapter provides context to the research presented in this thesis. This chapter details the National Health Service's journey to digitisation and describes electronic prescribing and medication administration (ePMA) systems.

Chapter 3 – Systematic literature review and narrative synthesis

A systematic literature review was conducted to identify and summarise the existing literature related to the impact of electronic prescribing systems on healthcare professionals' (HCPs) working practices in secondary care. Twenty-five papers were identified and four themes highlighted: communication, time taken to complete tasks, clinical workflow and workarounds.

Chapter 4 – Aim and objectives

The overall aim of this PhD was to explore the impact of ePMA systems on pharmacists' communication with other HCPs and identify areas of improvement. In order to achieve the overall aim, research objectives were identified to explore HCPs' perceptions and experiences of how ePMA systems had affected their communication with other HCPs. Communication strategies were also compared between ePMA hospitals and a paper-based hospital to identify similarities and differences.

Chapter 5 – Settings

In this chapter, the descriptions of the three London hospital sites that were studied in this thesis have been detailed. The study sites included two hospital sites with different commercial ePMA systems and one hospital with a paper-based prescribing (i.e. paper medication charts). The chapter describes the prescribing systems in place at each of the sites and details their clinical pharmacy services.

Chapter 6 – Qualitative focus groups and semi-structured interview study

Chapter 6 details the findings from focus groups conducted with pharmacists and semi-structured interviews conducted with doctors and nurses at the three study sites. The focus groups and interviews were conducted to gain an understanding of different HCPs' perceptions and experiences of ePMA systems and the impact on their communications with other HCPs.

Chapter 7 – Qualitative and quantitative observations with pharmacists

Observations were conducted with pharmacists at the three study sites to gain an insight into the benefits and challenges of using ePMA systems to communicate with other HCPs in practice.

Chapter 8 – Overall discussion and conclusion

This chapter brings together the key findings from the empirical studies and details the implications for practice, recommendations for ePMA system providers and suggestions for future research. The strengths and limitations of the whole PhD thesis are also described, followed by the overall conclusion.

This PhD aimed to explore the impact of ePMA systems on pharmacists' communication with other HCPs in an inpatient setting in the UK. This PhD also identified the potential consequences of ePMA systems on patient safety and areas of improvement of the pharmacists' working practices and the ePMA systems studied. In this thesis, two different ePMA systems were studied and compared to a paper-based system. ePMA is the future of healthcare and the current pandemic has highlighted the need for better NHS infrastructure and communication pathways. Communication is frequently cited as a major source of error in healthcare (Hignett et al., 2013). The main benefit of using ePMA is to relay secure and effective communication. However, this is greatly dependent on and driven by the people using the technology. It is therefore imperative to study and understand how HCPs are using ePMA to effectively communicate with each other regarding patient care. For this PhD, a mixed methods approach was used to answer the research aim and objectives. This was achieved by completing a systematic review, followed by a qualitative study exploring different HCPs' perceptions of the impact of ePMA systems on communication and then conducting quantitative and qualitative observations of pharmacists working with different prescribing systems. The next chapter provides the background to the thesis, including the English National Health Service's

(NHS) journey to becoming paperless and an overview of the existing literature on ePMA systems.

Chapter 2: Background

Hospitals trusts are making progress towards replacing paper-based prescribing and administration with electronic counterparts with the aim to promote and improve patient safety and modernise clinical practice (NHS England, 2019). The literature evaluating the impact of ePMA systems is growing, both in the UK and internationally. However, there remains limited research on the ways in which the working practices of healthcare professionals (HCPs) have changed since the implementation of ePMA systems. Working practices, in the context of healthcare, have not been well defined in the literature. This PhD explores one aspect of working practice; communication. Much of the communication that takes place in hospitals is safety critical (Macrae, 2017) and increasingly information technology is being designed and implemented to enable, improve and streamline communication between HCPs. The care of patients inevitably relies on different HCPs working together and sharing information. Improving documentation and communication about medications are just some of the motivations for the growing use of ePMA in secondary care to support health services (Cornford et al., 2009). There however remain significant gaps in the understanding of the role of ePMA systems in supporting communication in the delivery of healthcare.

2.1 English National Health Service road to digitisation

While developments in clinical technology have had a revolutionary impact on healthcare over the last three decades, the same cannot be said about the use of data and technology to improve health and communication (National Information Board, 2014). In England, the push for secondary care digitisation began in 2002 with the launch of the National Programme for Information Technology (NPfIT). However, the NPfIT was terminated in 2011 after failing to meet the goals set out to move the NHS towards a single, centrally-mandated electronic care record (Wachter, 2016). This was predominately blamed on the NPfIT failing to engage with trusts and HCPs, and setting unrealistic timelines to accomplish its vision (Wachter, 2016).

Following the failings of the NPfIT, the drive for digitisation stagnated. In 2012, the Secretary of State for Health, Jeremy Hunt, announced the push to digitise the NHS again and challenged the NHS to become paperless by the year 2018. The Five Year Forward View, published in 2014, set out the vision for the future of the NHS to accelerate its movement towards creating an 'electronic glue' through fully interoperable electronic health records that will enable different parts of the NHS to work together (NHS England, 2014). The National Information Board (NIB) was formed to lead the information revolution and published a framework titled, Personalised health and care 2020, in November 2014 (National Information Board, 2014). The framework aimed to support and deliver digital transformation outlined by the Five Year Forward view. It set out a series of proposals to expand the NHS-accredited health and care applications (apps) and digital information services, providing HCPs and patient carers access to data, and ensuring HCPs are making the best use of data and technology to provide the best possible care to patients (National Information Board, 2014). NHS Scotland has also published a good practice guide for a wide multidisciplinary audience to support the consistent and safe implementation of ePMA systems in Scotland, and provided an incremental approach to achieving the vision (NHS Scotland, 2014).

In 2015, as part of the plans presented in the Personalised Health and Care 2020 Framework, Local Digital Roadmaps (LDR) were created that presented details on how to achieve the commitment to digitise the NHS. The purpose of the LDRs was to begin the process of articulating how local communities will harness technology to accelerate change (National Information Board, 2016). Parallel to the LDRs, Sustainability and Transformation Plans (STPs) were created that covered all areas of NHS England and Clinical Commissioning Group (CCG)–commissioned activities. Its aim was to better integrate local authorities and services (Alderwick et al., 2016). The STPs are blueprints to help local authorities deliver a genuine and sustainable transformation in health and care and allow for shared understanding (NHS England, 2016). It was around this time

when clinician and digital expert, Professor Robert Wachter, was recruited to provide recommendations for the future of a digitised NHS.

2.1.1 The Wachter review

In 2015, Jeremy Hunt requested Professor Robert Wachter of the University of California to form an advisory group to guide NHS England on the process of digital implementation in secondary care (Wachter, 2016). A report was published by Wachter in 2016 entitled, 'Making IT Work: Harnessing the Power of Health Information Technology to Improve Care in England', which provided two categories of advice; ten overall findings and principles and ten implementation recommendations. The recommendations were outlined to inform the English health and care system's approach to the further implementation of IT in healthcare and to achieve this by 2020 (Wachter, 2016). Wachter and his advisory group drew upon the previous failings to digitise the NHS by NPfIT and the experience of health information technology in the US and highlighted the potential challenges, priorities and opportunities for healthcare in England. The Five Year Forward View document was described as 'ambitious' in Wachter's report but drew on the fact that England has the potential to improve its integration with clinical information systems as it had been successful in establishing similar systems in the primary care sector (i.e. general practitioners' surgeries). The report highlighted the need for the NHS to engage with information transformation in order to meet the growing demands of an ageing population and continue to provide a high level of healthcare at an affordable cost. Wachter also stressed that installing computers in secondary care in a push to digitise the current structure without altering the work and workforce would not allow the transformation to reach its full potential. As part of the recommendations he suggested building interoperability from the start, developing the workforce with knowledge of both clinical areas and informatics, and appointing National Chief Clinical Information Officers to oversee and coordinate clinical digitisation efforts (Wachter, 2016).

Wachter and his advisory group emphasised the need to adopt a phased approach to digitisation and at the same time make better use of government funding. Phase one

(2016 – 2019) recommended focusing on engaging and preparing local resources to digitise, and then to be followed by Phase two (2020 – 2023) allowing trusts to further mature their digital systems while maintaining a fast pace. In his report, Wachter believed that the target set to the NHS of becoming 'paperless by 2020' should be discarded as unrealistic as this target would be likely to set the NHS up to fail as it did previously (Wachter, 2016). The group appreciated the urgency for the NHS to digitise the secondary sector but recommended that staging the process would increase the likelihood of success, acceptance and digital maturity (Wachter, 2016). Wachter recommended that 2023 be a more reasonable goal to have robust clinical information systems implemented in all NHS trusts, along with a high degree of interoperability (Wachter, 2016).

2.1.2 Global Digital Exemplars

NHS England created the Driving Digital Maturity Programme that aimed to continue to drive the NHS to a paper free era. The programme was built on three key components; digital maturity assessments, local digital roadmaps and transformational support. Wachter's report recommended the recruitment of a National Chief Clinical Information Officer, but NHS England took this a step further by announcing an internationally recognised list of NHS secondary providers valued for their exceptional care delivered through the use of world-class digital technology and information, known as the global digital exemplars (NHS England, 2017). The global digital exemplars (GDEs) have a duty to share their learning and experiences with other organisations who are developing their digital technology. NHS England is currently funding 17 digitally advanced acute, 3 advanced ambulance and 7 advanced mental health trusts through international partnerships. GDEs provide other trusts with role models and motivation to continue to mature their digital technology. In their report the 'Next steps on the NHS Five Year Forward View', NHS England describes 'fast followers' who are other trusts in partnership with GDEs (NHS England, 2017). They work together to implement information technology and use the blueprints tried and tested by their GDE partner to

aid their digital maturity. The aim of this is to ensure learning is shared and the NHS continues to strive towards becoming paperless.

2.1.3 Digital maturity and use in practice

Wachter's report stated the NHS is an information-rich healthcare system but has an existing communication gap between the patients in hospital and the care they receive in the community. It is not possible to attempt to bridge this gap on a paper-based infrastructure (Wachter, 2016). With change comes a certain level of resistance and disruption, however with robust planning, sensible distribution of funding and mass engagement from all healthcare and government professionals the goal to digitise the NHS becomes feasible (Wachter, 2016). Wachter also drew upon the themes associated with previous failings of NPfIT's large scale implementation and referred to Heifetz's notion of adaptive versus technical change. According to this model, the technical change is usually straightforward to resolve but the adaptive change requires people themselves and systems to change (Heifetz, 1997). Wachter described in his report that technology itself promises to simplify and streamline the work and workflow but digitise on such a large and complex scale is adaptive change of the highest order (Wachter, 2016). Introducing digital technology into the NHS alone without preparing the system users of the changes to be expected to their working practices will likely lead to similar challenges and failures faced by the NPfIT.

In the US, huge investment has been made into maturing digital technology in all sectors of healthcare (Wachter, 2016). Studies based in the US such as one conducted by RAND health, have shown that users of electronic health records (EHR) such as doctors, approved the implementation of EHR in principle as it allowed remote access and improved quality of care (Friedberg et al., 2014). On the other hand, EHR was perceived to worsen professional satisfaction, due to poor system design, the time it took to use the system and the interference with face-to-face patient care (Friedberg et al., 2014).

In January 2019, the government published the NHS long term plan that set out the key ambitions for the service over the next 10 years. In the NHS long term plan, it was

reiterated that digital technology underpins some of the plan's most ambitious patient-facing targets as well as setting a new target for secondary care providers to become 'fully digitised' by 2024 (NHS England, 2019). Furthermore, the plan highlighted that the performance of the English healthcare system is ultimately dependent on its workforce, expanding the GDE group to share and create models for technology adoption and continue to promote interoperability (NHS England, 2019).

2.2 Electronic prescribing and medication administration systems

Electronic prescribing systems have been defined by NHS Connecting for Health as 'The utilisation of electronic systems to facilitate and enhance the communication of a prescription or medicine order, aiding the choice, administration and supply of a medicine through knowledge and decision support and providing a robust audit trail for the entire medicines use process' (NHS Connecting for Health, 2007). In the US, computerised physician order entry (CPOE) systems are not necessarily limited to medication prescribing but are also used by clinicians to directly and digitally enter pharmacy, laboratory, radiology and other orders into a computer system, which are then transmitted electronically to the respective department or service for execution (Gellert et al., 2015). Though CPOE describes the broader term of performing several tasks digitally, the term is often used synonymously with ePMA. Both systems can improve the ordering process by ensuring that the requests made are complete, unambiguous and legible (Bates et al., 1999). Hence these systems have been recognised as valuable tools in increasing efficiency and effectiveness of medical work (Niazkhani et al., 2009a). By moving towards a digitised healthcare system, organisations face implementation challenges, unknown immediate and/or long-term obstacles and potential negative effects on HCPs' working practices. However, the advantages of digitalising healthcare have been documented as accessibility, time savings and legibility (Black et al., 2011) and remains the motivation to continue rolling out and optimising the systems in hospitals across the UK and rest of the world. There have been areas around the topic of ePMA systems that have already been explored at great length such as implementation,

medication errors and the benefits and drawbacks of these systems (Ammenwerth et al., 2008, Black et al., 2011, Cresswell et al., 2013). However, there remains a gap in the literature to explore the impact electronic health records, specifically ePMA systems, have had on HCPs' working practices in a secondary inpatient care setting. As more knowledge is gained of the systems' benefits and challenges, it is important to further our understanding of how HCPs are using the technology in practice and in turn how this may affect patient safety.

2.2.1 Implementation of electronic prescribing and medication administration systems

Many researchers have explored the impact of implementation of ePMA systems. It has been suggested that implementing a new electronic system is likely to be one of the most disruptive planned events a hospital can experience and that it affects every employee and their workflow (Barnett et al., 2016, Cresswell et al., 2013). An early study conducted in the US using in-depth interviews studied the barriers to implementation and identified ways to overcome them (Poon et al., 2004). Physician and organisational resistance were also documented as common obstacles faced during and post-implementation of an electronic system. Ash et al. (2007) found that system users felt initial resistance to change as they perceived the systems to have a negative impact on their workflow. Other unintended consequences of CPOE systems included over dependence on technology, hardware demands and issues with communication among HCPs (Ash et al., 2007). On the other hand, the authors concluded in their review that users of the CPOE believed the electronic systems to have a positive effect on their workflow later (Ash et al., 2007).

Previous literature suggests that placing well-qualified clinicians with advanced informatics training in every hospital is a fundamental strategy to drive successful implementation (Cresswell et al., 2013, Poon et al., 2004, Wachter, 2016). These clinicians have an intimate knowledge of the physicians' workflow and can provide tailored support at the front line of implementation. Most studies to date have been in the US but research in England is on the rise due to the rapid rollout of ePMA systems across

the country. In England, the commercial market for CPOE and clinical decision support systems (CDSS) are relatively immature (Cresswell et al., 2014). Furthermore, it is not always possible to compare research from different countries due to the variable settings, different working practices and variations in system maturity.

2.2.2 Benefits and drawbacks of electronic prescribing and medication administration systems

The introduction of healthcare technology can be initially extremely disruptive, changing clinicians' established workflow and affecting patient experience (Cresswell et al., 2013). Zadeh and Tremblay (2016) completed a thorough review of the literature of many themes including benefits of electronic prescribing in different practice settings. The authors highlighted that the potential benefits included improvement in the quality of healthcare services, increased efficiency and effectiveness of prescribing and dispensing of medications, reduction in medication errors and healthcare cost savings (Zadeh and Tremblay, 2016). Seventy-three studies were selected by the authors and the key results found with electronic prescribing were categorised. Sixty-eight percent of the studies included in the review were from the US or Canada (n=49), only 16% were from European countries (n=12). It is important to note that practices differ among different countries and cannot necessarily be generalised to the UK market. Nonetheless, the benefits of electronic prescribing highlighted in the review are of interest. Medication error rates had reduced since the introduction of electronic prescribing was introduced and 83% of the literature reviewed by Zadeh and Tremblay (2016) shows this. The introduction of ePMA systems was primarily focused on reducing medication errors caused by issues associated with legibility and completeness of prescriptions. ePMA and EHRs are seen to facilitate better communication about patient medication and care between subspecialists and primary care (Abramson et al., 2012). Through an explorative interdisciplinary study, Cresswell et al (2016) identified that electronic prescribing systems have the potential to provide feedback on clinical performance to improve individual practice. Furthermore, the HCPs questioned in

Cresswell's study (2016) also highlighted that in order to maximise the benefits of electronic systems, the electronic systems must be flexible and fit in with complex user workflows and stressed the importance of not slowing down the work of the HCPs. Creating a system that is flexible and fits in seamlessly with individual hospitals but at the same time demands interoperability and centralisation is a challenging balance to achieve (Cresswell et al., 2016). Cresswell et al (2016) stated that in order to facilitate these, existing national and international experiences should be drawn upon. In another study by Cresswell et al (2014), a range of benefits were identified that were in line with existing literature. These included a reduction in prescribing errors, improvements in pharmacists' work practices, better adherence to guidelines and less time searching for medication charts (Cresswell et al., 2014).

In terms of drawbacks of an ePMA system, these vary depending on the type of system the organisation has in place. However, there are some recurring themes across the world and across systems that have been highlighted in the literature. Cresswell et al (2014) identified a number of medium-term risks associated with implementing an ePMA system with CDSS. These included: adverse effect on patients due to issues with computer systems, medication errors introduced by the system, lack of integration with other information systems and reduction in multidisciplinary discussions to name a few. Alerts have also been associated with user frustration and a previous review suggested a high burden of alerts may cause clinicians to override both important and unimportant alerts and compromise patient safety (van der Sijs et al., 2006).

2.2.3 Electronic prescribing and medication administration systems and working practices

A review conducted by Ahmed et al (2016) revealed two papers that examined the effects of ePMA on workflow (Niazkhani et al., 2009a, Ranji et al., 2014) and one that examined the impact on time (Eslami et al., 2008). The findings of the identified papers suggested that electronic prescribing was associated with significant workflow changes but the effects of these changes were mixed (Ahmed et al., 2016). One UK study showed that

prescribing medicines electronically took an average of 35 seconds longer compared to handwritten prescriptions and administration took the nursing staff longer to record as more information had to be entered on the electronic system that was not part of the written record previously (Evans et al., 1998). However, benefits of electronic prescribing were highlighted that included every prescription being complete and traceable to the prescriber. Electronic prescribing systems have been described to offer potential improvements in communication among patients, prescribers, pharmacists and other stakeholders but little data exists studying the practical implications of electronic systems on HCPs and their communication with patients and each other (Ahmed et al., 2016). In the review conducted by Ahmed et al (2016), it was highlighted that the reported impact on workflow in the literature is variable as the evidence was extrapolated from international literature, namely the US. The other limitation stated by Ahmed et al (2016) was that studies lacked focus on the medication-related workflows and therefore it was not possible to make generalisable deductions from the literature. This was because CPOE systems studied in previous literature from the US are not limited to just ordering and administrating medication (Ahmed et al., 2016).

Niazkhani et al (2009) performed a review of the impact of CPOE systems on clinical workflow on an international scale. Remote access was highlighted as the most valuable feature of CPOE systems, followed by access to knowledge sources, decision support, order sets and easier charting of medication. Six before-and-after studies in the review demonstrated significant decreases in the medication turnaround time (the time it takes for medications to be prescribed and administered to patients); however, five studies presented physicians' perceptions that more time was spent on ordering medications compared to the paper-based system (Niazkhani et al., 2009a). The users also found the system difficult to use due to hardware and software insufficiencies or lack of integration with other information technology. The literature is limited around the impact and consequences of ePMA and HCPs' working practices relative to other areas already discussed. Working practices encompass a number of clinical tasks carried out by

different HCPs and electronic prescribing systems have offered potential improvements in communication specifically among HCPs and their patients (Ahmed et al., 2016). Though these systems claim to improve communication among HCPs, and therefore improve overall working practices, the knowledge of this in practice remains limited. As the care of patients relies on different HCPs' contribution, there is a need to ensure the information is shared efficiently and effectively. While much effort has been focused on implementing electronic systems in hospitals, minimal exploration of how these systems have changed communication among HCPs and the potential impact on patient care has been conducted.

2.2.4 Theoretical perspectives

There are a number of frameworks and theories that are relevant to the design, implementation and use of ePMA systems in healthcare such as human factors design, human-computer interaction and normalisation process theory.

Human factors is a multidisciplinary effort that investigates and compiles information about human capabilities and limitations, and the application of that information to systems, software, procedures, environments, training, staffing and personnel management (Saathoff, 2005). The goal of improving patient safety has led to a number of paradigms for directing improvement efforts. The main paradigms to date have focused on reducing injuries, reducing errors, or improving evidence based practice (Karsh et al., 2006). Karsh et al (2006) proposed that in order to yield significant patient safety benefits, the designing of healthcare delivery systems, such as ePMA, should focus on supporting HCP's performance. An important overarching principle of human factors is to be familiar with the users of the system such as electronic prescribing. Understanding the needs of system users is an important issue as incorporating their views and requirements into the implementation and development of informatics practice can enhance users' acceptance and increase the usability of CPOE systems (Saathoff, 2005). The Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety is a human factors systems approach that has been

successfully applied in healthcare research and practice (Carayon et al., 2014). The SEIPS model is a dynamic model that suggests any change in the work system produces changes in the rest of the work system (Carayon et al., 2014). The key characteristics of the SEIPS model include: (1) description of the work system and its interacting elements, (2) incorporation of the well-known quality of care model developed by Donabedian (1978), (3) identification of care processes being influenced by the work system and contributing to outcomes, (4) integration of patient outcomes and organisational/employee outcomes, and (5) feedback loops between the processes and outcomes, and the work system (Carayon et al., 2014). Assessing the impact of technology on the work systems of various users is critical for understanding the systemic consequences of the technology (Carayon et al., 2014). This can help to clarify the benefits and challenges associated with the technology for different groups of users (Carayon et al., 2014). From a human factors engineering perspective, it is also critical to focus on other system factors that influence patient outcomes through the mechanisms of HCP performance. Such a system oriented paradigm urges thinking of HCPs in the context of their work, their organisation, and the tools that they use (Karsh et al., 2006).

Human-computer interaction addresses problems of interaction design: understanding user needs to inform design, delivering novel designs that meet user needs, and evaluating new and existing designs to determine their successes in meeting user needs (Blandford et al., 2016). A previous literature review identified four common areas of human-computer interaction issues of electronic health records (including electronic prescribing) during clinical encounters (Clarke et al., 2013). These areas included poor display of information, cognitive overload, navigation issues and workflow issues (Clarke et al., 2013). When introducing new interventions in healthcare, specifically changing the IT used, failing to consider usability issues may contribute to loss of productivity and decreased quality of patient care. This coincides with human factors as employing human-centred design to improve and streamline work processes for HCPs.

Task analysis is another important human factors principle that could be applied to ePMA systems. Understanding workflow can be difficult as many processes are often 'hidden' because clinicians are unaware of subtle behavioural changes that occur as they adapt to the environmental constraints (Weir et al., 2007). Task analysis is the process of breaking down into steps what a user does and why they do it, and using this information to design a new system or analyse an existing system. Task analysis is ideally used when designing a system as using it in the design process is one way to integrate the study of human process, including user capabilities and limitations (Saathoff, 2005). A common method of describing tasks is a hierarchical task analysis. This is a systematic approach for analysing complex processes in terms of the behaviour that is involved (Kirwan and Ainsworth, 1992). This method is ideal to use when trying to understand healthcare workflows and the users' needs. A previous study conducted in an outpatient setting observed the tasks of information technology-mediated medication management (van Stiphout et al., 2015). The task analysis method can be used to guide future design of interventions for the optimal use for IT in medication management (van Stiphout et al., 2015). The purpose of such studies is usually to create a framework, rather than understanding exactly how physicians accomplish tasks. As more ePMA and CPOE systems become available, the user interface design plays an important role in improving the users experience and acceptance. When adopting the user's perspective, system providers must try to see the interface from the user's point of view and understand their typical workflows, work environment and tools in order to give the users their desired system (Saathoff, 2005). Previous studies have studied the user's experience of working with electronic health records (including electronic prescribing) to understand their patterns of work and provide recommendations for improvement (Zheng et al., 2009). The aim of these studies was to improve the usability of the system (Zheng et al., 2009).

Other theories such as normalisation process theory identify factors that promote and inhibit the routine incorporation of complex interventions into everyday practice (Murray et al., 2010). The normalisation process theory focuses on what people do, rather than

what they believe or intend, and therefore focuses attention on aspects of individual and collective behaviour shown to be important in empirical studies of implementation processes (May et al., 2018). Previous studies have used normalisation process theory to explore staff expectations of electronic health record system (McCrorie et al., 2019). Normalisation process theory can be used to develop interventions that may be required prior to the intervention such as an electronic prescribing system. However, May et al (2018) suggest that this theory places undue emphasis of individual and collective agency without explicitly locating this within, and as shaped by, the organisational and relational context in which implementation occurs.

As the previous theories suggested, it is imperative to understand the needs, perceptions and challenges faced by the users of a system (such as ePMA). Studying the differences in their environments, training and organisational structures are also important areas to explore when trying to understand the motivations and perceptions of ePMA system users. In this PhD, an exploratory approach was adopted to understand the impact of ePMA systems on different HCPs. The next chapter presents a systematic review of the literature that aims to: (1) review previous literature to summarise prior research on the impact of electronic prescribing (eP) and ePMA systems on different HCPs' working practices and (2) specify the research aim and objectives for the rest of this PhD thesis.

Chapter 3: The impact of electronic prescribing systems on healthcare professionals' working practices in the secondary healthcare setting: a systematic review and narrative synthesis

The findings from this chapter were published in BMC Health Services Research, in October 2019, under the title "The impact of electronic prescribing systems on healthcare professionals' working practices in the hospital setting: a systematic review and narrative synthesis" (Mohsin-Shaikh et al., 2019).

3.1 Background

Electronic prescribing (eP) and electronic prescribing and medication administration (ePMA) systems are increasingly being implemented in clinical settings in an attempt to reduce medication-related risks and enhance patient safety (Ahmed et al., 2016). These systems affect HCPs' work and the way in which they perform their roles. Previous publications have highlighted successful implementation and use of electronic prescribing in primary care (Gagnon et al., 2014, Wachter, 2016). An earlier systematic review investigated the impact of hospital CPOE systems on inpatient clinical workflow, but included literature on all types of medical order and only up to June 2007 (Niazkhani et al., 2009a). While many safety benefits may exist, studies show that the adoption of new hospital health information technology also involves many sociotechnical challenges that can limit these benefits (Mozaffar et al., 2017). The focus of this chapter is to explore the current literature around the impact of eP systems on HCPs' working practices in a hospital environment by conducting a systematic review and reporting the findings. By conducting this review in a systematic approach, the literature can be studied critically and reliably (Moher et al., 2009). This review should also support future studies by identifying and contributing to narrowing the gaps in the literature.

3.2 Aim

The aim of this systematic review was to synthesise peer-reviewed literature assessing the impact of eP systems on the working practices of HCPs in the inpatient setting and identify implications for practice and research.

3.3 Objectives

The specific objectives of the systematic review were:

1) To describe the types of impact eP systems had on HCPs' working practices in the inpatient setting,
2) To identify ways in which eP systems had a positive or negative impact on HCPs' working practices,
3) To identify any suggested consequences of these changes in working practices on patient safety,
4) To identify gaps in the literature and suggest how they can be addressed.

3.4 Method

The Cochrane collaboration handbook (Higgins and Green, 2011) was consulted to aid formulation of the search strategy and screening process. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist supported the review process and final reporting (Moher et al., 2009). Following a systematic search, the included literature was synthesised using a narrative approach, rather than a meta-analysis. This approach was selected due to the anticipated heterogeneous nature of the literature which would therefore be better interpreted textually rather than statistically.

3.4.1 Databases

A structured electronic search strategy was created and used to find the appropriate papers in the following databases:

- The Cochrane Library

- PubMed
- Medical Literature Analysis and Retrieval System Online (Medline)
- Excerpta Medica database (Embase)
- Cumulative Index of Nursing and Allied Health Literature (CINAHL)

Snowball sampling was also used to obtain further studies that meet the inclusion criteria. This was conducted by reviewing the reference list of the literature found during the search and selecting potential literature that may fit the inclusion criteria. The local medication safety literature database at The Centre for Medication Safety and Service Quality (CMSSQ) at Imperial College Healthcare NHS Trust was also reviewed for potential papers.

3.4.2 Search strategy

The Cochrane collaboration handbook suggests that a systematic search should 'specify the types of population (participants), types of interventions (and comparisons), and the types of outcomes that are of interest (PICO)' (Higgins and Green, 2011). The search strategy was based on facets for - HCPs, eP, working practices and hospital inpatient settings. The key facet terms were developed using PICO. These terms were searched in the different databases and linked using the Boolean connection 'AND'. The medical subject headings (MeSH terms) within each key facet were combined, together with relevant free text words, using 'OR'. Table 1 presents the facets used for the search strategy and justification for using them. The PICO concepts have been underlined in the table.

Number assigned to each facet:	Facet:	Boolean connection:	Justification for facet term used:
1	Electronic prescribing systems	1 AND 2 AND 3 AND 4	This literature review aimed to assess the impact of electronic prescribing systems on the working practices of healthcare professionals. Therefore, electronic prescribing systems were the intervention. The comparator for the electronic prescribing system was considered to be any other electronic prescribing system or a paper-based system depending on the type of study.
2	Healthcare professionals		This literature review evaluated the impact of electronic prescribing systems on healthcare professionals who use the system. Doctors, pharmacists and nurses were included in the review as these groups have direct contact with the prescribing, administration and review of medication for inpatients. This was the population.
3	Inpatient		The focus of this literature review was on the inpatient population. All inpatient groups were included in the review.
4	Working practices		Studies reporting the impact of electronic prescribing systems on the selected population's working practices were evaluated. This was the outcome that was assessed as part of the literature review.

Table 1: Facet terms

Table 2 presents the keywords used to build the search strategy. The keywords were adapted for each database following piloting to improve the specificity and sensitivity of the hits. The search strategy, constructed with the support of specialist librarians, included combinations of keywords and controlled vocabulary. The details of the full search strategies can be found in appendix B.

Electronic prescribing systems	Healthcare professionals	Inpatients	Working practices
▪ Electronic prescribing ▪ CPOE ▪ Medical order entry system ▪ Medication alert system ▪ Computerised physician order entry ▪ Computerised provider order entry	▪ Healthcare professional ▪ Health personnel ▪ Doctor ▪ Physician ▪ Clinician ▪ Hospital medical staff ▪ Pharmacist ▪ Nurse ▪ Hospital nursing staff ▪ Registered nurse	▪ Inpatient ▪ Hospitalised patient ▪ Hospital patient	▪ Working practice ▪ Workaround ▪ Workflow ▪ Practice pattern ▪ Communication ▪ Staff time

Table 2: Keywords used to build search strategy

3.4.3 Types of studies

Systematic reviews were excluded from this review, however a search was conducted within the Cochrane database to retrieve previous relevant reviews completed in this area and their references screened for relevant literature that meet the inclusion criteria.

3.4.4 Types of participants

This systematic review evaluated the impact of eP on HCPs working in the inpatient setting, where HCPs were defined as doctors, pharmacists and nurses of all grades. Other members of the multidisciplinary team were excluded. All inpatient groups were considered when reviewing papers. Research conducted in all countries was included. Secondary and tertiary care settings were included such as general hospitals, specialist hospitals, teaching hospitals or any other hospitals. Literature based in primary care and outpatients was excluded.

3.4.5 Type of intervention

eP and ePMA systems have been defined by NHS Connecting for Health, ‘the utilisation of electronic systems to facilitate and enhance the communication of a prescription or medicine order, aiding the choice, administration and supply of a medicine through knowledge and decision support and providing a robust audit trail for the entire medicines

use process' (NHS Connecting for Health, 2007). In the US, computerised physician order entry (CPOE) systems are generally not limited to medication prescribing and administration but are also used to directly and digitally enter pharmacy, laboratory, radiology and other orders into a computer system, which are then transmitted electronically to the respective department or service for execution (Gellert et al., 2015). The focus of the present review were hospital eP systems, whether standalone or part of a wider ePMA and/or CPOE system. Studies reporting the impact of eP on HCPs' working practices were included.

3.4.6 Type of outcome

Working practices, in the context of healthcare, have not been well defined in the literature. For the purposes of this review, working practice was defined as HCPs conducting clinical work, diagnostics, monitoring, providing direct and indirect patient care, interacting and communicating with other HCPs and engaging in activities to provide patient care.

Studies comparing eP systems to paper-based systems were also included. The papers were reviewed to identify ways in which eP systems have had a positive or negative impact on HCPs' working practices. A secondary outcome of the benefits or consequences of eP systems on HCPs' working practices and the potential consequences on patient safety was assessed.

3.4.7 Inclusion and exclusion criteria

To complete a robust systematic search, a checklist of inclusion and exclusion was created. The titles and abstracts for the papers were initially screened for their suitability against these criteria. Table 3 summarises the inclusion and exclusion criteria checklist respectively.

Criteria	Inclusion	Exclusion
Time period	All up until 19 November 2018	
Publication language	English	Any other publication language
Setting	Studies that were conducted in one or more hospital settings – general hospitals, specialist hospitals, teaching hospitals or any other type of hospital	Studies based in a primary care or outpatient setting: e.g. GP practices, ambulatory clinics, residential or nursing homes
	Any inpatient group – including adult and paediatric patients, medical, surgical and critical care patients	
Study design	Any study design, including controlled, uncontrolled (such as uncontrolled before-and-after studies), observational (including cohort and case-controlled studies), descriptive (such as surveys) or qualitative designs	Viewpoints, editorials, conference/meeting abstracts, expert opinions and grey literature. Systematic or similar reviews (e.g. narrative, scoping and realist reviews) were excluded but their references were reviewed to identify relevant studies
Study participants	Studies focusing on doctors, pharmacists and/or nurses working with hospital inpatients. If there were a mix of any other healthcare professionals (HCPs) within a study, the study was only included if the data among the HCP groups could be distinguished	Studies that focused on other healthcare professionals e.g. physiotherapists, dieticians, occupational therapists unless the data could be extracted for the included HCPs
Intervention	Studies that focused on the impact of electronic prescribing (eP) systems on the working practices of HCPs	Studies that focused on the impact of paper-based systems for prescribing without any comparison with eP systems
	The hospital could have a previously implemented eP system, or an eP system implemented during the course of the study	Studies that focused only on the introduction or impact of barcoded medication administration/clinical decision support/alerts/mobile health technology
	Papers related to the introduction or impact of barcode medication administration/clinical decision support/alerts/mobile health technology but with the main focus being eP	Studies of a standalone discharge prescription system or specialist chemotherapy eP system

Table 3: Inclusion and exclusion criteria

3.5 Data extraction

3.5.1 Protocol registration

The international prospective register of systematic reviews (PROSPERO) is an international database of prospectively registered systematic reviews in health and social care, welfare, public health, education, crime, justice and international development, where there is a health-related outcome (Centre for Reviews and Dissemination, 2009). PROSPERO was checked to ensure there is no duplication in work and the systematic review protocol was registered with the organisation (registration number: CRD42017075804). The purpose of registering the protocol was to reduce unplanned duplication of reviews and provide transparency in the review process (Booth A et al., 2012).

3.5.2 Screening process

The literature search was conducted up to 19 November 2018. The primary researcher (SMS) conducted all the title, abstract and full text screening. A second screener was also involved in the two screening stages. The abstracts and titles of all studies were screened and assessed for suitability by SMS and removed obviously irrelevant studies and duplicate papers. A second researcher (MM) reviewed a random sample (10%) of the titles and abstracts. If there was doubt if a study should be included in the review, the full text of the paper was obtained and assessed against the inclusion and exclusion criteria. The full articles were then retrieved for all the papers shortlisted and screened by SMS. A third researcher (TM) independently screened a random sample (20%) of full text papers. Any full text papers SMS and TM disagreed on were then reviewed by a fourth researcher (BDF) and resolved. A data extraction template was created to allow standardisation of the data extracted from each study selected and piloted before first use. When the final papers were selected, the data was extracted using the data extraction table by SMS.

3.5.3 Data extraction table

A data extraction table was created to capture information from the literature (Table 4).

Information extracted from each paper included	
1	Year
2	Author
3	Country
4	Title
5	Study aim
6	Study design
7	Setting (hospital/ward/specialty)
8	Sample size
9	Duration of study
10	Electronic system used (type/brand if stated)
11	Comparator system (if any)
12	Population (type of healthcare professional)
13	Outcome measure(s) and main findings
14	Limitation(s) of study

Table 4: Data extraction fields

The complete data extraction table can be found in appendix C.

3.5.4 Quality of studies

Many assessment tools and checklists have been developed to appraise the quality and susceptibility to bias of studies (Archer S et al., 2017). The Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018) was used to assess studies' methodological quality. This tool was selected as it can be used with quantitative, qualitative and mixed-methods studies. Based on this appraisal tool, studies were awarded a score of unclassified, 25%, 50%, 75% or 100%, with scores of 75-100% considered high quality. Studies were not excluded based on quality but quality scores were presented descriptively.

3.6 Analysis

The Economic and Social Research Council (ESRC) Methods programme developed a guidance on the conduct of narrative synthesis in systematic reviews (Centre for Reviews and Dissemination, 2009). The guidance offers a framework and specific tools to help to increase the transparency and trustworthiness of narrative synthesis. The framework was used to support this review. The framework consists of four elements:

1) Developing a theory of how the intervention works, why and for whom
2) Developing a preliminary synthesis of findings of included studies
3) Exploring relationships within and between studies
4) Assessing the robustness of the synthesis

The data extracted underwent an inductive analysis as the review involved searching through patterns in the literature and identify patterns and relationships to mould future studies and the research question.

3.7 Results

The search resulted in 1,477 articles. Following deduplication and exclusion of four non-English papers, 1301 articles were identified to undergo title and abstract screening. One further paper was identified from the literature database available at the CMSSQ. The primary researcher (SMS) screened all 1301 articles and the second researcher (MM) screened a random sample of 10% (n = 130) of the titles and abstracts. 171 articles underwent screening of their full-text by SMS and a random sample of 20% (n= 34) were screened by TM. Of the 33 articles which underwent a full text review by TM, SMS agreed with 27. The inter-reviewer agreement was deemed almost perfect for the title and abstract screening (Cohen's kappa = 0.948) and moderate for the full-text screening (Cohen's kappa = 0.637) (McHugh, 2012). Six papers were reviewed by BDF and their inclusion or exclusion agreed by consensus. Twenty-five studies met the inclusion criteria. The screening process was summarised in the PRISMA flowchart (Figure 2). A random sample of 50% (n= 13) of the included papers underwent quality assessment by two authors (SMS and MB) independently and any disagreements on study quality were resolved by discussion. The MMAT quality assessment was completed by two reviewers for 13 studies, with strong inter-reviewer agreement (Cohen's kappa = 0.816). Once all the studies were assessed, ten were rated 100%, four as 75%, ten as 50%, and one as 25% (appendix D). The remaining articles were assessed by SMS. Fourteen of 25 studies were therefore deemed high quality (75-100% score).

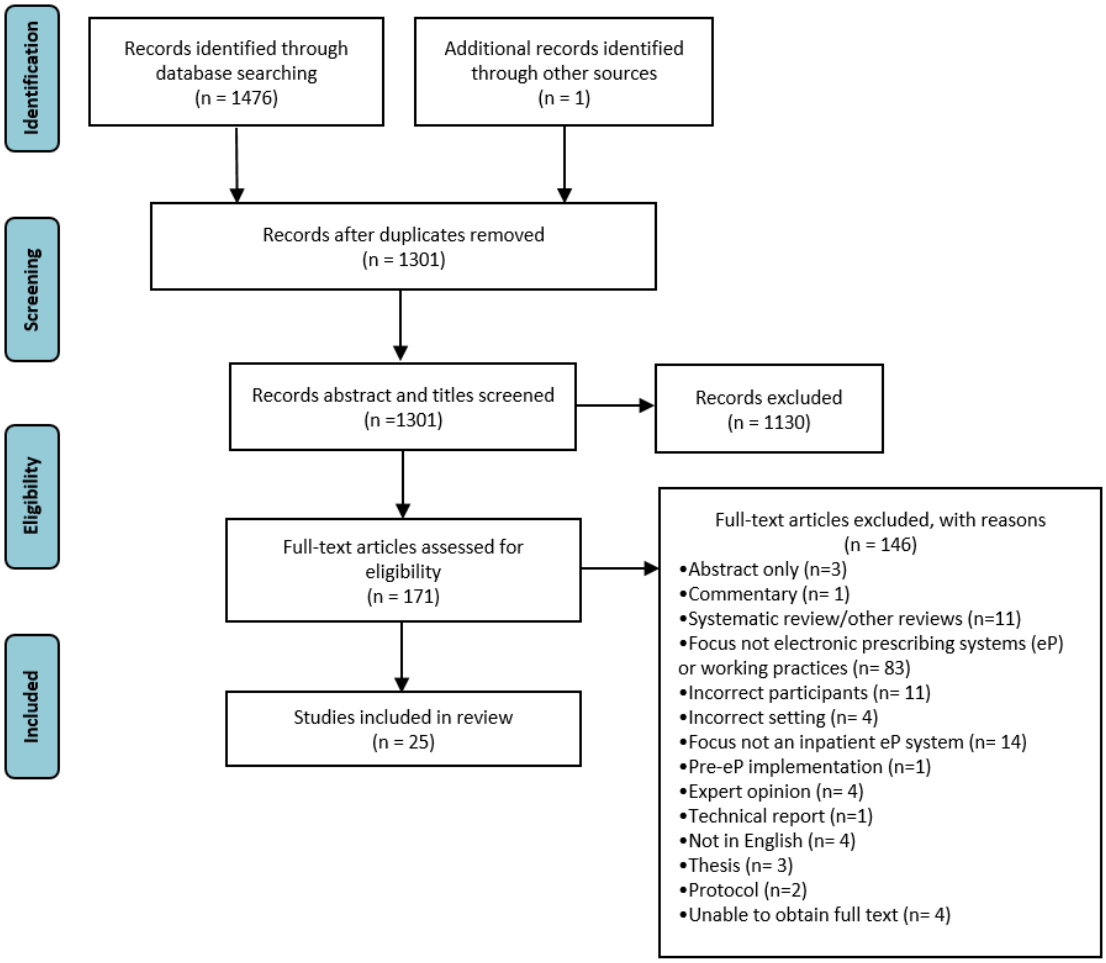

Figure 2: Preferred reporting items for systematic reviews and meta-analyses diagram (PRISMA)

3.7.1 Description of studies

Of the 25 studies, seven were from the UK, four from the US, four the Netherlands, three from France, two from Australia, two from Saudi Arabia and one each from Denmark, Spain and Iran. As shown in Table 5, the majority of the papers studied commercial ePMA systems (n= 19), one studied both a commercial and a home grown system (Pontefract et al., 2018), one study specified the use of a home grown system (Bedouch et al., 2012) and for four studies it was not possible to establish the system type. Sixteen papers studied CPOE systems with electronic medication administration and three studied CPOE without electronic medication administration, all from the same hospital. The included studies used a range of data collection methods and study designs, mainly cross-sectional. Most applied quantitative methods (n= 14) such as surveys, ten applied qualitative approaches including focus groups, interviews and observations, and one used mixed-methods (Beuscart-Zephir et al., 2005). Across the 25 studies, nurses were

included in 18, doctors in 17 and pharmacists in 9 studies. As working practices is an umbrella term for several clinical tasks the literature was reviewed and categorised into four elements: (1) communication (2) time taken to complete tasks (3) clinical workflow (4) and workarounds.

Type of electronic prescribing system	First author (Year)
Commercial	Armada (2014), Barber (2007), Baysari (2018), Beuscart-Z'ephir (2005), Davies (2017), Franklin (2007), Holden (2010), Hollister (2011), Khajouei (2011), Mehta (2008), Mekhjian (2002), Niazkhani (2009), Niazkhani (2010), Niazkhani (2011), Pelayo (2013), Van Wilder (2016), Weir (1996), Wenzer (2006), Westbrook (2013)
Home grown	Bedouch (2012)
Commercial and Home grown	Pontefract (2018)
Unspecified	Alsweed (2014), Ayatollahi (2015), Burgin (2014), Saddik (2014)

Table 5: Types of electronic prescribing and medication administration systems in the studies identified

3.7.2 Themes

Communication

Twelve papers highlighted the impact of eP systems on HCPs' communication with each other among professions. Two reported a positive impact on HCPs (Holden RJ, 2010, Weir et al., 1996), two reported no significant difference (Pelayo et al., 2013, Westbrook et al., 2013), three reported a negative impact (Beuscart-Zephir et al., 2005, Niazkhani et al., 2011, Niazkhani et al., 2010) and five reported a preference for verbal communication over electronic (Bedouch et al., 2012, Burgin et al., 2014, Khajouei et al., 2011a, Pontefract et al., 2018, Saddik and Al-Mansour, 2014). Two specifically reported a positive impact on doctor-nurse communication since introduction of eP (Holden RJ, 2010, Weir et al., 1996). In one of these, interviewed doctors perceived that communication with colleagues and nurses improved through better documentation (Holden RJ, 2010). Similarly, in the second study, nurses reported adequate communication with doctors when using eP (Weir et al., 1996). Furthermore, in this study and another qualitative study it was found that communicating orders electronically risked miscommunication between HCPs as there were no bedside systems to enter

medication orders (Niazkhani et al., 2011, Niazkhani et al., 2010). The doctor therefore had to rely on their memory or write a brief note on paper to remind them to prescribe medication later (Niazkhani et al., 2011, Niazkhani et al., 2010). In another study, it was reported that eP systems benefited the doctor-pharmacy and nurse-pharmacy workflows but hindered doctor-nurse workflows as the unidirectional nature of medical dominance in the ordering phase caused nurses difficulties in their workflow (Niazkhani et al., 2010).

One study suggested that eP systems disrupted the synchronous communication between doctors and nurses (Beuscart-Zephir et al., 2005). In France, Beuscar-Zephir et al. (2005) compared the communication of medication orders and administration process between three hospital sites (sites 1 and 3 were using two different commercial eP systems and site 2 used a paper-based system). The authors described observations of the doctor-nurse medical ward rounds in a paper-based and computer-based setting. In the paper-based environment it was found that the nurse accompanied the doctor during the medical round which naturally led to the two HCPs exchanging synchronous dialog regarding medication orders and plans for administration. The authors described that the cooperation in planning between the two HCPs and the resulting shared representation played an essential role in distributed decision making (Beuscart-Zephir et al., 2005). In the computer-based setting, the nurse did not accompany the doctors on their medical rounds eliminating the synchronous dialog and distributed decision making opportunities. The coordination between the two HCP groups relied on asynchronous and sequential actions (Beuscart-Zephir et al., 2005). Niazkhani et al (2010) also highlighted that the doctors and nurses frequently pointed out that without medical rounds there was little possibility for shared understanding therefore both groups relied on direct communication and discussion. Furthermore, the paper describes the eP system as ‘unidirectional’ and lacked the ability to allow information transactions (Niazkhani et al., 2010).

Two further studies revealed that both medical and nursing staff preferred verbal communication rather than communication through an eP system (Khajouei et al., 2011a,

Saddik and Al-Mansour, 2014). Khajouei et al. (2011) collected data from doctors and nurses using two similar survey questionnaires and obtained a response rate of 49% and 56% respectively. It was found that both HCP groups preferred verbal communication followed by communication via printout labels produced by the commercial eP system. The nurses stated that they used the printout labels to coordinate ordering activities with the doctors and other nurses but still used other means e.g. verbal communication or phone to clarify or explain a new medication ordering activity (Khajouei et al., 2011b). This study highlighted that some forms of communication are well received electronically (such as a medication order) but the nurse would be more likely to communicate with the doctor in person or over the phone if a prescription needed to be clarified. Nurses reported that they always supplemented eP communication with a phone call to confirm medication orders, which they perceived to add to their workload (Khajouei et al., 2011a, Saddik and Al-Mansour, 2014). Two studies reported no significant impact of eP systems on HCPs' communication (Pelayo et al., 2013, Westbrook et al., 2013). One identified common rounds, briefings and opportunistic exchanges as opportunities for medical and nursing staff to exchange patient-related information, and then compared the impact of these on communication between an eP site and a paper-based site; no statistically significant difference in cooperative activities was identified (Pelayo et al., 2013). Similarly, a controlled before-and-after time and motion study found that an electronic system was not associated with any significant change in the proportion of time medical and nursing staff spent in professional communication with each other (Westbrook et al., 2013).

Three studies focused on the impact of eP on pharmacists and their communication with doctors (Bedouch et al., 2012, Burgin et al., 2014, Pontefract et al., 2018). Bedouch et al (2012) conducted a prospective cohort study across seven medical wards in a French academic hospital to see if the pharmacists communicated their interventions when a CPOE system was available. The pharmacists were able to communicate their interventions in two modalities: (1) computer communication: the physician was alerted

to an intervention by an orange flag when reviewing the CPOE system, (2) oral communication: the pharmacist discussed the intervention directly with the physician either in the physician's office, during the medical ward round and documented the intervention in the eP system if appropriate (Bedouch et al., 2012). It was found that of the 448 interventions identified by the pharmacists, 79.2% were accepted by the physicians. It was found that pharmacists' interventions were well accepted by doctors when communicated both electronically and orally (Bedouch et al., 2012), but with a significantly higher acceptance rate for those communicated orally. This study also suggested that pharmacists preferred oral communication in situations requiring a rapid modification to medication (Bedouch et al., 2012). The findings in this paper resulted in the pharmacists being encouraged to favour oral communications for interventions as soon as possible especially during medical ward rounds. The study showed that pharmacists preferred oral communication in situations requiring a quick modification (Bedouch, 2012). Additionally, it was found that there was an increase in communication between doctor and pharmacist as eP introduced a new 'technical' expert role for pharmacists (Burgin et al., 2014, Pontefract et al., 2018), suggested to have evolved due to suboptimal doctors' training (Pontefract et al., 2018).

Time taken to complete tasks

Six papers focused on the impact of eP on time taken while completing particular medication-related tasks (Baysari et al., 2018, Franklin et al., 2007, Hollister and Messenger, 2011, Mekhjian et al., 2002, Van Wilder et al., 2016, Westbrook et al., 2013); the majority adopted uncontrolled before-and-after study designs (n = 4), one a controlled before-and-after design (Westbrook et al., 2013) and one was a longitudinal qualitative study (Baysari et al., 2018). Of the former, one focused on the impact of eP on nurses' medication-related activities (Van Wilder et al., 2016). This study suggested that eP did not significantly affect the length of time spent on a medication administration round but altered the distribution of tasks with a doubling of the time spent on documentation (Van Wilder et al., 2016). The task of searching for paper medication

charts reduced from 1.2% to zero post-eP implementation. This study continued to collect data during and one month after implementation with no settling in period. The duration of the medication round appeared to decrease post-eP but data collection ceased before the reason for this change could be fully explored (Van Wilder et al., 2016). In another study in which HCPs were interviewed at four time points, doctors and nurses perceived that prescribing and medication administration took longer post-eP compared to paper medication charts. Six months post-eP, participants perceived that they had become more efficient in using the system but the time taken for medication administration had not returned to pre-eP durations as the process now included additional steps such as double signing for each dose administered (Baysari et al., 2018).

One quantitative study explored the impact of a closed-loop eP system on staff time (Franklin et al., 2007). Nurses' medication rounds took less time post-implementation but more time was required for medication-related tasks outside the medication round. It was unclear from the paper what the definition of these tasks were outside of the medication round. Prescribing and pharmacists' reviews took more time post-implementation. It was highlighted since all medication charts were electronic, they were always accessible. There was therefore an increased workload of patients to be reviewed by the pharmacists. This could have contributed to the increase in the time taken to provide the service (Franklin et al., 2007). Conversely, another study found that time taken for a pharmacist to verify a medication order reduced compared to hand written orders (Hollister and Messenger, 2011). Another study also found that the time taken to communicate orders from the prescriber to the pharmacy and the time taken to dispense and administer medication to the patient improved (Mekhjian et al., 2002). This was because the eP system allowed some steps in the ordering process to be eliminated, contributing to time saved during the pharmacists' review (Hollister and Messenger, 2011, Mekhjian et al., 2002). In contrast, in a controlled study, the proportion of time taken for medical and nursing staff to complete medication-related tasks did not change relative to control wards (Westbrook et al., 2013).

Impact on clinical workflow

Three papers concluded that nurses perceived the introduction of eP to positively impact their workflow (Alsweed et al., 2014, Armada et al., 2014, Ayatollahi et al., 2015). In Alsweed et al. (2014) study, participants' views on the impact of eP on their workflow was assessed using a 5-point Likert scale survey. The survey revealed that participants on the whole were satisfied with their workflow after implementation and easy to manage (Alsweed et al., 2014). However, it was reported that nurses who believed they received substandard training for eP reported that they were less satisfied with their workflow (Alsweed et al., 2014). In another study, nurses rated their post-eP workload as good or very good in comparison to doctors who rated theirs as fair or poor (Armada et al., 2014). The nurses believed the eP system did not make discrepancies evident in the ordering process, hence disrupted their workflow (Armada et al., 2014).

Three papers suggested a negative impact on nursing workflow following implementation of eP (Barber et al., 2007, Niazkhani et al., 2009b, Wenzer et al., 2006). In a qualitative study, nurses reported being hesitant to adopt the system at the start, feared letting go of familiar aspects of their job and expressed resistance to computers becoming a more substantial part of their role (Barber et al., 2007). In a questionnaire study, responses of nurses switching from two different paper-based processes to eP reported that they would prefer to continue using the eP system, although the statistical findings in the study suggested that nurses believed that the new system did not support their work processes (Niazkhani et al., 2009b). Another study also reported that eP did not support a 'collaborative working environment', as doctors and nurses were less likely to negotiate and discuss patient treatments together (Wenzer et al., 2006). The physicians and nurses observed and interviewed in the study described the login process as time consuming and inflexible (Wenzer et al., 2006).

Doctors in some studies stated that their workflow was affected by the introduction of eP systems. Doctors saw advantages in having the ability to enter orders within and outside the hospital, allowing easy access to legible patient information, but perceived that

entering electronic orders took more time compared to the paper-based system and also had safety concerns around the system (Baysari et al., 2018, Davies et al., 2017). These perceptions support previous research that highlighted a longer duration for medications to be prescribed electronically (Armada et al., 2014, Franklin et al., 2007). Doctors also expressed their frustrations by describing a new eP system as being time-consuming, as it impacted their perceptions of the system's suitability and usability (Baysari et al., 2018). The notion of becoming over-dependent on the technology was suggested, but doctors perceived that having access to information improved clinical decision making (Armada et al., 2014). However, the extra steps needed to obtain the information from the system were seen as a burden and an increase in workload (Armada et al., 2014, Baysari et al., 2018, Holden RJ, 2010). Doctors had more negative responses towards the eP system compared to nurses and pharmacists (Davies et al., 2017).

Two papers presented pharmacists' perception of the impact of eP systems on their workflow (Burgin et al., 2014, Mehta and Onatade, 2008). In a small UK study, hospital pharmacists all highlighted that more clinical screening was being completed away from the ward and in one hospital the role of pharmacy technicians had changed to become more ward-based before the roll out of eP to support maintaining medication stock and dispensing items for the ward (Mehta and Onatade, 2008). Since the pharmacists were relieved of conducting these tasks post-eP, they had more clinical input on the wards by attending ward rounds (Mehta and Onatade, 2008). Five of seven hospital pharmacists interviewed believed the amount of time pharmacists spent on the ward had not changed and four reported that pharmacists visited all the patients daily whether they had a wireless or fixed device system (Mehta and Onatade, 2008). This contradicts the findings from another UK study that suggested pharmacists conducted their work away from the patient due to the lack of available computers in patient areas following the introduction of an electronic system (Burgin et al., 2014). As eP systems offer the flexibility to complete remote screening, pharmacists in both studies were concerned about reduced patient contact and denying patients opportunities to ask questions (Burgin et al., 2014,

Mehta and Onatade, 2008). Furthermore, during focus groups, pharmacists who had been using an eP system for 8 months reported that reduced patient contact had resulted in poorer relationships with patients (Burgin et al., 2014). Pharmacists at three hospitals reported their pharmacy workload had increased while their pharmacy workforce remained the same (Mehta and Onatade, 2008). In most cases, only one extra staff member (pharmacist, technician or system manager) was recruited to help implement and support the system (Mehta and Onatade, 2008).

Workarounds

Two papers explored the introduction of workarounds in the context of eP (Baysari et al., 2018, Niazkhani et al., 2011). Niazkhani et al (2011) referred to the definition previously documented in the literature as 'informal temporary practices for handling exceptions to normal workflow' (Kobayashi et al., 2005). A number of workarounds were identified at each stage of the medication use process (Niazkhani et al., 2011). At the point of prescribing it was highlighted that often the computer terminal was not near the patient, thus, the review and prescribing of medication took place away from the patient and was reliant on the prescriber's memory (Niazkhani et al., 2011). An example of a nursing workaround introduced following eP is nurses administering medication without an electronic prescription if the doctor was busy and not able to prescribe the medication at the patient's bedside (Niazkhani et al., 2011). In this situation, the nurse would start to administer the medication based on the doctor's verbal or paper-based order and either handwrite the order onto the medication record card (instead of affixing a label) or call the doctor to remind them to prescribe the medication (Niazkhani et al., 2011). In a paper-based environment, a handwritten order would satisfy the prescription requirements. However, with the electronic system used in this study, in which nurses administered against paper records, additional steps were required to produce a valid prescription such as an electronic order and to print a prescription label for nurses to administer against. In a qualitative study, it was found that 6 months after eP implementation, workarounds were adopted to overcome limitations of slow computers. Nurses no longer

took computers to the bedside and some nurses viewed this workaround to be less safe, as medication details and patient identification were no longer being checked immediately prior to medications being administered (Baysari et al., 2018).

3.8 Discussion

3.8.1 Summary of key findings

The purpose of this review was to describe the types of impact eP systems have had on HCPs' working practices. This review suggests that the 'devil is in the detail'; not only in the methods and measures used for the different eP studies, but also in how positive and negative outcomes may be affected by the nuances of the context and the implementation of technologies. Similar to the broader systematic review of CPOE conducted in 2009 (Niazkhani et al., 2009a), the benefits of eP systems included legibility, remote access and reduced times for certain tasks. It was also found that some processes were more time-consuming and restricted opportunities for team-wide discussion (Niazkhani et al., 2009a). However, this review went beyond aspects of clinical workflow to also include studies detailing the impact of eP systems on HCPs' communication, time taken to complete tasks, and workarounds. These new themes identified suggest that future research should focus on the impact of eP systems on different HCPs' working practices but also on how the eP system can support different HCPs working together. The findings also support those of a previous review of the barriers and facilitators to implementing eP systems in primary care (Gagnon et al., 2014). They found that eP system users reported benefits in saving time and improving efficiency (Gagnon et al., 2014). As in this review, challenges were also identified; including overdependence on technology and negative impact on workflow (Gagnon et al., 2014). This review suggested that users of eP and ePMA reported that the system often did not support their work processes and did not support a 'collaborative working environment' (Niazkhani et al., 2009b, Wenzer et al., 2006). The users reported to duplicate communication electronically and verbally as they were not confident in the information being transferred effectively (Saddik and Al-Mansour, 2014). Duplication of

the same task arguable could increase the HCPs' workload. Based on this review, depending on the eP system, there is a potential for the system to simplify or complicate previously paper-based workflows. This can only be identified once the end users are exposed to the workflow. It was difficult to make conclusions based on these studies as they all used different eP systems and the training provided to the HCPs using these systems was not always clear from the studies. Furthermore, the systems were being used in different clinical settings and potentially prescribing varying levels of complex medications. Generalising the findings from these studies would not be possible.

In this review it was also found that pharmacists were the least represented HCP group, included in only nine studies, suggesting them to be an under-researched profession. It could be argued that this reflects the fact that there are fewer pharmacists in the hospital setting compared to doctors and nurses. However, pharmacists play a key role in the medication use process in most hospital inpatient settings and are significant users of eP systems; thus, future research should explore the impact of eP on their working practices.

3.8.2 The impact of changes in working practices on patient safety

There were no papers that commented on the impact of an eP system on patients in detail, therefore this objective could not be evaluated. Some studies suggested that doctors believed they could provide timely information to patients as documentation was clearer and legible. In doing so, it was inferred that eP systems made prescribing safer (Holden RJ, 2010). However, it was suggested that prescribing away from the patient could lead to patient harm in the form of a medication-related error (Niazkhani et al., 2011) and a reference to concerns around reduced patient contact as pharmacists work away from the ward leading to missed opportunities to ask questions (Mehta and Onatade, 2008).

3.8.3 Implications for practice

There is a significant lack of consensus within the literature on the impact of eP systems on HCPs' working practices. As highlighted, eP systems have removed the need for

certain medication-related tasks such as searching for paper medication charts (Van Wilder et al., 2016); conversely such systems have introduced other time-consuming tasks such as login procedures that can delay ordering and medication dose adjustments (Wenzer et al., 2006). The literature implied that information is now accessible to all HCPs which has been considered both advantageous (Baysari et al., 2018) and a burden (Franklin et al., 2007). There was a reported increase in workload for all three HCP groups discussed in this review (Armada et al., 2014, Franklin et al., 2007, Mehta and Onatade, 2008, Niazkhani et al., 2010, Pontefract et al., 2018) which could in turn put pressure on the workforce. Hospitals may therefore need to monitor their workload in relation to the available workforce and redistribute work among health professions. Workforce managers and senior HCPs should identify and take steps to address time-intensive tasks locally in order to maximise the benefits and minimise the shortcomings of eP. Managers should encourage staff working in hospitals to continue oral communication as studies have found that tasks are more likely to be acted on if communicated orally compared to electronic communication (Bedouch et al., 2012).

3.8.4 Implications for future research

This review has identified a number of gaps as all four themes identified require further exploration in order to draw more definitive conclusions. Importantly, variability among studies and settings were identified, which made it difficult to draw firm conclusions. Researchers should examine the differences among contexts, study designs and implementation strategies to facilitate future research and shed light on why there is such heterogeneity in study findings. Furthermore, one of the aims of this review was to identify any suggested consequences of changes in working practices due to eP systems on patient safety which was not fulfilled. There is an important gap to bridge between the impact of eP systems on patient care and safety which can be further explored in future work. This review also reveals that relatively little research has been conducted on how pharmacists are affected by eP. There needs to be further research into understanding the impact of eP on their working practices.

3.8.5 Strengths and limitations

There are several strengths in this systematic review. This review, unlike previous reviews, focused on eP rather than CPOE to achieve a more focused review. The facets and keywords were generated by a rigorous process and with the support of previous literature, academic supervisors and specialist librarians. To reduce the risk of bias a strict inclusion and exclusion criteria checklist was followed and the review protocol was adhered too. Furthermore, a different second reviewer was involved in the screening of the title and abstract stage, screening of the full text stage and conducted the quality assessment. An additional reviewer was available to provide their perspective if the first and second screener could not agree. Fourteen of the twenty-five studies were deemed of high quality (75-100%) and only one of very low quality (25%).

Despite the aforementioned strengths, there were also a number of limitations. The review was limited to studies published in English and excluded work published as abstracts only. Four papers were potentially eligible for inclusion in this review but could not be retrieved. The retrieved papers focused on different aspects of working practices for different HCPs, which made comparing findings challenging. It is also important to acknowledge international variation in the type, method and purpose of working practices relating to medication and therefore eP may be expected to have different effects in different contexts.

3.9 Conclusion

It is important to acknowledge that the type, method and purpose of certain working practices in different countries vary as well as within an organisation down to the ward level. In terms of changes in the types of communication, time taken to complete tasks and clinical workflow all presented mixed evidence for their effects. This review consolidated previous work but also introduced more dimensions to the previous themes identified. Researchers should further explore why such heterogeneity exists among different settings.

With regards to communication, many countries in the world rely on verbal orders even with an eP system available. This is not a practice adopted in the UK therefore the communication regarding medication between HCPs' usually surround confirmation of the prescription or a clinical intervention due to an incorrect or harmful medicine. It would be beneficial to further explore the communication culture in the UK setting as the work in this area was limited. It would be important to explore the purpose, how and the channel HCPs use to communicate especially now with the implementation of different eP systems. In particular, pharmacists were least represented in the literature in this review and are a potentially important group of HCPs to observe and study for future work due to their unique workflows, communication with multidisciplinary teams and experience with the eP system. This literature review clarified how this gap could be addressed and led to development of aim and objectives, which are presented in the following chapter.

Chapter 4: Aim, objectives and study design

The previous chapter described a systematic review conducted to gain a wider understanding of the impact of eP and ePMA systems on healthcare professionals' working practices. Communication was one of the areas identified to have been affected by ePMA, but with the literature exploring the impact of ePMA on healthcare professionals' communication being mixed and somewhat limited. The studies of the impact of ePMA on pharmacists' communication was also insufficient.

Building on the findings from the systematic review, the remainder of this PhD seeks to explore the impact of ePMA systems on pharmacists' communication with other HCPs working in inpatient settings through a mixed methods approach.

4.1 Research aim

The overall aim of this PhD was to explore the impact of ePMA systems on pharmacists' communication with other HCPs and identify areas for improvement.

4.2 Research objectives

In order to achieve the aim for this PhD, the following specific objectives were identified:

- To explore hospital pharmacists' perceptions of how ePMA systems have, or could, impact their communication with their colleagues and other HCPs;
- To explore hospital doctors' and nurses' perceptions of how ePMA systems have, or could, impact their communication with pharmacists;
- To explore the perceived challenges associated with HCPs using ePMA systems to communicate with pharmacists;
- To observe whether there are any differences in communication strategies between hospitals using ePMA and one using a paper-based prescribing system;
- To identify potential consequences of any differences in communication strategies on patient safety;

- To make recommendations for practice and generate further research questions for subsequent studies.

4.3 Research paradigms

Research paradigms are a set of beliefs and practices, shared by communities of researchers, which regulate inquiry within disciplines (Bunniss and Kelly, 2010). Positivism takes a more structural view of society rather than the interactions between individuals (Bunniss and Kelly, 2010). This paradigm adopts an objective and quantitative approach that can be analysed, therefore can demonstrate correlations and can often be replicated. However, positivism lacks fluidity and is not able to gain an insight into individuals. Furthermore, positivism may be able to demonstrate validity through trends and correlations but this paradigm is unable to interpret and explain why they might exist (Bryman, 2012). Although positivist paradigms are useful frameworks to answer specific questions, this paradigm looks to test theories rather than have an inductive approach (Creswell and Plano Clark, 2011). As the aim of this PhD was to study the impact of ePMA systems on pharmacists' communication with other HCPs, it was not possible to use this paradigm exclusively to understand individual's experiences and challenges with ePMA systems using a ridge quantitative approach.

The interpretivism approach focuses on trying to gain an insight into the unique experiences of individuals and groups (Bunniss and Kelly, 2010). The focus of this paradigm is on the use of an inductive approach and gathering diverse interpretations. The use of qualitative data can provide hidden meanings and uncover individuals or groups motivations behind their actions. Due to the highly focused nature of this paradigm on individuals or groups, it may be challenging to generalise the findings to a wider population (Bryman, 2012). Constructivism is an interpretive framework whereby individuals seek to understand their world and develop their own particular meanings that correspond to their experiences (Creswell and Plano Clark, 2011). The constructivist approach does not generally begin with a theory but develops the theory inductively. Constructivism relies on qualitative data collection methods and analysis or a

combination of both qualitative and quantitative methods (mixed methods) (Creswell and Plano Clark, 2011). In this PhD thesis, a more interpretivism/constructivism approach was adopted in order to navigate the experiences, challenges and practices of pharmacists working with ePMA systems and how these systems were being used to communicate with other HCPs.

4.4 Study design

In order to address the above objectives for this thesis, a mixed method approach was selected. An exploratory sequential, embedded design was adopted to collect the data. Specific pharmacy tasks were considered to be studied in detail however, with limited previous research this was not possible to focus on particular tasks. An exploratory qualitative study was first conducted using focus groups and semi-structured interviews to gain an insight into different HCPs' opinions and experiences with ePMA systems at three different trusts in London. The findings from this study informed the next study involving observations of pharmacists working at these trusts. The researcher gained an understanding of how the different HCPs reported that they used the ePMA or paper-based system to communicate with each other and the following study observed if pharmacists did as they said in the focus groups.

The second study in this thesis was a quantitative study with a secondary qualitative data collection strand. This study design was selected as it allows for one principal method, quantitative in this case, to be explored with the other method, providing a secondary/supportive role (Hadi et al., 2013). In the embedded design, the supplemental strand is added to enhance the overall design of the study (Creswell and Plano Clark, 2011). In the case of this study, the quantitative data was collected using a data collection form and the qualitative data was collected through probing questions and field notes.

According to Creswell and Plano Clark (2011), four key decisions should be considered when choosing an appropriate mixed method design to use in a study and have been described in Table 6 and Figure 3 below:

Basic characteristics of the embedded design	Key decision made by the researcher for the purposes of the present study	How the key decision influenced the study design used in this thesis
Level of interaction between quantitative and qualitative strands	Interactive	In this thesis, the first study collected qualitative data that informed the second study. An *interactive* level of interaction existed between the quantitative and qualitative strands as the data sought to answer the same research questions for the second study
Determine the priority if the quantitative and qualitative strands	Quantitative > qualitative	Study 2 prioritised the *quantitative* strand. The qualitative methods were used in a secondary role to support the observations
Determine the timing of the quantitative and qualitative strands	Sequential & Concurrent	In study 1, the researcher collected qualitative data that informed the second study. In study 2, the researcher collected data for both the quantitative and qualitative strands during the same phase of the research
Determine where and how to mix the quantitative and qualitative strands	Design phase	A single data set was not sufficient to answer the research question; therefore, qualitative data was collected adjacent to the quantitative data. The two data strands were analysed separately but brought together during the final phase of interpretation

Table 6: Characteristics of an embedded design approach (Adapted from Creswell & Plano Clark, 2011)

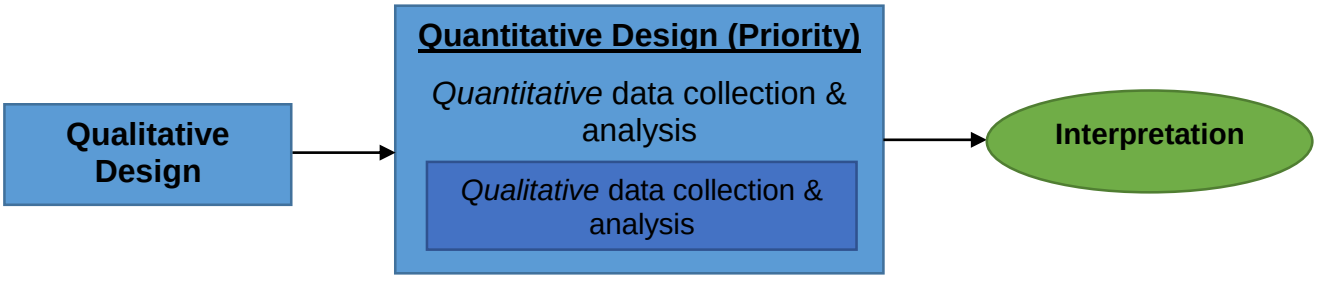

Figure 3: Diagrammatic representation of a mixed method embedded design (Adapted from Creswell & Plano Clark, 2011)

The expectation was that the two empirical studies would explore the current views, challenges and successes of pharmacists using an ePMA system to communicate information with other HCPs and comparing this to the tradition paper-based system.

The empirical studies in this thesis were conducted at two hospital trusts that used different commercial ePMA systems and one that used a paper-based prescribing system (i.e. paper medication charts). The next chapter describes the hospital sites involved.

Chapter 5: Settings

The empirical studies for this PhD were conducted at three London teaching hospital trusts. This chapter describes the setting for each site.

5.1 The study sites

5.1.1 Site 1

Site 1 is a large teaching hospital trust comprising five hospitals with a total of 1,200 beds. The trust provides acute and specialist healthcare for around 1.5 million people every year in North West London. The organisation employs 12,000 staff members (as of financial year 2018/2019), which include 2,700 doctors, 4,800 nurses and midwives, and 130 pharmacists. The trust comprises three clinical divisions:

1) Medicine and integrated care division,
2) Surgery, cardiovascular and cancer division,
3) Women's, children's and clinical support division.

During this PhD, the studies were conducted at three of the hospital sites within this trust. Further details of each of the three hospitals involved in this research can be found below in Table 7.

Hospital site	Specialities	Inpatient bed capacity	Inpatient wards
A	Acute and specialist services, 24-hour accident and emergency, hyper-acute stroke unit	444	29
B	Specialist hospital including renal, haematology, cancer and cardiology care	346	28
C	Major acute hospital, maternity centre, major trauma centre, 24 hour accident and emergency, paediatrics	484	31
Total		1274	88

Table 7: Demographics of three hospitals at site 1

5.1.2 Site 2

Site 2 is a teaching district general organisation made up of hospital plus community care services serving 500,000 people living in North London. The organisation has a total of

470 inpatient beds and provides inpatient, outpatient and emergency services. The hospital site involved in this study has a total bed capacity of approximately 207 beds. The organisation employs around 4000 staff members (as of financial year 2019/2020), which include 150 doctors, 230 nurses and midwives, and 40 pharmacists. The total number of inpatient wards at site 2 was 22 at the hospital site in this study. The trust comprises five clinical divisions:

1) Children's and young people;
2) Acute patient access, clinical support services & women's Health;
3) Emergency and integrated medicine;
4) Surgery & cancer;
5) Adult community health services.

5.1.3 Site 3

Site 3 is a district general hospital with university status. It is part of integrated healthcare trust providing care to patients in North West London. The organisation is made up of 3 hospitals with approximately 1200 inpatient beds. The whole organisation has about 8687 staff members (as of financial year 2019/2020). The studies for this PhD were carried out at one of the hospitals within the trust. The total bed capacity of this hospital is approximately 800, across 37 inpatient wards. The trust comprises 5 clinical divisions:

1) Emergency & ambulatory care;
2) Integrated medicine;
3) Surgery;
4) Integrated clinical services;
5) Women and children.

5.1.4 Summary of study sites

Table 8 presents the number of hospitals within each site and the hospital sites within the trusts that were included in the empirical studies.

	Site 1	Site 2	Site 3
Total hospitals	5	1	3
Hospitals involved in the research	3	1	1

Table 8: Summary of sites involved in this thesis

5.2 The pharmacy service

The wards at the hospitals received a pharmacy service typical of that in UK hospitals. A pharmacist would visit their allocated ward on weekdays to provide a clinical service. During their visit, the pharmacist was responsible for performing medication histories, medication reconciliations, reviewing medication charts, completing discharge prescriptions and ordering individual medication for inpatients and ward stock. The pharmacist would also counsel patients regarding new, changed or stopped medications and provide medical and nursing staff support with medication related queries. When pharmacists clinically checked medications and were satisfied, they would sign (with a green coloured pen or electronically) against the medications. This documentation was available for other HCPs to see that a clinical check has been carried out by a pharmacist. Depending on the size and complexity of the ward, pharmacists could be conducting their clinical service for anywhere from an hour to the entire working day. The pharmacists may be supported by a medication management pharmacy technician (MMPT) in order to complete their clinical work. Sites 1 and 3, at the time of the studies, operated a limited pharmacy service on weekends. The inpatients dispensary was open for a limited time but no ward pharmacy services were provided on the weekend. Site 2 had a seven-day clinical pharmacy service. A pharmacist visited wards that receive patients directly from accident and emergency (two admissions wards & two surgical wards) and higher risk wards (one paediatric ward and intensive care). This weekend clinical service was equivalent to the service provided on weekdays and the pharmacists were on site from 9am to 5pm. Site 1 operated a residency service, where a band 6 pharmacist was present at one of the trusts' sites to deal with medication supply requests and clinical queries out of hours. Sites 2 and 3 had an oncall service where the band 6 pharmacist took any calls from the hospital off site.

Any orders for medications that were not available on the ward would be requested from the inpatient dispensary. In the dispensaries across the three study sites, medication was dispensed in the manufacturer's original pack (original pack dispensing) or the

product was packed down if a smaller quantity was requested by the ward pharmacist. At all three sites, an electronic discharge system was used by doctors and pharmacists. Doctors would prescribe the discharge medication electronically and the pharmacists were responsible for clinically screening the medicines and making a supply to the patient if appropriate. All hospital sites also encouraged the patients to bring in their own medications from home, patient's own drugs (PODs), that were stored in the patient's locker and administered to the patient by the ward nurses. Figure 4 below provides a summary of the ward pharmacists' responsibilities.

Figure 4: An infographic summarising the role of the ward pharmacist at all three study sites

5.2.1 'Pre-11' discharges at site 2

At site 2, there was a hospital wide initiative aiming to have patients discharged before 11am. If a discharge prescription was written 24 hours prior to discharge, the medications were expected to be available and ready on the ward at 9am on the day of discharge. The nurse looking after a patient who was medically fit for discharge was responsible for ensuring the patient could be safely discharged. They informed the pharmacist the day before or first thing in the morning of the patients who would be discharged home before 11am. Pharmacists prioritised completing the discharge prescriptions and ensured that patients' medication was dispensed by the pharmacy.

It was noted during the observations that the process of completing a discharge prescription was complex and the pharmacist was required to complete multiple steps in multiple programmes. The diagram (Figure 5) below is a simplified version of the process.

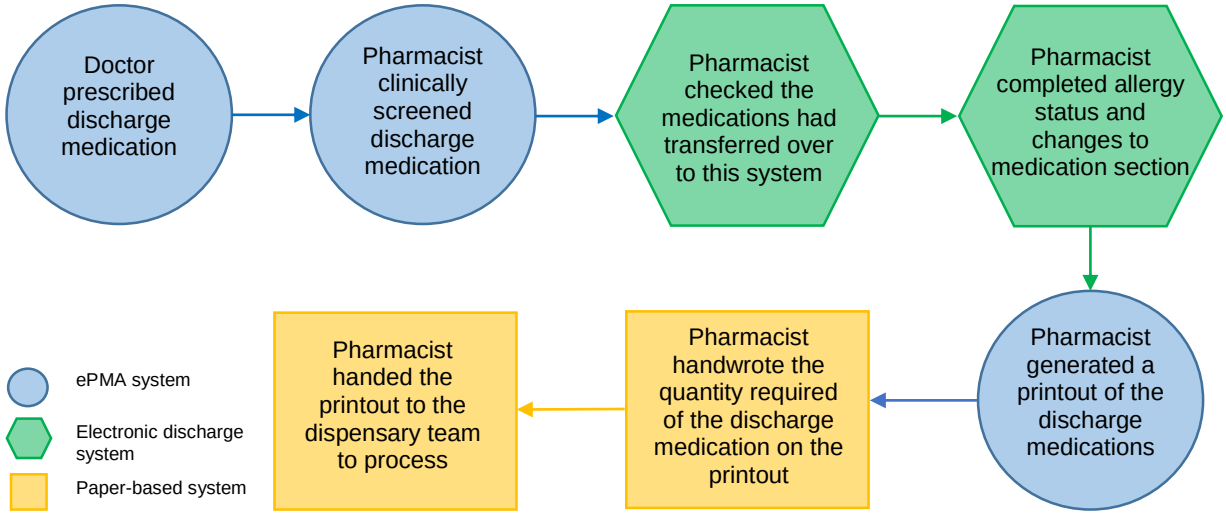

Figure 5: The process of screening a discharge prescription at site 2

At sites 1 and 3, the hospitals did not have a 'pre-11 discharge' initiative. The ward pharmacists were informed of discharge prescriptions by a doctor or nurse on the ward. The pharmacists were able to check the electronic discharge list to identify any patients being discharged. The discharges could be screened in one electronic system. Pharmacists at site 3 used the paper medication chart to review the medication against the electronic discharge prescription.

5.3 The prescribing systems

5.3.1 The ePMA system at site 1

The ePMA system at site 1 was a commercially available system originating from the United States of America called Cerner. Electronic medical records (EMR) and ePMA were rolled out within the organisation in a phased approach that began in March 2015. ePMA was first piloted on two wards at one of the hospitals (gynaecology and elderly care) in 2015. Following successful implementation and optimisation, it was then rolled out to all inpatient clinical areas across the trust except the intensive care units, that used another commercial ePMA system in place prior to the rollout and was still in use at the

time of the studies. In 2017, the trust was recognised as a leader in the adoption of digital technologies to improve patient care by being selected by NHS England as a global digital exemplar site.

The ward pharmacists were able to access the ePMA and EMR using an NHS smartcard. Most of the trust computers had the ePMA/EMR system installed. The ward pharmacist would usually log into the system from a computer in the pharmacy office or a computer on the ward. On the wards there were fixed computer terminals and computer on wheels (COWs), usually located at the nurses' station and doctors' office. Once the pharmacist located a computer and logged in, the pharmacist was able to click into different patient records to access their medical notes, observations, blood results and medication chart. The inpatient ePMA system required the clinicians to prescribe medications, the pharmacists to screen the medications and the nurses to administer the medications. These tasks were completed on different tabs within the ePMA system. The ePMA system included a pharmacy dashboard that pharmacists used to view all of the patients admitted to the ward. It was possible to check the dashboard for newly admitted patients and those who were started on new medicines as they were highlighted with icons on the dashboard. Figure 6 presents a simplified version of the dashboard that the ward pharmacists utilised to initially review patients on their ward. The patients were listed in order of their bays e.g. Bay A, bed 1, Bay A, bed 2.

Patient name, age, gender date of birth, hospital number	Patient location	Length of stay, estimated discharge date	Icon to indicate if patient's allergies have been recorded	Icon to indicate if patient's medication history has been completed by pharmacy	Patient demographics i.e. weight & height	Patient's creatinine level	Icon to indicate if patient's venous thromboprophylaxis assessment has been completed	Unverified medication orders	Pharmacy notes

Figure 6: Pharmacy dashboard at site 1

As Figure 6 shows, the ward pharmacists were able to access patients' records and were able to view the basic information about every patient from the dashboard. Pharmacists were also able to view every patients' blood results, clinical observations and medical notes.

Pharmacists and prescribers used the medication orders tab within a patient's record to prescribe and review medications. This page listed the medication the patients had been prescribed during their inpatient stay. Along with the patients' medication history, pharmacists were able to document handovers or notes for other pharmacists or pharmacy technicians under the 'medication history' section that appeared under the active inpatient medications on the medication orders tab. If the pharmacist was required to screen a medication for a patient, this was indicated by a distinct pestle and mortar icon displayed next to the medication order. The pharmacist had to open another program within the system in order to screen these medications. Within this program, the pharmacist would then need to select an 'accept' action from a drop-down menu next to the medication they would like to screen and then click verify to screen it. Once the medication was screened, the pestle and mortar icon was removed. The ePMA system at site 1 had limited clinical decision support (CDS) at the time of the study. CDS has been defined as 'a software that is designed to be a direct aid to clinical decision-making, in which the characteristics of an individual patient are matched to a computerised clinical knowledge base and patient-specific assessments or recommendations are then presented to the clinician or the patient for a decision' (Sim et al., 2001). The ePMA system was able to alert prescribers and pharmacists when a patient had an allergy to a prescribed medication. If medication was not available on the ward as ward stock, it was the pharmacist's responsibility to order an adequate supply from the inpatient pharmacy. At site 1, the nurses notified pharmacists of these medications in the communication diary. The pharmacist then transcribed a handwritten medication order on a standardised form and endorse the supply next to the prescription on the ePMA system under the 'pharmacy supply' section. There was also a section with each medication prescribed for the pharmacist to add administration instructions to inform nurses at the time of giving patients their medication. The transcription sheet, at the time of the study, was on paper and was faxed or physically taken to the inpatient pharmacy.

If the pharmacist was required to screen a patient prescription for discharge, the pharmacist was able to access this list from the discharge tab within the ePMA system. Once the pharmacist had reconciled and screened all the medication on the discharge prescription, they may choose to return the prescription to the ward, if no medications were required from the pharmacy, or send the prescription to the pharmacy to be dispensed. This step was completed electronically.

Paper prescriptions were still in use to prescribe parenteral nutrition and a 'dummy' prescription was prescribed on the ePMA system to direct HCPs to this paper prescription. The ePMA system was not connected to the pharmacy dispensing system used at the trust at the time of the study.

5.3.2 The ePMA system at site 2

The ePMA system at site 2, JAC, was a commercially available system with a large installed base of ePMA and medicines management systems in UK hospitals. The ePMA system was an integrated electronic prescribing, medication administration and pharmacy system linked to the hospital patient information management system and was intended to replicate the paper process. The ePMA system was rolled out within the organisation in a phased approach that began in 2013. It was piloted on a cardiology ward and rolled out to other wards one at a time. The ePMA system was then rolled out to all inpatient clinical areas across the hospital except the neonatal intensive care unit, day treatment centre and accident and emergency as they used paper medication charts in these areas. These areas used paper medication charts at the time of the studies and were not observed. The medical notes at this site were still on paper during the studies. The medical notes were handwritten and placed in a locked cabinet in the doctors' office on each ward. Site 2 was selected by NHS England to partner with a GDE site in order to accelerate their digital maturity in 2017.

Similar to site 1's system, ward pharmacists were able to access the ePMA system using a fixed computer terminal or a COW, on or away from the ward. Similar to site 1, the pharmacist would need to find a computer or COW on the ward in order to carry out their

ward duties. To access the ePMA system, the pharmacist was required to log in with their personal username and password. Once logged in, pharmacists had access to patients' inpatient prescriptions, dispensing records and discharge medications. If a pharmacist wanted to access a patient's blood results, these would be accessible through a different programme that required a separate username and password. Similarly, patient observations and discharge letters could only be accessed through separate programmes with different usernames and passwords. In order for pharmacists to clinically screen medication for a particular patient, they would need to access the 'prescriber order entry' tab within the ePMA system, select the medication they wanted to clinically screen and click 'verify'. This would change the colour of that particular medication from blue to white. When a medication was required by a patient that was not available on the ward from the stock, the pharmacist or pharmacy technician (if the medication had been clinically screened) was able to request these through the ePMA system and print out an electronic order request for the inpatient medication items. This was usually carried out by the ward technician, but on occasions that the medication needed to be clinically checked before being ordered, the pharmacist completed these steps. The order was then printed and handed to the inpatient pharmacy to be dispensed by the ward technician.

Paper medication charts were used on all wards for oxygen prescriptions, parenteral nutrition, variable rate intravenous infusions, intravenous fluids, variable rate insulin and warfarin. As noted above, the prescribers were responsible for creating a 'dummy' prescription on the ePMA system in order to make other HCPs aware of the paper prescription.

5.3.3 The medication chart at site 3

The paper medication chart at site 3 had recently been updated at the time of study. The latest revision of the medication chart was created in January 2019 and was rolled out in March 2019. Ward managers were also advised, through a memo, on how to obtain a supply of the new medication charts. The medication chart could be used for 14 days. If

a patient had been admitted for more than 14 days and still required regular medication to be administered, a new medication chart was written by the doctors. A copy of the medication chart can be found in appendix E.

The paper medication chart was structured as follows:

- Front page – once only drugs, patient details; height, weight, admission date
- Page 2 – Drug history page, 'pharmacy section'
- Page 3 – Venous thromboembolism (VTE) risk assessment
- Page 4 – Anticoagulant prescriptions including; low molecular weight heparin, mechanical thromboprophylaxis, fondaparinux for acute coronary syndrome (ACS), variable prescription for warfarin and direct oral anticoagulants
- Page 5 – Variable rate continuous intravenous insulin infusion and regular subcutaneous insulin prescriptions
- Page 6 - Regular subcutaneous insulin prescriptions and Methicillin-resistant Staphylococcus aureus (MRSA) colonisation reduction prescription
- Page 7 – Antimicrobial therapy prescriptions, there were spaces on the chart to start an 'Initial Antimicrobial Prescription'. This prescription must be categorised as possible diagnosis of infection or probable diagnosis of infection.
- Page 8-11 – regular medication prescriptions, oxygen prescription
- Page 12-13 – when required prescriptions
- Page 14 – Codes for drugs prescribed but not administered
- Page 15 – Variable rate infusion prescriptions
- Page 16 – Intravenous (IV) and subcutaneous (SC) infusion therapies

Pharmacists documented and annotated the medication charts with a green coloured pen (it is common practice for pharmacists to use this colour pen in the UK). They annotate the medication charts with supply endorsements, administration instructions and amending prescriptions. The pharmacists are expected to write in black pen if documenting in the medical notes as was the expectation from all other HCPs. If medication was required for a patient that was not stock on the ward, the pharmacists at site 3 made a written request on a standardised form (transcription sheet) and endorsed the paper medication charts with the quantity supplied. The organisation at the time of the studies, were in the process of requesting tenders from ePMA system suppliers.

5.4 Clinical pharmacists

The information regarding pharmacists' typical day on the ward was gathered through the observations with different pharmacists and detailed discussions with senior clinical pharmacists at the study sites.

5.4.1 A typical ward pharmacist's day at site 1

At site 1, the ward pharmacist usually started work at 9am. If the pharmacist was band 7 or above, they usually had a desk in the pharmacy department, with a computer. They would be able to log into this computer to check their emails and print the ward handover. The pharmacist could also log into the ePMA system using the password-protected NHS smartcard to gain an overview of how many new patients had been admitted to their ward and any new medication prescribed since their last review. The pharmacist could review the patients on their ward on the pharmacy dashboard page of the ePMA system.

When the pharmacist made their way to their ward, they would usually be expected to seek the nurse in charge to find out if any patients were being discharged that day. They would also locate the ward's nurse-pharmacist communication diary (usually in the medication room on the ward). The diary contained medication orders for patients on the ward written by the nurse looking after them. The pharmacist would write the medications required from the diary, details of any patients going home as per the nurse in charge and who the new patients were on the ward onto their ward handover sheet that was printed earlier. The medication orders were written onto a paper transcription sheet to be dispensed by the inpatient pharmacy later. The ward pharmacist who worked on their own (without a ward-based technician), usually prioritised the discharges, any new medication not available as stock on the ward, completed medication histories and medication reconciliations for new patients and then followed up on any queries. The pharmacists who had a ward technician supporting them usually did not have to complete the ordering of medication and patient medication histories. The technician would verbally handover to the pharmacist when they completed these tasks. It was noted that

the pharmacists who had ward technicians had time to focus on outstanding medication queries and clinical screening.

5.4.2 A typical ward pharmacist's day at site 2

At site 2, the ward pharmacist usually started work at 9am. A pharmacy technician was allocated to most wards and some technicians started their day at 8am. The pharmacist would meet the technician face-to-face, on the ward or in the pharmacy department, or call them to obtain a handover. The pharmacy technician notified the pharmacist of any 'pre-11' discharges, new patients and of any new medication orders that required a clinical screen by the pharmacist. The pharmacy technician's role was to regularly communicate information from the nurse in charge and patients to the ward pharmacist. The ePMA system at site 2 did not have an electronic pharmacist dashboard like site 1 at the time of the study and it was not possible to gain an overview on who the new patients were admitted to the ward since the last time the pharmacist was on the ward. Pharmacists used a paper handover from the previous day and compared it to the new list to assess who the new patients were. The ward technician verbally informed the pharmacist of any new patients as they usually reviewed the handover before the pharmacist would reach the ward. The pharmacists used the printed list of patients on paper to document their outstanding tasks and any handover notes from the technician.

Pharmacists were able to access ePMA system from the pharmacy department before visiting the ward. Similar to site 1, the pharmacist would make their way to their ward and usually be expected to seek the nurse in charge to find out if any patients were being discharged that day. The pharmacists were able to use a COW or fixed computer terminal on the ward to carry out their work. All the wards had a communication diary for nurses to write their medication order requests for the pharmacist. It was the role of the ward technician to follow up on the medication orders and the pharmacists' responsibility to ensure all the medications had been ordered and reviewed by them if necessary. The ward technician informed the pharmacist of any medication that needed to be clinically screened and then ordered but often the technician ordered the screened medicines.

Pharmacists prioritised patient discharges, reviewed patients new to the ward and dealt with clinical queries raised by doctors and nurses during their time on the ward.

5.4.3 A typical ward pharmacist's day at site 3

All the pharmacists were expected to attend a daily clinical pharmacy meeting in the morning at 9am. At the meeting, the senior pharmacists notified staff regarding any staffing updates, information dissemination and any notifications for teams. After this meeting, all ward pharmacists would go directly to their ward to start their clinical work. When the pharmacist arrived on the ward, they looked to collect a ward handover sheet with a list of patients admitted on the ward and compared the list to their last handover or look at the date of admission to assess how many new patients they had to see. Following this, they would look at the ward diary and annotate their handover sheet with any medication orders requested by the nurses for particular patients. Some wards had pharmacy technicians to support the pharmacists with medication history taking, patient counselling and medication ordering. The technicians were often on the ward for a limited time and would handover verbally the tasks that they had completed and that were still outstanding to the ward pharmacist. Similar to the other sites, pharmacists would liaise with the nurse in charge on the ward to discuss any patients being discharged.

The ward pharmacists did not regularly use a computer during their ward visit. On occasion, they would check patients' blood results or the summary care record (SCR) to obtain a full medication history. The pharmacists entered the patient bays to collect the medication charts, located at the end of the patient's bed, and reviewed them while by the patient. For discharges, the pharmacists would take the paper medication charts to a computer terminal to review the electronic discharge medication. If inpatient medication supplies were required for patients on the ward, the pharmacists transcribed the order onto a transcription sheet and then faxed it over to the inpatient pharmacy dispensary.

The first stage in exploring the impact of ePMA systems on pharmacists' communication was to conduct qualitative work to gain an insight into their perceptions of ePMA systems' impact on their communication with their colleagues and other HCPs. This was

conducted through a series of focus groups with pharmacists and semi-structured interviews with doctor and nurses at the three study sites. This study will be described in the next chapter.

Chapter 6: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter- professional communication and electronic prescribing and medication administration systems in an in-patient setting: a focus group & interview study

6.1 Introduction

As discussed in previous chapters, the introduction of hospital inpatient ePMA systems is likely to have affected the way in which HCPs work. The biggest information repository in health care arguably lies in the people working in it, and the biggest information system is the web of conversations that link the actions of these individuals (Coiera, 2000). The existing literature is limited to the US setting, certain specialities and particular workflows; there is therefore a need to further study the impact of ePMA systems on HCPs' working practices in an inpatient setting and outside the US. Previous literature has highlighted the importance of effective communication in healthcare for continuity of care and patient safety (World Health Organization, 2017).

The systematic review described in chapter 3 identified communication among HCPs as a working practice affected by the introduction of ePMA systems. This chapter investigates the impact of ePMA systems on HCPs' intra- and inter-professional communication through a series of focus groups with pharmacists and semi-structured interviews with doctors and nurses. This study focused on pharmacists' communication in particular as they were identified as an under-researched group of HCPs, who play an integral role in the management of patient medication and its safety. Doctor and nurses were invited to take part in this study to incorporate their experiences and perspectives of ePMA and its impact on their communication with their ward pharmacists.

6.2 Aim and objectives

6.2.1 Aim

To explore hospital pharmacists', doctors' and nurses' perceptions of how ePMA systems have affected, or are expected to affect, the way they communicate with each other in an inpatient setting.

6.2.2 Objectives

There are six objectives:

1) To explore the methods that pharmacists, doctors and nurses report using to communicate within their teams and with each other;
2) To explore pharmacists', doctors' and nurses' awareness and perceived frequency of use of different communication methods;
3) To explore the perceived quality and accuracy of different communication methods;
4) To explore the perceived barriers and facilitators to communication using both ePMA and paper-based systems;
5) To explore how ePMA systems could be used to improve communication between HCPs;
6) To make recommendations for future practice and research.

6.3 Method

6.3.1 Study design

This was a qualitative study comprising focus groups and semi-structured interviews. Three NHS hospital trusts described in the previous chapter were invited to take part in this study. As described, two hospitals had an inpatient ePMA system that had been in place for at least two years, and one used paper-based prescribing (i.e. paper medication charts) at the time of the study.

Focus groups are a form of group interview in which the discussion is centred on a specific topic and facilitated by a moderator (Plummer, 2008a, Plummer, 2008b). These group discussions are commonly organised amongst participants with similar backgrounds and can help to gather a group's perceptions (Blandford et al., 2016). Focus

groups are particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way (Kitzinger, 1995). This method was chosen in order to obtain rich data to explore pharmacists' experiences and points of view on ePMA or paper-based systems and the impact on their working practices in a way that cannot be achieved through observations or questionnaires. Medical and nursing staff were invited to take part in semi-structured interviews to gain an insight into their experiences and perceptions of ePMA or paper-based systems and the effect on communication. Semi-structured interviews were the chosen method to collect data from doctors and nurses as initial discussions with the local coordinators suggested poor participant numbers for focus groups for these HCP groups.

Five to eight pharmacists were expected to attend each of the focus group sessions. Between three to four focus groups were planned to take place at each hospital trust. Participant numbers were consistent with recommendations in the literature (Plummer, 2008a, Plummer, 2008b). Five semi-structured interviews with doctors and five semi-structured interviews were aimed to be carried out at each participating hospital trust. The focus groups were expected to last between 45-60 minutes and the semi-structured interviews 30-45 minutes. The focus groups and semi-structured interviews were all conducted by the PhD student in a meeting room at the different participating hospital sites and refreshments were provided. All the focus groups and semi-structured interviews were recorded and later transcribed. The PhD student also took notes during the focus groups and interviews to highlight any important or interesting discussions. The planned number of participants were derived from previously published literature suggesting that theoretical saturation should be achieved with these numbers (Saunders et al., 2018).

6.3.2 Ethical approvals and considerations

This study was registered with UCL data protection team (UCL Data Protection Registration Number: Z6364106/2018/05/20 health research) and approved by UCL

Research Ethics Committee (Project ID number: 11927/001). Permission was obtained from the participating hospital trusts to access their sites for data collection through Health Research Authority (HRA) approval (IRAS project ID: 247707, Protocol number: 18/0293) with the support of the UCL Joint Research Office (see appendix F and appendix G). A local capacity and capability approval or letter of access was obtained from each of the participating sites.

The participants were provided with a participant information leaflet (appendix H) and asked to provide written consent (appendix I) prior to conducting the focus groups and semi-structured interviews.

All participants were informed that their participation was entirely voluntary. They were told that there would be no penalty or loss of benefits for choosing not to participate and were informed that they may also discontinue participation at any time without any consequences. However, they were advised that once they had attended the focus group, they would not be able to withdraw their data as it was not possible to identify their individual contributions in the audio recording. The participants who were invited to take part in the semi-structured interviews were informed that they were able to withdraw their data up to one week after the semi-structured interview took place. All participants were provided sufficient time to read through the participant information leaflet, given the opportunity to ask the PhD student any questions regarding the study and provided a signed consent form before taking part in the study.

6.3.3 Data handling and management

General demographic data were collected from all participants (i.e. occupation, years in practice) during the focus groups and interviews. Their names were documented on their signed consent forms but their names were not shared or used in any reports or in this thesis. The audio recordings were recorded digitally on a UCL School of Pharmacy audio recorder and then transferred onto a password protected UCL computer. Some recordings were transcribed by the PhD student, but the majority were transcribed by a UCL approved transcribing service. UCL acted as the data controller for this study. All

the transcriptions and quotes used were anonymised so the information could not be traced back to an individual. Paper-based information/data from the study (e.g. consent forms) were stored in a locked cabinet within UCL. All data were stored in accordance with the General Data Protection Regulation (GDPR) and any information stored on the computer was password protected and could only be accessed by the research team. The analysis of the data was carried out by the PhD student and reviewed periodically by their academic supervisors.

6.3.4 Population, recruitment and setting

A senior member of the pharmacy clinical services team/research department at each of the participating hospital trusts was contacted and asked if they would be willing to be a local co-ordinator. The PhD student liaised through the local co-ordinator to recruit participants. The local co-ordinator sent an email to pharmacists, medical and nursing staff inviting them to take part in this study. The participants were selected by convenience and snowball sampling (Blandford et al., 2016). The local coordinators emailed participants who were most accessible to them. The participants were then encouraged by the local coordinator to speak to colleagues who may also be interested in taking part. The participants were asked to email the PhD student directly if they were interested in taking part and were provided up to two weeks to respond. If potential participants did not respond in this time, it was assumed that they did not want to participate. The respondents were then emailed the information leaflet and consent form to familiarise themselves before attending a focus group or semi-structured interview. The participants were required only to attend one; focus group or semi-structured interview. A meeting room within the participating hospitals was booked during normal working hours (such as during participants' lunch time) and an invitation sent to the participants to attend with the details of time and location.

6.3.5 Inclusion and exclusion criteria

Participants between 18-75 years were invited to take part in this study. All pharmacists, band 6 and above, of all specialities, employed at the participating trusts were invited to

take part in the focus groups. Doctors (of all grades and specialities) and nurses (band 5 and above) were invited to take part in the semi-structured interviews.

Other HCPs such as dieticians, physiotherapists and occupational therapists were excluded as they do not regularly engage with the ePMA system/paper medication charts. Pharmacy technicians, assistants and pre-registration pharmacists were also excluded from this study. The focus of this study was on the communication pharmacists had with doctors, nurses and other pharmacists.

6.3.6 Pilot focus group and semi-structured interview

A pilot focus group was organised by the PhD student and attended by four pharmacists and a pilot semi-structured interview was conducted with a medical doctor. All of these participants were conducting research at UCL School of Pharmacy. The pilot focus group and semi-structured interview were conducted prior to starting the study, to ensure clarity and suitability of the topic guides. The pharmacists were emailed the participant information leaflet and consent form before attending the pilot focus group. The PhD student piloted the questions to the group and at the end of the session, the pharmacists were asked to provide their feedback on the focus group and documents. No changes were suggested. Similarly, the participant information leaflet and consent form were emailed to the doctor before the interview. The PhD student piloted the questions with the doctor and at the end of the interview the doctor was asked to provide their feedback on the interview and documents. No changes were suggested.

6.3.7 Focus group and interview procedure

The questions the participants were asked during the focus groups and semi-structured interviews were broadly based on the following:

1. General demographic information;
2. Methods currently available to communicate information to pharmacists, doctors and nurses;
3. Type of information exchanged with pharmacists, doctors and nurses;
4. The future/redesigning of the ePMA system

5. Perceived advantages and disadvantages of using ePMA systems to communicate information

Topic guides were used during the focus groups (appendix J) and semi-structured interviews (appendix K) to facilitate the discussions.

6.3.8 Resources and topic guides

The following resources were made available on the day of the organised focus groups/semi-structured interviews:

- Consent forms
- Participant information leaflets
- Focus group/semi-structured topic guide (for the PhD student only)
- Two audio recorders
- Pink and blue self-adhesive notes
- Pens
- Refreshments

6.4 Data analysis

All of the audio recordings from the focus groups and semi-structured interviews were anonymised by the PhD student. Transcripts were read and coded by the PhD student using a general thematic coding methodology (Braun and Clarke, 2006). An inductive approach was used to analyse the data. The qualitative analysis was facilitated by the use of NVivo 12 Pro (version 12.2.0) software. The transcripts were initially coded line-by-line with codes grouped into similar themes to produce the preliminary themes. The coding, categorising and identification of emergent themes were processed manually in an iterative approach. Similarities among the data were organised and annotated in a Microsoft Excel spreadsheet. The PhD student's academic supervisors oversaw each stage of the analysis and provided feedback on coding and analysis. Any discrepancies were resolved by a consensus.

6.5 Results

6.5.1 Participant demographics

Fifty-eight pharmacists took part in nine focus groups, three per hospital trust, between September and October 2018. All of the pharmacists at the two ePMA sites had some experience with paper-based systems prior to the current ePMA. The focus groups lasted between 39-63 minutes. Pharmacists' demographics can be seen in Table 9 and Table 10.

	Focus group	Pharmacist number	Years qualified	Agenda for change band	Gender	Speciality	Experience with electronic prescribing & medication administration
Site 1	1	1	3	7	F	Rotational	✓
		2	2	6	F	Resident	✓
		3	2	6	F	Resident	✓
		4	2	6	F	Resident	✓
		5	>10	8a	F	Specialist medicines	✓
		6	6	8a	M	Gastroenterology	✓
		7	24	8b	F	Neurosciences	✓
		8	2	6	F	Resident	✓
	2	9	15	8b	M	General manager	✓
		10	>25	8b	F	Women and children's	✓
		11	4	7	M	Human Immunodeficiency Virus (HIV)	✓
		12	12	8a	F	HIV	✓
		13	2	7	F	High cost medications	✓
		14	7	8a	F	Women & children's	✓
		15	2	7	F	Admissions	✓
	3	16	3	7	F	Medicines optimisation	✓
		17	1	6	M	Resident	✓
		18	1	7	F	Renal	✓
		19	2	6	F	Resident	✓
		20	9	8a	F	Women & children's	✓

Table 9: Focus group pharmacists' characteristics at site 1

	Focus group	Pharmacist number	Years qualified	Agenda for change band	Gender	Speciality	Experience with electronic prescribing & medication administration
Site 2	1	1	3	7	F	Rotational	✓
		2	2	6	F	Rotational	✓
		3	3	8a	F	Electronic prescribing & medication administration (ePMA)	✓
		4	5	7	F	Rotational	✓
		5	19	8a	M	Respiratory	✓
		6	18	8b	F	Infectious diseases	✓
	2	7	>20	7	F	Medication safety	✓
		8	2	6	F	Rotational	✓
		9	4	6	F	Rotational	✓
		10	4	7	F	Rotational	✓
		11	1	6	F	Rotational	✓
		12	6	7	F	Women & children's	✓
	3	13	2	6	F	Rotational	✓
		14	1	6	M	Rotational	✓
		15	5	8a	M	Medicines information & formulary	✓
		16	16	8a	F	Women & children's	✓
		17	18	8a	F	Intensive care & surgery	✓
Site 3	1	1	8	8a	F	Rheumatology	✓
		2	5	7	F	Intensive care	×
		3	3	7	F	Gastroenterology	×
		4	14	8a	F	Care of the elderly	×
		5	3	7	M	Rotational	✓
		6	9	7	F	Medicines information	×
	2	7	6	8a	F	Acute emergency	×
		8	4	7	F	Acute medicine	✓
		9	6	7	F	Rotational	✓
		10		7	F	Rotational	×
		11		7	F	Rotational	×
		12	10	8b	F	Gastroenterology	✓
		13	7	8a	F	Inflammatory bowel disease	✓
		14	6	7	F	Gastroenterology	×
		15	8	8a	F	Nutrition & Intestinal failure	×
	3	16	2	7	M	Rotational	×
		17	2	7	F	Rotational	×
		18	12	8a	F	Cancer services + ePMA	✓
		19	20	8b	F	Cancer services + ePMA	✓
		20	8	8a	F	Emergency services	✓
		21	20	8b	F	Clinical services manager	×

Table 10: Focus group pharmacists' characteristics at site 2 and 3 (The cells in black indicate missing information)

Fourteen doctors and twelve nurses were recruited to take part in semi-structured interviews across the three participating hospitals trusts between September and November 2018. The majority of participants had experience working with both ePMA and paper based systems. Only one doctor at site 3 only had experience working with a paper based system. The interviews with the nurses and doctors lasted between 12-44 minutes and 16-53 minutes respectively. The doctors' (Table 11) and nurses' (Table 12) demographics can be found below. There were fewer doctors and nurses who participated at site 3 as the staff were preparing for an external inspection.

	Doctor number	Years qualified	Agenda for change band	Gender	Speciality	Experience with electronic prescribing & medication administration
Site 1	1	10	Consultant	M	Paediatrics general	✓
	2	8	Core trainee 6	F	Paediatrics general & Accident & Emergency	✓
	3	2	Core trainee 1	M	Internal medicine	✓
	4	2	Core trainee 1	M	General medicine & Geriatrics	✓
	5	4	Speciality trainee 1	M	Geriatrics	✓
Site 2	1	3	Speciality trainee 1	M	Care of the elderly	✓
	2	<1	Foundation year 1	M	Care of the elderly	✓
	3	<1	Foundation year 1	M	General surgery	✓
	4	<1	Foundation year 1	F	General surgery	✓
	5	4	Speciality trainee 2	F	Paediatrics	✓
Site 3	1	2	Foundation year 2	F	Microbiology	✓
	2	4	Speciality trainee 1	M	Breast surgery	✓
	3	3	Speciality trainee 1	M	Obstetrics & Gynaecology	×
	4	4	Speciality trainee 1	F	Paediatrics	✓

Table 11: Semi-structured interview doctors' characteristics at all three study sites

	Nurse number	Years qualified	Agenda for change band	Gender	Speciality	Experience with Electronic prescribing & medication administration
Site 1	1	3	6	F	Head & neck, maxillofacial surgery, Cardiology	✓
	2	21	7	F	Paediatrics	✓
	3	8	8a	F	Paediatrics	✓
	4	3	6	F	Emergency & research	✓
	5	9	7	F	Emergency & research	✓
Site 2	1	2	5	F	Paediatrics	✓
	2	4	5	F	Paediatrics	✓
	3	18	5	F	Cardiology	✓
	4	25	7	F	Orthopaedics	✓
	5	1	5	F	Cardiology	✓
Site 3	1	19	7	F	Ear, nose & throat, Plastics & wound care	✓
	2	17	7	F	Mental health	✓

Table 12: Semi-structured interview nurses' characteristics at all three study sites

6.5.2 Themes and codes

Five major themes were identified from the focus groups and semi-structured interviews. These were derived inductively during thematic analysis. Data analysis was conducted concurrently with the focus groups and semi-structured interviews and theoretical saturation was achieved. The themes and their subthemes are listed in Table 13.

	Theme	Subthemes	
1	**Modalities of communication**	Within professions	
		Across professions	
		With patients	
2	**Pharmacists' visibility**	Physical presence	
		Written communication	
3	**Human-Computer interactions**	Reliance on technology	
		Redefining job roles	
		Impact on knowledge	
		Access to information	
4	**System limitations**	Hardware	
		Software	Different screen views for different healthcare professionals
			Single user access
			Limitations of the electronic medication chart
5	**The future of electronic prescribing and medication administration systems**	Messaging centre	
		Alerts when changes made to prescriptions	
		Electronic medication requests	
		Read only feature	

Table 13: Themes and subthemes generated from the focus groups and semi-structured interviews

6.5.2.1: Theme one - Modalities of communication

The majority of HCPs expressed that they preferred and believed the most effective method of communication with their colleagues and other HCPs was face-to-face. Several reasons were provided to suggest why face-to-face was the preferred method of communication. These included: being able to communicate information quickly and clearly, the information is instantly received by others and HCPs are able to gauge their colleagues' understanding through their body language.

> *"…you can have a kind of two-way dialogue about something in a way that you can't with written communication to the same extent, for it's much slower to do that"* (Site 1, Doctor 2)
>
> *"…face-to-face, I think, is always preferred, because when you're having a conversation it might not just be exactly one point, or you might need some further clarification. And I think sometimes there can be some misunderstanding via*

email, for example…it's not always clear over the phone, whereas you can follow up with a few questions in the same conversation" (Site 1, Nurse 5)

"I think another benefit of face-to-face is you can read the body language. So yes, you know whether they're actually taking you seriously or not"

(Site 1, Focus group 1, Pharmacist 6)

"…immediate reassurance that the message has been communicated effectively and will be acted upon" (Site 1, Doctor 1)

Within professions

The doctors interviewed stated that the majority of their communication with other doctors was verbal, primarily face-to-face due to the nature of their work involving ward rounds and multidisciplinary team (MDT) meetings.

"The main one is face-to-face and we'll discuss a patient's case either opportunistically at the bedside or…in the office" (Site 1, Doctor 5)

Though face-to-face communication was the preferred method of communication by doctors, it was suggested that they also wrote in the medical notes for their colleagues to provide an audit trail and to summarise patients' progress.

"…the medical notes, we put everything in there. Literally everything. Everything is documented" (Site 3, Doctor 4)

"…writing in the medical notes whether that be paper or electronic, you're indirectly communicating with people by what you've written as your assessment and plan" (Site 1, Doctor 2)

A few doctors indicted that they often used Whatsapp (a messaging application) to communicate within their teams when their colleagues were not available face-to-face. The purpose of using Whatsapp was variable among the doctors as some stated they used it for logistical reasons, such as coordinating annual leave, while others suggested they used it to communicate queries regarding patients to their seniors.

"We've got a WhatsApp group which we mainly use for logistical things. So, if someone's going on leave, or if they are going somewhere else, that would be the main thing" (Site 1, Doctor 3)

"So if there's information, so for example if it's an image, if it's a CT [computerised tomography] scan and you want an opinion on that, because the radiology report hasn't come back for example, you can possibly take a photo just without any patient identifiers and send it [on Whatsapp] to your registrar or even consultant..." (Site 3, Doctor 3)

When further explored, the doctors explained that Whatsapp was beneficial for sending information, such as photographs and direct messages, over to their colleagues and this was perceived to reduce communication errors.

"…sometimes to be honest it just depends on what you or where you know that person is, for example if they're busy and you're in clinic, if they're [senior doctors] in theatre, it might be best for you to Whatsapp them than to bleep or call because Whatsapp means that when they come out they'll have all the information in front of them, there's no middle man who has to pass on the information so it reduces any errors of communication" (Site 3, Doctor 3)

Pharmacists also indicated that Whatsapp is used by specific pharmacy teams to coordinate their work.

"We have a Whatapp group with the admissions team because we've got quite a few different wards, so we just use Whatsapp to communicate."

(Site 1, Pharmacist 15, focus group 2)

Nurses suggested that their primary form of communication with other nurses was face-to-face. They also stated that they would also document issues and queries in the medical notes for other nurses to be aware of.

"That will be communicated face-to-face…Pretty much 90% of the time…"

(Site 1, Nurse 4)

This nurse was asked what they perceived the other 10% of the communication between nurses to comprise.

> *"Documentation…through [electronic medical notes] notes, or… [electronic prescribing and medication administration medication] chart, have they given any medication previously if patient's been there for a long period of time, what they documented, what's been done, if they're not available to talk"*
>
> (Site 1, Nurse 4)

Pharmacists in the focus groups across the different sites suggested a range of methods they use to communicate with other pharmacists. The most common forms of communication were verbal and electronic via emails.

> *Pharmacist 18:* *"So it was verbal, face-to-face handover"*
>
> *Pharmacist 16:* *"Email, as well, if you're not on the same site"*
>
> (Site 1, Focus group 3)

The pharmacists at site 3 revealed that although they did not have ePMA, they had access to an electronic system, used for patient discharges, to write handovers to other pharmacists and to review them.

> *"…we have an [electronic discharge] system, so it's that kind of electronic handover, and on that, we can write down exactly what's happening with the patient, and then so if another pharmacist was covering, that information is on there"* (Site 3, Pharmacist 4, focus group 1)

Across professions

Doctors and pharmacists across the sites stated that they communicated information to nurses verbally. Some pharmacists also suggested that they may leave written information on the medication chart, paper and/or electronic, to help nurses with administration of medications.

"It would be exclusively face-to-face or written, or if I'm on another ward, then I might pick up the phone" (Site 1, Doctor 3)

"…usually face-to-face. They're usually at the bedside" (Site 3, Doctor 1)

"…documenting how they crush, or whatever, or often antibiotics. There are certain things that need to be given after a dialysis. Those kind of hints and tips I'll put on the drug charts, so it flags up to them"

(Site 1, Focus group 3, Pharmacist 18)

Nurses across the sites similarly reported that their main method of communication with doctors was verbal as they would have opportunities to discuss patient-related queries on ward rounds.

"Mainly phone calls, or face-to-face. We mainly talk about it in ward rounds. We have multiple ward rounds a day. You either get the handover and you let the doctor know in the morning if anything needs… Let the doctor or whoever know what needs to be prescribed. If anything changes, you call them, or they are around on the ward or at the second handover you do the same thing again"

(Site 1, Nurse 1)

A nurse at site 2 also suggested that doctors are able to make changes to prescriptions away from the ward by accessing the ePMA system remotely.

"…it's mainly face-to-face or over the phone. If they're not on the ward they can change it [the prescription] anyway" (Site 2, Nurse 1)

Some nurses who used the ePMA system highlighted that often doctors did not inform them when a new medication is prescribed or changed.

"*I do find…that drugs appear on [ePMA system] and they're [nurses] not told…we don't know the drug is on there unless they [prescriber] tell somebody. Even though it's a good system, if you don't tell us it's on there we won't know unless we check"* (Site 1, Nurse 5)

Nurses across all three sites stated that they commonly communicated with pharmacists over the phone or face-to-face. One of the nurses at site 1 explained how it is more challenging to get in touch with a pharmacist on a weekend.

> *"…Monday to Friday its face-to-face because they are around on the wards and they also carry a bleep system which we would bleep them if we have any issues…And then the weekend is really difficult in that the medications, it would be the on-call system, trying to get through to main pharmacy, up and down to pharmacy trying to get stuff, stock or TTAs [to take away prescriptions] for [discharge medication], so it is more difficult at the weekends"* (Site 1, Nurse 2)

Nurses also explained that they communicated medication orders with pharmacists through a pharmacy communication diary. This was a common practice across the three sites in the study.

> *"…we'll have a pharmacy book as well, and you write whatever it is required for the pharmacist and then when the pharmacist get to the ward, [because] we have limited pharmacy time…they will check and then sign the drug chart"*
>
> (Site 3, Nurse 1)

Pharmacists explained how they regularly communicated with doctors verbally, often face-to-face, if available on the ward, or over the phone. Some pharmacists also stated that they would sometimes document important or lengthy information, following a verbal discussion, in the medical notes.

> *Pharmacist 21: "Verbal… face-to-face"*
>
> *Pharmacist 16: "If they're on the ward, face-to-face"*
>
> *Pharmacist 18: "Mainly face-to-face, if you want anything to get done"*
>
> (Site 2, Focus group 3)
>
> *"I think it also depends on how much you're handing over, so if the patient has loads of issues with them, they'll [pharmacists] just tend to write structured notes*

because if you say it to them [doctors] over the phone, they tend to forget half of what you've said. At least there if you've written it in a note your back's covered"

(Site 1, Focus group 1, Pharmacist 2)

Some doctors were also aware of pharmacists documenting in the paper medical notes or on the paper medication charts at site 3.

"Pharmacists as well will sometimes document in the medical notes as well in green pen, if there were any changes which need to be made…but they will usually write changes in the drug chart, so at the front of the drug chart, any medications which need to be prescribed and then they'll make amendments inside the drug chart for any medications which have been prescribed that haven't been prescribed appropriately" (Site 3, Doctor 3)

Pharmacists at site 3, who use paper medical notes and medication charts, expressed their concerns on the potential impact of ePMA systems on their relationships with other HCPs. They perceived ePMA systems to reduce their face-to-face communication with each other and other HCPs.

"…you'd have less face-to-face relationship with your team and nurses and the doctors if everything's electronic. It's kind of like, oh I've seen so-and-sos name like 50 times, but I don't actually know who that is, so you lose that sort of bond with your colleagues on the ward if everything's electronic"

(Site 3, Focus group 1, Pharmacist 3)

With patients

Doctors highlighted that having access to the medication chart remotely, through ePMA systems, could lead to reduced face-to-face time with patients.

"…if you're doing it [prescribing] remotely, there's a problem of not having to go to the patient's bedside to get the drug chart. It means you don't actually look at the patient, and there's a lot of information that you can get just from seeing them at the end of the bed. Perhaps the patient has a less of an opportunity to

ask questions about particular medication, as well, because when I'm going to pick up a medication, I might say, I'm just changing this. So, I might be less inclined to communicate our plans to the patient, as well." (Site 1, Doctor 4)

Pharmacists also perceived themselves to have reduced patient contact when using ePMA.

Pharmacist 7: "…I mean you don't go around to see patients anymore."

Pharmacist 1: "That's true"

Pharmacist 6: "It isolates, yes."

Pharmacist 7: "And when I... Basic training 24 years ago that I had was that you need to go and look at the patient and see if they have a catheter bag or a trache[ostomy] or an IV [intravenous] line or a NG [nasogastric] tube and we don't do that so if we're also not going and talking to our junior doctors, sitting down here and writing notes, then I think it becomes more of a problem."

(Site 1, Focus group 1)

The pharmacists at the paper-based site also perceived that the introduction of an ePMA system could reduce the pharmacists' interaction with patients.

"…Less patient facing because we're going to be stuck on a computer, trying to add our bits and pieces" (Site 3, Focus group 2, Pharmacist 9)

6.5.2.2: Theme two - Pharmacists' visibility

Physical presence

As pharmacists at the ePMA sites were able to access patient records, including medication charts, away from the ward, their presence on the wards appeared to have reduced. Remote clinical screening and contacting prescribers over the phone had instead increased according to both doctors and pharmacists. Participants at all the sites were concerned about the impact of this on patient care.

"Often the pharmacist is doing their stuff on the patient's record remotely, and, in terms of tips about a prescription…they're less available if they're not on the ward, so I'd then have to phone them up or send them a bleep, which I do often do if I…can't find out the answer from the BNF [British National Formulary] or some other reference." (Site 1, Doctor 4)

"I do notice a lot of people doing their ward from their desk, which I really dislike and I think it has been fed back on some wards that people don't even know that a pharmacist's there, or who their pharmacist is anymore"

(Site 1, Focus group 2, Pharmacist 12)

"You don't need to physically leave your chair. That is the biggest disadvantage, because everything's available on the screen, you don't have to look at anything or anyone" (Site 3, Focus group 3, Pharmacist 18)

Though doctors at site 1 explained they preferred face-to-face communication with pharmacists, they also suggested that their communication with pharmacists had changed since the implementation of ePMA. They believed that they saw less of their ward pharmacists so had to resort to telephoning them. Furthermore, a doctor explained that they felt their questions needed to be specific for the pharmacist rather than opportunistic as they were not always on the ward. The doctors believed the types of queries they would discuss with the pharmacist had also changed.

"Face-to-face used to be the most common thing with paper-based system. So, your pharmacist would typically be on the ward checking the paper drug charts, and you could say, 'by the way, I don't know about this thing' and just informally check things because you'd know who they were, and you'd see them on a daily basis. I think, from places I've worked where they have the electronic prescribing systems, the physical presence of the pharmacist is less because they can check the charts remotely. So, then I'd bleep them if I had a specific query"

(Site 1, Doctor 2)

Written communication

Doctors at the two ePMA sites believed that pharmacists' written communication reduced, since the introduction of ePMA, and perceived that pharmacists use other forms of communication such as bleep to provide their recommendations. They also highlighted that there was no longer any green writing that was traditionally used by pharmacists to annotate paper medication charts.

> *"The thing that's lost is the written communication. You would write on a drug chart, and you would write lots of things, and then the next day you would go, and you would check that drug chart, and some things would be changed in green pen. And it's those little things that are lost because now you only really get told about the things that are worth saving up for the whole week or worth taking the time to call you. So, it's only the big things that you hear about. All the little things that were wrong with your prescriptions you don't hear about."*
>
> (Site 1, Doctor 1)

> *"It might be better for them to just bleep us, or get in contact with us, so we know that they've done something, or they want something. Which is what happens now, I don't think they write too much in the notes"* (Site 2, Doctor 3)

> *"…so they will write in green pen, so a different coloured pen. Normally it's green actually and that way it's obvious what changes they're recommending, and it's up to you whether or not you implement them or whether or not you start the medications that they're asking you to start"* (Site 3, Doctor 3)

6.5.2.3: Theme three - Human-computer interactions

Reliance on technology

Some doctors and pharmacists felt that using an ePMA system could lead to overdependence on the technology. These doctors suggested that reliance on technology could lead to errors and loss of situational awareness.

"…[there is a] certain level of trust that people have in an electronic system that they assume because it's on the computer, that it will be right. And they assume that there's a lot more by-way-of-safety mechanisms built in in terms of checking their prescriptions than there is, necessarily. That can be quite a dangerous false reassurance in terms of the level of sophistication" (Site 1, Doctor 2)

"sometimes it can slightly disengage your brain, having everything almost automated. It requires a different kind of attention to paper charts"

(Site 1, Doctor 3)

" I find that sometimes that writing things out makes my brain work in that sense, where it makes my brain work, and you go, oh…I haven't checked the renal function. Whereas when you're electronic you just almost lose a bit of that."

(Site 3, Focus group 1, Pharmacist 2)

However, doctors who had previous experience working with ePMA systems and now worked with paper suggested that they would still discuss queries with pharmacists even with the online resources available through the ePMA system.

"I definitely still do go to the pharmacist because electronic prescribing helps with prescribing and being safe at prescribing whilst there's the pharmacists…I would still always double check just for further advice on things" (Site 3, Doctor 1)

Some doctors and nurses at sites 1 and 2 believed that the ePMA system improved their knowledge with regards to medication doses and rationale of choice.

"I think it improves knowledge…I think there are lots of medications that have the doses written in already. All that means is that I'm seeing that dose and then, so when I'm having to write it down, I remember it better, because there's a much better recall…I think spelling, because you are seeing it more often, and you will only see it spelt correctly…So that I think is actually better in terms of knowledge building. I feel where doses are there, it also improves knowledge"

(Site 1, Doctor 3)

"It's almost like a memory trigger, which I found really helpful initially when I was not familiar with pretty much any dose" (Site 2, Doctor 4)

"It's really good because actually when you open [ePMA system] and someone put the notes exactly the rationale why the medication was not given or why it was delayed and then you can take from this point" (Site 2, Nurse 5)

In contrast, some doctors and pharmacists believed that the ePMA system de-skilled prescribers.

"A system over time, over time sort of de-skills prescribers in a certain way" (Site 2, Focus group 3, Pharmacist 16)

Shift in responsibility

A doctor at site 1 with experience working in a paper-based environment provided an insight into the difference between the responsibilities of doctors and pharmacists with maintaining the in-patient medication chart.

"I've come from a different trust where it's been paper prescribing…I found that the ownership was very much on the doctor to prescribe…I think having worked here now on an electronic system, as physicians, we're almost a bit more lax because we know that there's a pharmacist who has the autonomy, shall we say, to prescribe or to clean up our mess as it were. Anecdotally on a ward round, if VTE's [venous thromboembolism prophylaxis assessments] not done it's no problem because the pharmacist will just do it. Whereas and I think that's not the correct way of going about it" (Site 1, Doctor 5)

The pharmacists at site 1 also discussed the notion of shifts in responsibility regarding the medication chart. The pharmacists felt that the doctors were not able to competently complete tasks on the ePMA system such as the medication prescribing on the discharge letters. The pharmacists therefore had taken on the role of prescribing discharge medications in order to support the doctors. Pharmacists also discussed that it was unclear how much of the prescribing responsibilities they should take on.

"It's almost like we try and steer them away from messing about with our nice drug history, and have we rightly or wrongly taken on that role, that, yes we are going to be helping them fill in all these details of why there are changes to then help the TTA ["to take away" – discharge letter & medications]. Then actually when the TTA is done we perhaps have more ownership"

(Site 1, Focus group 2, Pharmacist 10)

Access to information

All the HCPs felt that an ePMA system was able to provide them with more information and they were able to document more details regarding their patients. The HCPs at the paper-based site also felt that ePMA systems would allow access to more information in order to make informed decisions about patient care. At the ePMA sites, it was suggested that having remote access to the ePMA system allowed for better communication with colleagues and other HCPs.

"Instead of just saying…'patient refused', you can actually write on the [electronic] drug chart which is at the most relevant place, why the patient refused...You can include so much more detail about that, so from that point of view it allows doctors to have a much more patient-centred conversation about their medication, if they are refusing or if they don't like it or are having difficulty with it. It allows nurses to understand much better about administration. So, if there is a complex administration, or if there are complex indications for medication"

(Site 1, Doctor 3)

"And when you stop medications, they'll ask reasons for stopping and things like that so, it gives you a lot of information. When you're doing discharge summaries, you have no idea why medications are started or stopped and you sometimes end up making assumptions. So, in that sense, it's quite good"

(Site 3, Doctor 2)

"The same thing goes for the example we gave of the nurses' administration of antibiotics. If you're saying this over the phone no one is going to retain that information, but if you write it on a note on [the ePMA system] they can easily go back and check it out as many times as they want"

(Site 2, Focus group 1, Pharmacist 1)

6.5.2.4: Theme four - System limitations

Hardware

The main limitation the pharmacists perceived at the paper-based site of using ePMA systems relating to the hardware was the lack of computers available in patient areas. If there was a lack of computers, pharmacists were unable to carry out their work on the wards and may have to resort to working away from the ward.

"…finding computers that are working and have the [ePMA system] available. Because… if the doctors are trying to access it, the nurses are trying to get it, the pharmacists are trying to get on it, there's going to be a lot of people trying to…use all of those computers" (Site 3, Focus group 2, Pharmacist 14)

"I also think if we're using electronic prescribing systems dependent on us having access to a computer all the time, and that might not be the case all the time. If you're on the ward for example…you might have computers on wheels, so we don't have access straight away." (Site 1, Focus group 2, Pharmacist 14)

Software

A number of issues were highlighted by HCPs who use ePMA systems related to its functionality and poor interface design. The subthemes identified by the different HCPs suggest poor ePMA interface design and potential consequences on inter-professional communication. These are described in further subsections below.

1) Different screen views for different healthcare professionals

Doctor and pharmacists at all three sites expressed their frustrations regarding the different options to document information. They were concerned that other professions

would not be able to find the information they document on the ePMA system. One doctor stated that it was challenging to deal with queries from nurses regarding medication administration as the doctor was not familiar with the screen layout the nurses regularly used.

> *"I also am aware that the nurses look at a different screen than what I use often. They're at the drug admin page or something rather than drug admin summary…so I'm not familiar with…the view that they use. So, if they're ever asking me about…a question and showing me the screen, I will ask them to flick the screen to my view so I can understand what they're talking about. So, then, we're not even singing off the same hymn sheet"* (Site 1, Doctor 4)
>
> *Pharmacist 2: "…there's not much consistency in terms of where you document things so for example I could document something different to what [pharmacist A] can or [pharmacist B] can and I think it's easier to miss, whereas on paper it's documented in one place if that makes sense"*
>
> *Pharmacist 3: "…everyone has different views so somewhere I might write, the doctors might not see or the nurses might not see it which is a bit annoying"*
>
> (Site 1, Focus group 1)
>
> "I feel like you have to look at different screens to get the same picture."
>
> (Site 1, Focus group 3, Pharmacist 16)

2) <u>Single user access (limitation highlighted at site 2 exclusively)</u>

This limitation was highlighted by HCPs at site 2 exclusively. The HCPs discussed a common problem of not being able to access the patient's medication charts when another HCP was viewing a patient record. A nurse at site 2 explained the lack of multi-user access can lead to a delay in patient medication administration and can be stressful and frustrating for nursing staff to work around.

> *"…the age-old problem of hunting around for a drug chart is kind of replicated in electronic form by the systems that only allow single user access at any one point.*

So, instead of wandering around trying to find a paper drug chart, you're wandering around trying to find out who's logged on to that patient so that they can close it so that you can modify. It's replacing one problem with another"

(Site 1, Doctor 2)

"I know the girls [nurses] really do get frustrated if they can't give a drug. I think they find if it's blocked, that's frustrating; they want to give it. Just so they've delayed something for an hour or two hours and it doesn't let you give it then. I think they find that frustrating, that they can't, sort of, override it somehow. You've got to get the doctor to prescribe it as stat rather than give it two hours later. Because they might have gone off the ward for a scan, or whatever. I think they find that frustrating" (Site 2, Nurse 2)

In contrast, at site 1, pharmacists expressed that having access to the ePMA system simultaneously was beneficial to them and allowed for real time consultations to take place with senior members of staff if they needed clinical advice.

Pharmacist 1: "Everyone can access it at the same time, at any one time and it's all in one system so your blood results and your pictures of wounds all in one so you don't have to switch from window to window."

Pharmacist 2: "That's what I was going to say as well that everything is all in one...It's easier to access when you want to quickly check something in the afternoon if you're not around, like if you're not looking at the paper charts."

Pharmacist 3: "…if you're wanting to clarify with a specialist pharmacist or something you can give them a hospital number and it's really good communication that way you're basically seeing the chart whereas if it's paper, not everyone's able to come up to the ward with you."

(Site 1, Focus group 1)

3) Limitations of the electronic medication chart

Doctors reported that the electronic medication chart often did not display all the information they needed at first glance and some were unsure of where to find additional information. They also stated that it was not always made clear if a pharmacist had amended their prescription, as previously on paper it was obvious due to the green colour pen used by pharmacists when amending prescriptions. The doctors felt that by not being able to see this information, they would find it more difficult to learn from their mistakes.

> *"If the drug dose was changed, if the pharmacists had to correct something…There's no communication on there [electronic prescribing system]… the problems are the loss of the green pen. I think it's a big problem. And the loss of the overall…there's lots of information that the drug chart used to carry that has been lost. I think that's the main thing."* (Site 1, Doctor 1)

> *"Not all of the systems show you whether your prescription has been checked or how it's been modified, as well. So, it's less easy to see a glance, like you could with paper, how that script has been changed to then see what you need to do differently next time."* (Site 1, Doctor 2)

> *"I'm aware that they can make notes on the medication section of [the ePMA system], but they're not particularly obvious. I think on the paper drug chart, in my experience, it's been a lot more [clearer] on this because you can see the green pen more clearly."* (Site 1, Doctor 4)

> *Pharmacist 5: That brings me onto my next bit that important notes can be ignored. So you get a pop-up and it's easy to move on and kind of just…*
>
> *Interviewer: Ignore it.*
>
> *Pharmacist 3: My one about the notes is that it's not used to its best potential.*
>
> (Site 2, Focus group 1)

6.5.2.5: Theme five - The future of electronic prescribing and medication administration systems

The HCPs across the three sites all had suggestions for improvements for future ePMA systems to enhance communication among HCPs.

Messaging centre

All three HCP groups across the three sites suggested an electronic messaging centre for non-urgent information to be communicated to other HCPs. An electronic medication reconciliation form was suggested that would be useful for pharmacists to document their medication reconciliation queries. The doctors could then review this form and act on the recommendations or comment back on why they may have chosen to make a change to a patient's medication.

> *"In terms of communication though, there's no messaging system. Maybe it'd be good if the pharmacist, for example, who'd done a drug reconciliation, can write, not as a pop up, but as a message system. So, like a new system feature within [the ePMA system] to say that regular meds [medications] have been charted. And then it, it will, you'll see an inbox…That'll be good."* *(Site 2, Doctor 3)*

> *"…so for little changes, non-urgent queries, non-urgent things I think it would be really nice because then it's on your timetable. So, when you've got some time, you could flick through your messages, and you could… Because it would work around your day, I think it would be really good."* (Site 1, Doctor 1)

> *"The message centre sounds interesting, and it was an interesting route of communication that this consultant had used with me whereas previously she would have sent an email."* (Site 1, Focus group 2, Pharmacist 10)

> *"…medicine reconciliation form and it can give a prompt to say what medication were missing"* (Site 3, Doctor 1)

Specifically, doctors at site 1 expressed the need for a better feedback system. Some doctors felt that the ePMA system did not make it clear when prescriptions were changed

and they would not have the opportunity to learn from their mistakes. The doctors felt that receiving feedback from HCPs was now reliant on that HCPs deeming the error to be important enough to contact them for.

> *"I think a great worry of mine is that I make mistakes that I never find out about. And I know I make mistakes that no one ever tells me about, and that is awful because then I will make the same mistake again…Feedback, at the moment, is reliant on someone deciding that it's necessary and email that person. So, we're not enormously in the habit of it…so I think having an easy message, an easy system, and normalising continuous feedback about everything would, I think, be really valuable."* (Site 1, Doctor 1)

> *"If there's an equivalent inbox for the pharmacist who's altered your prescription in this way, that would really help me in terms of seeing… Because often we don't get that feedback at all."* (Site 1, Doctor 2)

Alerts when changes are made to prescriptions

Nurses at the two ePMA sites stated that it would be useful and time-saving for them to be notified electronically when a new medicine had been prescribed or when a prescription has been altered by the prescriber or when the discharge medication was ready for a patient.

> *"…but maybe a system where they can inform you on [the ePMA system] that it's [changes to medications] been done or they can inform you, I've written up the dose, or the TTAs [to take away prescription] have been done, rather than you then having to chase it up constantly. Because that's probably what I do, when I know I've got a discharge I know then I've got a good few hours to try and wait and try and sort that out."* (Site 2, Nurse 2)

A doctor at site 1 was under the impression that nurses receive a notification when a new medicine is prescribed. However, this feature did not exist at the time of this study for the system in use.

"I think on the electronic prescribing, I'm aware that the nurses will get like a notification if [you] prescribe something…if I prescribe something, I walk around to tell the nurse that I've prescribed it, and it's already been given because they've picked up on the fact electronically. I just don't trust that enough to be sure that it's going to happen." (Site 1, Doctor 4)

Electronic medication requests

Pharmacists and nurses suggested that medication requests for patients should be made electronic rather than using fax or medication order books. This would improve efficiency, save time and reduce transcribing errors.

"I mean I think fax is outdated. Because often finding a fax that works is quite hard. So, faxing things is quite dated whereas electronic would be so much better" (Site 1, Nurse 2)

Pharmacist 13: "And if it was paperless as well. With the way we obviously transcribe everything, if we need to order something that we could just see, this is [ward name] and these are all the orders for all the different patients. I used a prescribing system of [ePMA system] and everything is linked from the ward, so you know that you've got ten meds [medications] that have been prescribed overnight and these are new. And then you can just verify them with send to pharmacy and then dispensary get a "bing" and say that [ward name] order has been done and printed off and dispense it. Or you just literally manually click it through. It makes labelling a lot quicker, the whole process a lot quicker, from my experience anyway.

Pharmacist 12: "So you can print transcription sheets automatically. You just put your orders in and then it automatically printed out a transcription sheet in dispensary without having to do anything else"

Pharmacist 13: "Also reduces errors as well because you're not having to just look at someone's handwriting and be like, is that a five or a six, or eight" *(Site 1, Focus group 2)*

Read only feature

As mentioned earlier, HCPs at site 2 expressed their frustrations with single user access when using their ePMA system. Participants stated that this was often a problem if another HCP forgot to come out of a record and would have to spend their time trying to locate the HCP still logged into the patient's record. Pharmacists suggested that a read only feature would allow them access to the patient's record in order to provide doctors, nurses and other pharmacists with advice regarding patient medication.

Pharmacist 14: *"Well at least they could have like a view option.*

Pharmacist 13: *"A view option at least."*

Interviewer: *"Like a read-only"* (Site 2, Focus group 3)

6.6 Discussion

This qualitative study has provided new knowledge on hospital doctors', nurses' and pharmacists' perceptions and desire from an ePMA system. This study supports findings from previous research demonstrating the importance of collaborative communication and the benefits and challenges of using ePMA systems to support communication as detailed in chapter 3 of this thesis.

6.6.1 Modalities of communication

One of the aims of this study was to explore the communication methods available to pharmacists, doctors and nurses within their teams and with other HCPs. The HCPs across the sites expressed unanimously a preference for verbal communication, ideally face-to-face communication. Previous systematic reviews have also concluded that face-to-face communication is considered one of the most common forms of collaboration by HCPs (Gharaveis et al., 2018), even when a mature computer-based record system is available for information exchange (Coiera, 2006). Previous research has shown that

pharmacists' recommendations have a higher acceptance rate by prescribers, especially when delivered verbally compared to other modalities (Bedouch et al., 2012). It was also observed in another study that nurses and doctors preferred working in a paper-based prescribing environment that allowed for more negotiations and discussions for better collaborations regarding patient treatments (Wenzer et al., 2006). Participants in the present study also highlighted that along with face-to-face communication, non-verbal communication was an important indicator of the other HCP understanding the information given to them. Body language and facial expressions are known to play an important role in communication as they provide a better indication of the meaning behind the words (Vermeir et al., 2015). The participants interviewed in this study showed an understanding of this importance and how it plays a role in the effectively communicating with other HCPs.

A few doctors alluded to the use of a messaging app on their mobile phones to share information with other colleagues in their team. In previous research conducted in the UK, doctors were found to be a professional group who commonly used their personal devices at work (Mobasheri et al., 2015). Some doctors who were interviewed in this PhD study explained that they exclusively used it to coordinate the team and tasks whereas, others stated that they used the messaging app to gain clinical advice from their peers and seniors. A study in the UK recorded the types of communication events doctors made using a messaging application (Whatsapp) on their mobile phones (Johnston et al., 2015). The communication events were grouped as; administrative questions, clinical questions, information-giving or instruction-giving. The study found that the most common type of communication event was clinical questions, followed by information-giving comments and administrative questions. This corroborates the views of some of the doctors who were interviewed in this study. Furthermore, a systematic review also broadly suggested that mobile devices can improve workflow, efficiency and quality of communication (Martin et al., 2019). Messages including photos and patient-related clinical information were found to be commonly exchanged between doctors that

enabled them to perform work-related tasks (Mobasheri et al., 2015). Using messaging apps for clinical practice has also been found to be beneficial in hospital by doctors and nurses in previous research (Ganasegeran et al., 2017). The use of mobile technology was found to improve the quality of clinical discussions and patient handovers and give faster response times (Martin et al., 2019). Martin et al (2019) concluded that there is potential for the use of mobile technology to transform communication and teamwork in hospitals but more evidence-based research is required to secure the 'right' technology for the real-world settings (Martin et al., 2019). A recent multi-site qualitative study explored pharmacists' experiences of using Whatsapp to support the delivery of out-of-hours pharmacy service (Rathbone et al., 2019). The study concluded that pharmacists overall had a positive experience when using Whatsapp to communicate with their colleagues but had concerns regarding the legality, governance and training for work-related messaging (Rathbone et al., 2019). Pharmacists did not discuss their use of Whatsapp during the focus groups, but reported being were aware that some specialist pharmacist groups (e.g. admissions) coordinated their activities using the app.

The HCPs at the two ePMA sites stated that they used some features of their ePMA system and NHS emails to communicate information within their profession. Pharmacists stated they sometimes communicated information to other pharmacists using email if they were not based at the same hospital. Both doctors and nurses stated that they regularly documented information for members of their teams in the paper or electronic medical notes. Medical notes are not just a means of communication involved in the care process for a patient but can also serve a medico-legal value (Vermeir et al., 2015, Westbrook et al., 2019). Often written communication is not relied on exclusively as notes because it may be incomplete and timeliness has been reported as a problem too (Vermeir et al., 2015). The participants agreed that electronic medical notes were perceived to be an audit trail of the patients' hospital journey rather than a means to communicate among HCPs. This has been previously noted in the literature (Coiera, 2006). Doctors and nurses did state in their interviews that they regularly document in

the medical notes to update any HCPs of patients' assessments and future management plans.

During the focus groups and interviews, HCPs were not asked to comment on the impact of ePMA on their communication with patients. However, HCPs at all three sites raised concerns regarding reduced patient contact. There is literature to support this perception suggesting that working on ePMA is potentially more time consuming and often completed remotely, away from the patient (Shemilt et al., 2017). In previous studies, pharmacists have suggested that the removal of the paper prescription chart from the end of a patient's bed had resulted in the removal of the physical and social link between them and the patient (Burgin et al., 2014). Since the introduction of ePMA systems, pharmacists in previous focus groups implied that they now had a choice whether to see their patients or not (Burgin et al., 2014). Some studies have suggested that pharmacists who spend less time physically seeing their patients do not see this as a disadvantage. These pharmacists were able to extend their clinical role by taking part in the MDTs (Mehta and Onatade, 2008). Pharmacists in this study believed the ePMA system would consume a significant amount of their time and therefore impact on the time available to them to interact with patients. Shemilt et al (2017) echoed a similar view from pharmacy managers in a qualitative study who also stated that ePMA systems were more time consuming and inhibited patient contact (Shemilt et al., 2017). On the contrary, a recent study comparing two hospitals, an Australian and an English hospital pre and post-ePMA implementation, found that English pharmacists increased their time engaged in medication discussions with patients, but there was no significant change in the Australian rate (Westbrook et al., 2019). There continues to be a difference in opinion and lack of data as to the impact of ePMA on pharmacist-patient contact. Pharmacists believed patient contact had reduced as a consequence of working away from the ward (i.e. their office). Previous studies have highlighted that remote screening and reviewing denies patients the opportunity to ask questions and results in a poorer relationship with patients (Burgin et al., 2014, Mehta and Onatade, 2008).

6.6.2 Pharmacists' visibility

One of the challenges perceived by pharmacists at all three sites was the reduction in pharmacists' presence; both physically on the wards and in documentation after the introduction of ePMA systems. This was also echoed in a recent study conducted by McLeod et al (2019), who concluded that pharmacists felt they had more interactions with other HCPs, but less face-to-face communication since ePMA implementation (McLeod et al., 2019). Senior UK pharmacists have previously stated that this behaviour was more likely to be seen among junior pharmacists, who may not have the confidence to directly speak with other HCPs such as doctors (Westbrook et al., 2019). This finding was previously noted by Burgin et al (2014), who suggested that the implementation of ePMA systems made junior pharmacists feel more able and freer to document in the electronic notes rather than paper records. Older pharmacists perceived their clinical note entries to have stayed the same and stated they preferred to communicate verbally (Burgin et al., 2014). It has been suggested in previous literature that older pharmacists may feel less equipped with computer skills compared to the junior pharmacists (Burgin et al., 2014). On the other hand, pharmacists in this study did state that they often checked the medical notes in order to update themselves of their patients' medical plans, but rarely documented their interventions or advice in the medical notes themselves (Burgin et al., 2014). Pharmacists have previously been known to consult written resources prior to engaging in spoken communication (Mesler, 1991). Furthermore, it has been commonly noted in previous research that pharmacists do not write frequently in medical notes and gauged their method of communication based on the context of the situation (Pullinger and Franklin, 2010). Similarly, pharmacists in the focus groups specified they would only document in the medical notes if the information was lengthy or of high importance. Pharmacists preferred the use of oral communication in this study. The lack of written documentation by pharmacists in the medical notes had previously been thought to be due to a number of factors including: fear of litigation, fear of criticism and lack of ownership of health records (Pullinger and Franklin, 2010). A quantitative study revealed that English hospital pharmacists halved the time they spent in

professional communication following the introduction of ePMA (from 5.8% of their time to 2.4%) and experienced overall low levels of inter-professional communication (Westbrook et al., 2019). Professional communication was defined as 'communicating with other health professionals about work-related matters. Includes: meetings and, handover discussions' (Westbrook et al., 2019). Interestingly, pharmacists working with ePMA systems in Australia were substantially more engaged with clinical teams with a high proportion of their time spent in professional communication, medication discussions and social interactions (Westbrook et al., 2019). In the study conducted by Westbrook et al (2019) it was found that 40% of all Australian pharmacists' work time involved tasks with others, and 30% of tasks involved face-to-face communication. In contrast, English pharmacists spent over 80% of their time working alone, a reflection of their lower levels of time spent in professional communication, medication discussions and extremely low levels of social interactions (Westbrook et al., 2019). This may be due to the nature of pharmacists' work being different in Australia compared to the UK, with different information-seeking practices (Rixon et al., 2015).

This study also revealed that doctors perceived there to have been a reduction in the pharmacists' presence on the wards too; this has not previously been documented in the literature. Doctors at site 1 highlighted that their threshold for approaching pharmacists regarding medication related queries was now much higher than before. They felt that they were now less likely to ask the pharmacists questions as they were perceived to not be physically present on the ward. If the doctor wanted to reach the ward pharmacist, they would have to take an additional step to call or bleep them. The importance of relationship building and establishing rapport was also reflected in doctors' wishes in a previous mixed method study conducted in Australia, who stated they wanted to maintain an easy, accessible team-based relationship with pharmacists who could provide them with continuous support (Coomber et al., 2018). They also expressed their preference for oral communication as both groups would benefit from a closer relationship and doctors appreciated the skills and presence of pharmacists on the ward (Coomber et al.,

2018). The doctors in the semi-structured interviews also felt that they were receiving less feedback from pharmacists as their recommendations were less obvious on the ePMA charts. Previously, pharmacists documented on the paper charts in green pen highlighting any changes and recommendations that were always distinguishable from other HCPs. Previous research has also indicated that pharmacists felt their written presence has reduced and doctors and nurses always knew the pharmacist had endorsed the medication with their 'safety stamp' (Burgin et al., 2014). This was also reflected by the doctors interviewed in the current study. Pharmacists suggested that they documented less on the ePMA system as much of their documentation prior to ePMA was now built into the electronic prescriptions (Burgin et al., 2014). This potentially could reduce pharmacists' workload but may not be easily seen by other HCPs.

6.6.3 Human-Computer interactions

It is known that often people treat computers as if they were people consequently superimposing social expectations on technologic interactions (Coiera, 2000). The doctors in this study discussed their concerns regarding the impact on their knowledge and overdependence on technology since the introduction of ePMA systems. They expressed their fear of over reliance on technology and fewer opportunities to reinforce learning. Some ePMA systems may incorporate some level of clinical decision support (CDS). However, it is important to note that sites 1 and 2, at the time of this study, had minimal CDS incorporated into their systems. CDS can support users to access education material, however, studies have found that those doctors who have only worked with CDS technologies may develop knowledge gaps (Campbell et al., 2006). Furthermore, using electronic health records has also been documented to potentially decrease narrative note taking skills and clinical knowledge (Lu, 2016). Often, ePMA systems have been noted to reduce prescribers' situational awareness, where this involves having an understanding of the activities of others that provides a context for your own activity (Campbell et al., 2009). A certain degree of iterative and interactive communication among HCPs is essential to promote and support situational awareness

in medical work (Campbell et al., 2009). Even with minimal CDS within their respective ePMA systems, the doctors felt that they were becoming reliant on the automated technology and had become disengaged from their prescribing. All the HCPs in this study agreed, that the ability to access the ePMA system remotely was advantageous; however, it is possible for prescribers to enter orders for prescriptions at any time that can lead to a loss of situational awareness according to previous literature. The use of information and communication technology leading to decoupling (Alpay et al., 2004). Decoupling can have positive effects on the efficiency of the communication process but can potentially have a negative effect on the effectiveness of the communication process (Alpay et al., 2004). What newer technology lacks is the immediacy of communication that is essentially the receiver providing feedback information relayed back to the sender. This increases the cognitive complexity of the communication for the recipients as it is reliant on their interpretation and increases the risk of the information being misunderstood (Alpay et al., 2004). This was debated amongst the doctors in the semi-structured interviews and stated that ePMA systems have improved their knowledge due to the repetition of seeing completed prescriptions that have already been built into the system. The doctors also stated that they would still prefer to check their recommendations with another HCP e.g. a pharmacist. When this was previously examined in a clinical setting, it was found that people have a preference to turn to each other for information and decision support (Coiera, 2000). Previous work has also found that even with a mature computer-based system in place, 50% of information exchanges occurred face-to-face and only 10% through the electronic medical records (Safran et al., 1999). The literature on how health technology such as ePMA making HCPs better informed has been widely documented in the literature, but greater focus needs to be placed on using this technology to have a better power of decision making and in turn improving HCPs' knowledge and understanding of their patients (Alpay et al., 2004).

Pharmacists felt that their role had changed since working in an environment with an ePMA system and consequently felt that it was their responsibility to maintain the

medication chart and to prescribe on behalf of the doctors more often. Past and present research has also identified that there has been a shift in the role of pharmacists post-ePMA and they were taking on more of a transcribing role, by ordering medication based on doctor's verbal request and were having to adopt an ePMA support role (Aarts et al., 2007, McLeod et al., 2019). In practice, McLeod et al (2019) highlighted that pharmacy staff often received the same level and quantity of training as doctors and other HCPs. Moreover, pharmacists have questioned their role and felt an unexpected loss of their professional profile within the clinical environment, however felt that their relationship with doctors has increased significantly (Burgin et al., 2014). This was attributed to doctors contacting pharmacists regarding technical queries with the ePMA system. The pharmacists stated that though their initial interaction with the doctors may involve a technical query, they found these interactions often led to conversations about prescribing (Burgin et al., 2014). In previous work, there were concerns raised regarding a reduction in the role of pharmacists to mere dispensing since ePMA, but pharmacists have argued that they play a much broader role by; looking at the entire patient picture and challenging medication omissions and new prescriptions (Aarts et al., 2007). It has been suggested in previous research to redefine and place pharmacy technicians in a position to tend to stock control and dispensing, allowing pharmacists to have more clinical input by attending ward rounds (Mehta and Onatade, 2008). Growing shortages of the HCP workforce may be an additional reason for a shift in prescribing roles, as doctors feel they have to delegate tasks to other HCPs (Aarts et al., 2007).

Remote access to electronic patient medical notes and medication chart has been documented as a positive feature of ePMA systems in literature summarised in chapter 3 and previous reviews (Niazkhani et al., 2009a) and by the participants in this study. ePMA systems have been noted to be efficient from the doctors' perspective because they can generate, send and approve prescriptions directly to the pharmacy even from remote locations (Zadeh and Tremblay, 2016). The participants agreed with the benefits of remote access but expressed their concern of this practice leading to reduced face-

to-face contact with other HCPs and patients. Some literature suggests that ePMA creates an 'illusion of communication' as some users of ePMA systems assume that an electronic prescription will be efficient and do not understand that a fast computer does not guarantee a fast, accurate, notification to the person who must act on the order (Campbell et al., 2006). Remote prescribing could lead to an increase in the likelihood of errors due to; miscommunication, delayed initiation and execution of orders (Campbell et al., 2006). Another study which also used qualitative methods to address the impact of ePMA on medication errors highlighted that electronic prescribing improved the pharmacists' ability to identify prescribing errors, but it also led to reduced face-to-face contact with other healthcare staff and patients, because they no longer need to visit the wards to get the clinical information they needed for effective prescription review (Savage et al., 2010). This change in practice could have a significant effect on inter-professional communication (Savage et al., 2010). In our study, participants alluded to concerns of reduced collaborative work but shared more positive experience with remote access as they believe HCPs were able to add more information to the medication chart compared to when using paper medication charts. This allowed them to share more information and provide clearer patient hand overs. Doctors even suggested that having access to more information allowed them to make informed decisions regarding patient care. During data collection, doctors referred to the electronic discharge prescriptions, that are often written up by a junior member of the team, and do not necessarily know the patient's hospital journey. These junior doctors are able to review all the electronic documentation, that details the care of the patient and can relay it to primary care. This in turn can improve patient safety by ensuring important information is clearly transferred between HCPs and sectors of healthcare.

6.6.4 System limitations

The lack of computer terminals was highlighted as a challenge by many HCPs in this study. The HCPs reported that often the computers were not available, were not charged or did not have the ePMA system installed on it. It is possible that the lack of computers

available for the HCPs meant that they were not able to perform their usual work on the ward and had to work away from the ward. This in turn could create the perception of the HCP not being available or present for other HCPs to contact and communicate with. The lack of hardware has often been referred to the 'rate-limiting step' for HCPs to carry out their work in previous literature (Callen et al., 2013, McLeod et al., 2019). HCPs spent a significant amount of time searching for paper medication charts on the ward prior to ePMA (Van Wilder et al., 2016). Though this is no longer an issue at the ePMA sites, this problem has been replaced with HCPs having to look for a functional, available computer.

Participants at the ePMA sites raised an issue regarding different HCPs having different views on the ePMA system. A doctor felt that HCPs were not 'singing off the same hymn sheet'. This may be due to different access levels for different HCPs. However, participants highlighted that not all the information was available for them and other HCPs to see and consequently could hinder discussions between them. Inconsistences in interfaces has been previously highlighted as a limitation to workflow (Campbell et al., 2009). If HCPs are not able to view the same screen to discuss patient cases it may lead to miscommunication and errors. Participants at site 2 in this study explained how they were not able to access a patient's record if another HCP had the patient's ePMA record open. All the HCPs expressed their frustration regarding this feature. Some participants believed that this was a safety feature so that only one HCP could make changes to a patient's record at one time. The majority of HCPs felt it was a hindrance and interrupted their workflow. Additionally, pharmacists at site 2 suggested that if they were able to access the patient's ePMA record simultaneously they would use this to communicate information accurately and in real time with other senior pharmacists if they needed to consult them. Single user access has not been noted as a limitation in previous literature; conversely, multi-user access has been cited in the past as advantageous by system users (Ahmed et al., 2016, Niazkhani et al., 2009a).

Doctors explained that they were no longer able to obtain written feedback as they previously did on paper. Pharmacists in this study stated that they still documented their advice on the ePMA system for prescribers, yet were not confident that prescribers could see the information and often ignore the pop-up notifications created by pharmacists. Prescribers stated that when working on paper, they often recognised pharmacists' documentation on their prescriptions as they usually annotated changes in a green pen. Pharmacists were still documenting their advice and amending medications on the ePMA system, but it was not possible for other HCPs to know what had been changed, when and by who at a glance. In previous literature it has been documented that often doctors' prescription errors are corrected without the original prescriber becoming aware of it (Aarts et al., 2007). Doctors in previous studies have commented that they did not receive feedback about their prescription errors on the ePMA system (Puaar and Franklin, 2018). Authors have previously noted that few organisations have the ability to provide prescribers with feedback, but ePMA systems can provide enormous capacity to provide real-time feedback (Westbrook et al., 2012).

6.6.5 The future of electronic prescribing and medication administration systems

The participants were asked to suggest any improvements they would like to see in future ePMA systems to facilitate communication among HCPs. Most of the participants suggested that a messaging centre would be valuable to them to communicate information with their colleagues and other HCPs outside of their profession. Doctors stated that they would find a messaging centre within the ePMA system useful as pharmacists and other HCPs could send them prompts regarding non-urgent queries, rather than interrupt them while on ward round. Doctors and pharmacists said that they would often discuss medication reconciliation issues with each other and suggested a medication reconciliation form within the messaging centre would be beneficial to ensure all the items highlighted by the pharmacist are acknowledged and followed up. It was also suggested that providing prescribers with continuous feedback through a messaging centre regarding their prescribing. A previous study where a feedback

dashboard was introduced found that feedback was delivered in a controlled timely manner, but this led to more pressures on staff (Shemilt et al., 2017). Coupled with the fact that ePMA allows other users to see who created a prescription, there could be potential for ePMA systems to generate individual feedback to the prescribers. A previous randomised mixed method study was conducted in a large NHS foundation trust teaching hospital (Redwood et al., 2013). The study provided one group of junior doctors with a junior doctor dashboard which indicated if there was potential for patient harm due to prescribing activity and also provided the group with a weekly email with a link to his/her unique individual dashboard for personalised feedback. The improvement in clinical findings from the computer medicated feedback were small but the junior doctors, in principle, had a positive attitude about receiving feedback. Interestingly, Redwood et al (2013) mentioned that participants also expressed their concern about the use of the data for surveillance and the potential for the data to be used for clinical accountability and disciplinary action.

Previous literature has discussed the usefulness and challenges of having alerts within ePMA systems at different stages of the medication use process, from prescribing to administration (Bell et al., 2018). As CDS within ePMA mature and become more sophisticated, participants in this PhD study suggested specific alerts, which would aid their workflow, improve patient coordination and reduce interruptive communication. Nurses in particular suggested an alert to appear when a patient's medication had been changed or when a new medicine had been prescribed. They stated that often the prescriber would not highlight changes to prescriptions when completed electronically. Nurses at the two ePMA sites noted that waiting for prescriptions to be changed or completed, especially discharge medications, often meant they had to chase the prescribers face-to-face or over the phone. They described that this process was time-consuming, inefficient and interrupted their workflow. A doctor in one of the semi-structured interviews was under the impression the system they used at their hospital was able to notify nurses, which was not the case. This suggests that some users of the

ePMA system have inaccurate expectations of how the system can perform. Their lack of insight may be due to education and training or experience. The doctor also stated that they would often go and tell the nurse verbally, even if they thought the nurse had received a notification as they lacked ‘trust’ in the system. A study in the Netherlands supported a similar feature where a label print out was created for every new/changed prescription (Khajouei et al., 2011b). The nurses would then collect these labels and proceed with administrating the medication. Khajouei et al (2011) concluded that nurses in their study stated the printout labels indicated to them that a new order, or a change or discontinuation of previous orders had occurred. Even with this feature, the nurses in the study said that they would still use other means to coordinate medication ordering activities and would do this verbally (Khajouei et al., 2011b). Similarly, in a mixed-method study in the Netherlands, the nurses described frustrations due to the lack of synchronisation when using an ePMA system (Pirnejad et al., 2008). Nurses stated that they had no idea when and what would come out of the system's printer and they could not be sure why the prescription plan had been changed. Nurses and doctors were not aware of each other's work progress, leading them to constantly remind each other to perform tasks, for example through repeated phone calls (Pirnejad et al., 2008).

A read-only feature was suggested by pharmacists at site 2 to overcome the challenge with single user access. HCPs were unable to access a patient’s ePMA record if another HCP had the record opened from before. Pharmacists suggested that a read-only feature would allow them access to the patient’s record in order to provide doctors, nurses and other pharmacists with advice regarding patient medication. This would be beneficial to allow for collaborative discussions around patient care in real time (Niazkhani et al., 2009a). This would enhance and improve communication among HCPs and was highlighted as a useful feature by site 1. When using paper medication charts, HCPs also had limited access to information simultaneously. The benefits of multi-user access has been previously well documented in the literature, and is often identified as an advantageous feature of ePMA systems (Ahmed et al., 2016, Niazkhani et al., 2009a).

6.7 Implications for practice

This qualitative study enabled different HCPs' views and opinions to be shared from their wide range of experience. It was established that the current ePMA system at both sites was not being used to its maximum potential to communicate among different HCPs, but they are eager to utilise the system more. The HCPs highlighted their concerns regarding the system's impact on their work and relationships with other HCPs. Managers and senior team leaders working with doctors, nurses and pharmacists should voice their concerns if they would prefer to streamline communication processes. However, this research consolidates previous work that suggests that verbal communication is preferred and, in some circumstances, is essential for effective information exchange. HCPs should continue to adopt verbal communication with other HCPs to continue to build rapport and offer a more team-led approach to patient care. Pharmacy, information technology and hospital managers should observe the terminals available for pharmacists to ensure there is enough working hardware for them to carry out their work on the wards. If sufficient terminals are available for HCPs, they should be encouraged to work with other HCPs on the ward to make their presence more apparent and accessible. Education and training remains an important element for all HCPs regarding the expectations and limitations of ePMA systems, as we found in this study some HCPs were under the impression the system could do more than it was capable of doing in practice.

ePMA system providers should take regular feedback from their users of the system and incorporate this back into the ongoing development of their solutions as they would to mature their systems. Some features should be targeted to improve their workflow with other HCPs such as alerts and electronic orders. Coloured text may be a simple solution for pharmacists' written communication to become more visible on the ePMA charts and would be in line with what all the HCPs were used to and appreciated when using paper medication charts.

6.8 Implications for future research

The hospitals that have established ePMA systems should now look to further optimise the system to make it work for their organisation and culture. This research suggests that across different prescribing systems, fundamentally the hospitals have similar visions on how to improve their systems with the aid of technology. For example, the three sites all highlighted the benefits of introducing a messaging centre within their ePMA system to directly message other HCPs queries, advice and follow ups. Future research should further pilot and investigate the benefits and challenges of introducing this type of feature and its likelihood for successful uptake by HCPs.

The semi-structured interviews and focus groups provided the perspective of the pharmacists, nurses and doctors independently. To further clarify their opinions, it would be of value to conduct focus groups with a mix of these HCPs in order to gauge if these communication problems are solely down to the introduction and implications of the ePMA system or if further interdisciplinary training is needed to overcome communication and administration problems.

6.9 Strengths and limitations

This is the first study where more than one prescribing system was studied and involved different HCP groups. Over 80 different HCPs across the three sites were recruited and provided a variety of experiences and opinions. Doctors, nurses and pharmacists of different grades and specialities were recruited in this study. Interestingly, the themes and subthemes were similar across the professions and different system users.

Unfortunately, the required number of nurses and doctors at one of the hospital sites in this study were not recruited. This was due to staffing pressures at this particular site as the hospital was imminently expecting an external inspection. Since focus groups and semi-structured interviews were held during lunchtimes, they had a maximum duration of 1 hour, which may have reduced the opportunity for further discussion. In addition, the focus groups that were conducted included junior and senior pharmacists. A possible

disadvantage of this could be that junior pharmacists were not able to express their concerns when in a group of more experienced pharmacists. Most of the doctors who took part in this study were less than 4 years qualified. Arguably, these doctors often have the most interaction with ePMA systems as they do most of the prescribing for patients. Furthermore, the communication strategies and benefits and challenges of their prescribing systems used by the participants in practice were not observed as part of this study.

6.10 Conclusion

This study provided an insight into HCPs perceptions regarding how they communicate with each other, in both paper and ePMA prescribing environments. The majority of HCPs involved in this study described both benefits and challenges of using an ePMA system with respect to how information was communicated to each other. Participants in this study also suggested that the two current ePMA systems were not being used to effectively communicate information to other HCPs. However, there is potential scope for these systems to improve, and to include the suggestions made by the participants. There were concerns from pharmacists and doctors regarding pharmacists' reduced visibility, both in documentation and in physical presence, that has occurred following implementation of ePMA systems. The purpose of the next chapter is to build on the perceptions and experiences described by the participants by observing their communication strategies in practice. The next chapter describes the quantitative data through observations of ward pharmacists' communication strategies from each of the study sites and have been presented along with qualitative descriptions of the contexts.

Chapter 7: How have electronic prescribing and medication administration systems affected pharmacists' communication in an inpatient setting? A multi-site observational study

7.1 Introduction

Patient care involves a multi-disciplinary team who need to share information and discuss the patient's management for their benefit (Coiera, 2006). As a consequence, there is a need to transfer information among individuals in a secure, clear and timely fashion. Electronic medical records, initiated in primary care, revolutionised the way in which information is documented and are now considered an integral and essential element of workflow (Bouamrane and Mair, 2013). Learning from past successes in primary care, digitisation of secondary care through the introduction of EMRs and ePMA is thought to have transformed hospital culture, structure, governance, workforce and training (Wachter, 2016).

The purpose of this study was to explore the impact of ePMA systems on pharmacists' communication with each other and with other HCPs. There has also been relatively little work to understand the internal communication strategies and requirements in the hospital setting compared to the primary care sector (Coiera, 2006). The study described in the previous chapter explored pharmacists' own perspectives on the benefits and challenges of using an ePMA system on their communication with other HCPs through focus groups. Through observations of clinical pharmacists, the aim of the work presented in this chapter was to gain an insight into the benefits and challenges of these systems in practice. Together, the two studies aimed to provide a rich insight into the benefits and challenges pharmacists face when using an ePMA system and to explore whether ePMA systems could transform pharmacists' communication in secondary care.

7.2 Aim and objectives

7.2.1 Aim

To explore how pharmacists communicate with each other and with other HCPs in an inpatient setting and how ePMA systems may affect this.

7.2.2 Objectives

There were four main objectives:

1) To describe ward pharmacists' activities involving communication during their allocated ward visits;
2) To document who initiates the communication exchanges, the channel of communication used and the nature of the communication exchanges;
3) To explore whether there are differences in communication strategies between hospitals using ePMA and one using paper-based prescribing systems, and the nature of any differences;
4) To identify any potential consequences of any differences in communication strategies on patient safety and make recommendations as needed.

7.3 Method

7.3.1 Study design

This study was an embedded mixed-methods design, with a quantitative descriptive study as the principal approach to data collection supplemented with complementary qualitative data. This study design was selected as it allowed for the quantitative findings to be further explored through the qualitative data in order to address the above aim and objectives. This study involved observing pharmacists during their usual ward visits. Quantitative data was collected to document the different channels and locations of communication events and their content; qualitative data was collected through field notes and brief discussions with the observed pharmacists at the end of the observation to gain an enhanced understanding of communication practices. This study took place on general medical and surgical wards at three NHS hospital trusts. Specialist wards, such as intensive care and admissions units, were excluded. Where possible, wards of similar specialities were selected across the hospital trusts for the observations. The total

number of observations were determined following pilot work and a subsequent sample size calculation.

7.3.2 Definitions

A communication system involves people, the messages they wish to convey, the technologies that mediate conversations, and the organisational structures (Coiera, 2006). In this study, when the pharmacist began a patient-related information exchange with another HCP (or a HCP with the pharmacist), this was documented as a communication event on the data collection form. The definitions of communication and other common terms for the purposes of this study are found below:

- Communication – the exchange of information, thoughts and feelings among people using speech or other means (Kourkouta and Papathanasiou, 2014);
- Initiator – the person who instigates the information exchange;
- Communication channel – the medium along which information was conveyed. There are a variety of different communication channels such as; face-to-face, telephone, email, medical records;
- Mode of communication – how the information was conveyed i.e. synchronous (e.g. face-to-face, telephone) or asynchronous (e.g. email, note on the medication chart/in electronic medical record);
- Content of communication – the purpose of the information exchange e.g. feedback on a medication error;
- Communication event – a single, one-way information exchange mediated through asynchronous or synchronous means (one message). This was the unit of interest in this study.

The content of communication category was further classified in Table 14. The above definitions and listed categories were developed inductively from the communication events observed during the pilot study and later some terminology was modified using a similar Australian study (Westbrook et al., 2019). Medication charts refer to both the paper and electronic versions. The task ‘medication review’ was listed as a communication event as the pharmacists’ documents on the paper or electronic medication chart that a pharmacist has clinically checked the prescription. This is also to make other HCPs aware.

Task category	Definition
Medication supply request	Discussing/documenting a medication supply *(excludes documentation next to medication prescription – classified as medication endorsement)*
Discharge update	Discussion/documentation/handover regarding patient discharges *(excludes reviewing/documenting on the discharge prescription – classified as Screening a discharge prescription)*
Medication history	Information gathering/taking/documenting or discussing a medication history
Medication reconciliation/bloods review	Reviewing/discussion regarding medications/blood results and identifying any discrepancies
Medication review	Signing the medication chart for clinical appropriateness
Clinical advice	Providing clinical advice to healthcare professionals e.g. drug interactions, contraindications, alternative treatments
Administration advice	Providing advice regarding the route, formulation, time of medication administration
Remove/amend prescription	Discussing/documenting an inaccurate prescription (i.e. an error), removing duplicate prescriptions
Patient handover/update	Discussing/documenting a patient's clinical and social status
Prescribe medication	Creating a medication order on paper or electronically to be administered to a patient
Medication endorsement	Endorsing a medication supply next to a medication prescription
Screening a discharge prescription	Reviewing/documenting medication for discharge

Table 14: Categories for content of communication on data collection form

7.3.3 Sample size

The data collection form was piloted, and the data were used to calculate the sample size. The details of the two pilot observations that were conducted can be found in section 7.3.9. We determined the primary comparison in this study to be paper against ePMA systems. The core outcome of interest was defined as the proportion of communication events that were synchronous against the proportion of communication events that were asynchronous communication events. Table 15 presents the data collected from the two pilot observations at one of the study sites. A sample size for the comparison of 2 proportions calculation was performed using the PS – Power and Sample Size Program (version 3.1.2) and used the following equation (n= sample size):

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 * \left(p_1(1-p_1) + p_2(1-p_2)\right)}{(p_1 - p_2)^2}$$

The sample size calculation took into account the type 1 error probability for a two sided test. This is the probability of falsely rejecting the null hypothesis. This test used a 95% confidence level ($Z_{\alpha/2}$) meaning that there was a 5% chance of getting a type 1 error. The power of 80% (Z_{β}) was the probability of detecting a significant difference when one exists and correctly rejecting the null hypothesis. p_1 and p_2 are the expected sample proportions of the two groups. The pilot study data indicated that the rate of asynchronous communication was 0.47. Therefore, the synchronous communication rate was 0.53 and 1089 communication events would need to be studied at each hospital trust to be able to reject the null hypothesis. The null hypothesis was that there was no difference in the proportion of synchronous and asynchronous communication between ePMA and paper sites. The Type I error probability associated with this test of this null hypothesis is 0.05.

	Pilot 1	**Pilot 2**	**Total**
Total communication events	70	59	129 *(100%)*
Number of synchronous communication events	39	30	69 *(53%)*
Number of asynchronous communication events	31	29	60 *(47%)*

Table 15: Data from Pilot 1 and 2 observations

It was therefore anticipated that 15-20 pharmacists at each of the hospital trusts would need to be observed in order to achieve the required number of communication events (1089 events per hospital trust). The observations were expected to take place over 60 working days (20 working days per hospital trust). It was assumed that 50-70 communication events would be recorded per pharmacist observed. The duration of each observation was expected to vary depending on the amount of time the pharmacist spent conducting their clinical duties but was estimated to be 2-4 hours each observation day subject to the size and complexity of the ward and local practice.

7.3.4 Ethics and confidentiality

For this study, NHS research ethics committee (REC) approval was obtained (see appendix L). This study was initially reviewed by the health research authority (HRA) who advised that this study should be reviewed by NHS REC and the confidentiality advisory group (CAG) as they were concerned that the PhD student was not part of the direct care team and may be exposed to confidential patient information, such as overhearing patient names when undertaking observations of pharmacists. CAG approval is required when the research involves access to confidential patient information without consent. The study was subsequently approved by West of Scotland REC (ref: 18/WS/0239) and the CAG (ref: 19/CAG/0006), and by the HRA (see appendix M and appendix N).

As part of this process, the CAG advised that some patient and public engagement activity should be undertaken to seek views around the study and the potential disclosure of confidential patient information during the pharmacists' observations. A patient and public advisory group relating to the Centre for Medication Safety and Service Quality at Imperial College Healthcare NHS Trust (ICHNT) were therefore invited to feed back their views on the study. The eight members of the group were all supportive of the proposal and the methodology. The group agreed that it would be inappropriate to ask patients to consent to this research, as they felt it would be disproportionately burdensome on patients. The study was also presented to the research partners group at Imperial College Healthcare NHS Trust who were also supportive of the research and requested that the findings from the research be presented to them at a later date as a means of dissemination back to patients.

A participant information leaflet (appendix O) and written consent form (appendix P) was issued to every participating pharmacist prior to conducting the observation. As per the REC committee's recommendations, a patient information leaflet was also created to give to any patients interested in finding out more about the observations of the pharmacists (appendix Q). The committee also advised that a ward poster (appendix R)

should be displayed on the wards for the duration of the observation. The poster was aimed at informing patients, other HCPs and visitors of the research taking place on that particular ward.

7.3.5 Data handling and management

Participants' names were documented on their signed consent forms, but their names were not shared or used in the reports. General demographic information was collected about the observed pharmacist including gender, years qualified, speciality/band and previous experience with paper and ePMA systems. This information was considered anonymous, as it does not allow identification of the individuals to whom it relates, and it is not possible that any individual could be identified from the data by any further processing of that data, or by processing it together with other information which is available or likely to be available. General information about the ward in the observation was also collected, such as specialty, number of beds and number of patients on the ward during the observation. No patient details were recorded in this study.

The observations were documented on a data collection form and field notes made on sheets that were attached to the data collection form. The information from the data collection form was transferred onto a Microsoft Excel spreadsheet and later uploaded to IBM SPSS Statistics (version 26) for analysis within UCL. The data was stored in accordance with the General Data Protection Regulation (GDPR). The study was registered with UCL Data Protection (ref: Z6364106/2018/07/74 clinical research). Any paper-based information/data from the study (i.e. consent forms and paper data collection forms) was stored in a locked cabinet within UCL. Data stored on the computer was password protected and only the research team had access to it until the PhD thesis was submitted and completed and all the potential publications had been accepted. Thereafter, all raw data was deleted or destroyed. The analysis of the data was completed by the UCL research student. The processing, storage and disposal of data collection forms, consent forms and field notes were completed in accordance with all applicable legal and regulatory requirements, including the GDPR. Only the PhD student

leading the evaluation and her PhD supervisors had access to the participants' anonymised data. The anonymised raw data will be available for other researchers to access through UCL research data storage facility and will be retained electronically at UCL for ten years.

7.3.6 Population and recruitment

A senior member of the pharmacy clinical services team/research department at each of the participating hospital trusts was contacted and asked if they would be willing to be a local co-ordinator. The PhD student liaised through the local co-ordinator to recruit participants. The local co-ordinator sent an email to ward pharmacists inviting them to take part in this study. The participants were selected by convenience and snowball sampling (Blandford et al., 2016). The local coordinators contacted potential participants who were most accessible to them and therefore the easiest to approach. The participants were then encouraged by the local coordinator to speak to colleagues who may also be interested in taking part.

Potential participants were asked to email the PhD student directly if they were interested in taking part and were provided up to two weeks to respond. The potential participants were emailed the information leaflet and consent form to familiarise themselves before organising a day to conduct the observation. The potential participants were informed that they may be observed twice in the study. A mutually convenient day for the observation to be conducted was organised by the PhD student and each pharmacist who had agreed to be observed.

7.3.7 Inclusion and exclusion criteria

All qualified pharmacists, band 6 and above, working on adult general medical and general surgical wards were eligible to take part in this study.

Doctors, nurses, pharmacy technicians, pre-registration pharmacists and patients were excluded from this study. Specialist wards, such as intensive care and admissions units were also excluded.

7.3.8 Observation procedure

Prior to data collection, the ward manager and/or lead consultant of the ward, where the pharmacist was working, were contacted to inform them of the research and to obtain permission for the PhD student to be present on the ward. The PhD student accompanied the pharmacist while they undertook their clinical duties on their allocated ward. The observation also included any preparation work the pharmacists conducted before going to their ward. Before the observation began, the pharmacist was provided with the participant information sheet and allowed time to read and ask questions regarding the study. If the pharmacist agreed to take part in the study, they were invited to sign the consent form. General demographic information was collected about the observed pharmacist including gender, years qualified, grade and previous experience with paper-based prescribing and ePMA systems. General information about the ward was also collected such as specialty, number of beds and number of patients on the ward during the observation. Only the patient bed number was documented on the data collection form to record the different communication events that were observed.

A data collection form was used to collect information regarding the number and types of communication events pharmacists had with HCPs on the ward. For each communication event the following information was collected, without recording any HCPs' names:

1) Who the communication was initiated by,
2) Who the communication was with,
3) The location of the communication exchange,
4) The channel of communication, and
5) The content of the communication (as shown in Table 14).

The start and end time of the observation was noted by the PhD student. During the observation, field notes were also collected about any situations or reflections that could not be collected using the quantitative data collection form. At the end of the observation, the PhD student discussed particular communication events with the pharmacist to clarify details or to explore their feelings about them (e.g. if it was noted by the PhD student

that the pharmacist appeared frustrated while using the ePMA system during a communication event). This information was documented as part of the field notes. The PhD student requested a copy of the clinical pharmacy standards from a senior member of the pharmacy clinical services team at each of the study sites. However, it was not possible to see them for all of the sites.

7.3.9 Pilot observations

Two pilot observations with two different pharmacists were organised by the PhD student at one of the hospital sites using ePMA. The main purpose of the observations were to gain information to support the sample size calculation and test the usability of the data collection form. No changes were required of the data collection form. Table 16 presents information regarding the pharmacists and wards observed during the pilot observations.

	Pilot 1	**Pilot 2**
Gender	Female	Male
Band	7	8a
Years qualified	3	6
Previous experience with electronic prescribing and medication administration systems	No	Yes
Ward speciality	Orthopaedic surgery	Gastroenterology
Total observation time (mins)	264	220
Total communication events	70	59
Number of patients on the ward	24	24
Number of medication charts reviewed	24	24
Number of patients seen face-to-face	1	1

Table 16: Pilot observation

7.4 Data analysis

This study design primarily collected quantitative data to describe the different channels, locations and nature of communication exchanges at the different study sites. The qualitative information was summarised narratively to provide context to the quantitative data. Descriptive analysis was conducted for the three individual hospital sites to summarise the data using IBM SPSS Statistics (version 26). Chi squared tests were

used to explore the relationship between categorical variables. This test compared the observed frequencies of cases that occur in each of the categories with the values that would be expected if there was no association between the two variables being measured (Pallant, 2016). Logistic regression was also conducted to evaluate the association between an exposure (ePMA) and a binary outcome (i.e. synchronous against asynchronous communication). The hypothesis for this study was that pharmacists at the ePMA sites were less likely to engage in synchronous communication compared to the paper-based site. The PhD students' supervisors reviewed each stage of the analysis and provided their feedback. The data on the location of communication exchange between the pharmacist and other HCPs were grouped to present the data as ward-based communication or non-ward based communication and compared across the three sites. Table 17 below presents how the data were grouped for this purpose.

Ward based	Non-ward based
▪ Nurses' station ▪ Doctors' office ▪ Drug room ▪ Patient bay/beside	▪ Pharmacy office ▪ Another ward

Table 17: Grouped categories for the location of communication events

Similarly, the data for the channel of communication the pharmacists used to communicate information to other HCPs per site was grouped. During the observations, it was noted that there were many different channels available to communicate through, so the categories were collapsed for the purpose of the analysis as shown in Table 18.

Verbal communication	Electronic communication	Paper-based communication
▪ Face-to-face ▪ Telephone	▪ Written communication on electronic medication and administration chart ▪ Written communication in electronic medical notes ▪ Whatsapp – messaging ▪ Email ▪ Electronic discharge letter ▪ In-house electronic program	▪ Transcription sheets ▪ Ward communication diary ▪ Fax ▪ Written communication on paper drug chart ▪ Written communication on paper medical notes

Table 18: Grouped categories for the channel of communication

During the data collection period, it was found that pharmacists and other HCPs communicated through a mixture of communication channels as described in Table 18. Figure 7 presents how the data was further grouped into synchronous and asynchronous communication.

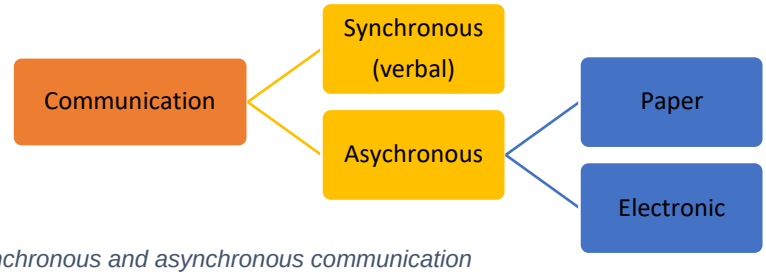

Figure 7: Synchronous and asynchronous communication

7.5 Results

7.5.1 Participant demographics

A total of 60 individual observations of 50 different pharmacists were conducted across the three participating study sites between March and July 2019. Pharmacists of different seniority were recruited across the hospitals. The majority of pharmacists at the ePMA sites had experience with paper-based systems prior to the current system at their hospital. The observations lasted between 32 and 453 minutes. Further details of the observations and a summary of the pharmacists' demographics can be found in Table 19. The full list of pharmacists' demographics and details of the wards observed during the study at the three study sites can be found in appendix S and appendix T.

		Site 1	Site 2	Site 3
Total number of observations		20	20	20
Total number of communication events observed		749	677	1000
Number of medical wards		10 *(62.5%)*	6 *(67%)*	10 *(67%)*
Number of surgical wards		6 *(37.5%)*	3 *(33%)*	5 *(33%)*
Total observation time (mins)		2703	2879	2908
Median time spent completing ward duties per observation (mins)		121.5 *(37-453)*	140.5 *(32-273)*	155.5 *(52-258)*
Number of wards with a pharmacy technician		7 *(35%)*	20 *(100%)*	8 *(40%)*
Pharmacists' demographics				
Number of different pharmacists observed		18	12	20
Median number years qualified (range)		4.5 *(0.7-25)*	6 *(0.6-20)*	4 *(1-36)*
Number of non-medical prescribers		4 (22%)	1 *(8%)*	6 *(30%)*
Grade of pharmacist	Band 6	6 *(33%)*	4 *(33%)*	7 *(35%)*
	Band 7	4 *(22%)*	4 *(33%)*	9 *(45%)*
	Band 8a	5 *(28%)*	2 *(17%)*	3 *(15%)*
	Band 8b	3 *(17%)*	2 *(17%)*	1 *(5%)*
Gender	Male	7 *(39%)*	2 *(17%)*	6 *(30%)*
	Female	11 *(61%)*	10 *(83%)*	14 *(70%)*

Table 19: Ward and pharmacist demographics

The quantitative data collected in this study is next presented in the following subsections. The qualitative field notes collected during the observations are presented narratively below each relevant graph.

7.5.2 Ward pharmacists' activities at the three study sites

Sixty observations in total were conducted across the three study sites. The majority of pharmacists observed in this study were female and junior to mid-grade (band 6 – 7). Six pharmacists at site 1 and two pharmacists at site 2 stated that they had only worked with ePMA systems and had never used paper medication charts. At site 3, four pharmacists stated that they had experience working with an ePMA system prior to the paper-based system at this site.

Pharmacists at all three sites were observed to carry out similar clinical work and communication with other HCPs. The variance in practices could be explained due to different organisational and team structures that are discussed in later sections of this chapter. Site 3 had pharmacy clinical standards that set out the expectations of the pharmacist's role, the way they were expected to document and the type of work they

were expected to carry out during their ward visits. Sites 1 and 2 did not have detailed written documentation, but all pharmacists received similar information during their induction training according to the senior clinical lead pharmacists at the two sites. The pharmacists also received training on how to use the ePMA system from the ePMA pharmacy team. At both sites 1 and 2, it was observed that different ward pharmacists documented their notes in different locations on the ePMA system. However, pharmacists at site 3 communicated their written information in similar locations on the paper medication charts. Wards at sites 1 and 2 that had a technician working with the pharmacist were observed to work in parallel with the pharmacist. The technician would have a verbal handover with the ward pharmacist before the pharmacist started their ward work. They supported the pharmacist with medication and stock requests, medication histories and patient counselling.

The total number of communication events observed at the three study sites can be found in Table 20. Overall, more communication events were observed to have been initiated by the ward pharmacists with other HCPs across the three sites. The highest proportion of communication events observed per observation were noted at site 3 followed by site 2 then site 1.

	Site 1	**Site 2**	**Site 3**
Total number of communication events	749	677	1000
Number of communication events initiated by the ward pharmacists	600 *(80%)*	434 *(64%)*	765 *(77%)*
Number of communication events initiated by other healthcare professionals	149 *(20%)*	243 *(36%)*	235 *(23%)*
Mean number of communication events observed per observation ± standard deviation	37 ± 12	34 ± 14	50 ± 25

Table 20: Number of communication events at the three study sites

7.5.3 Communication initiation, channel and content

One of the objectives of this study was to document which HCPs the ward pharmacist initiated communication exchanges with while carrying out their ward duties and using what channel of communication. As seen in Table 21, across all three sites it was found that the ward pharmacists most commonly initiated communication with other pharmacists. This was followed by the ward pharmacists initiating communication with doctors at sites 1 and 3 and multiple HCPs at site 2. The most common channel of communication by ward pharmacists at sites 1 and 2 was written communication on the ePMA chart (*50%* and *40%* respectively) followed by face-to-face (*29%* at both sites). At site 3, the most common channel of communication used by pharmacists to communicate was written communication on the paper medication charts (*55%*), followed by face-to-face communication (*23%*). When pharmacists were asked to clarify who the documentation was directed to, on the ePMA system or the paper medication chart, the pharmacists unanimously responded that it was for other pharmacists who may look at the medication chart at a later date. It was also found that of all the communication channels utilised by the ward pharmacists to communicate with other pharmacists at sites 1 and 3, paper transcription sheets (*10%* at both sites) were the second most common channel used. Pharmacists at site 2 however were observed to rarely handwrite transcription sheets for two reasons. Firstly, the ward technicians took on the role of ordering the vast majority of medications required for patients on the ward and secondly the ePMA system could facilitate electronic medication requests, so medication orders rarely needed to be transcribed by hand. It was observed at both sites 1 and 3 that when a pharmacist did have a pharmacy technician supporting them on the ward, it was expected for the technician to complete the ordering of the required medications. However, very few pharmacists in this study at sites 1 and 3 had pharmacy technician support with them on the ward.

Most common recipients of the ward pharmacists' communication events			
	Site 1	**Site 2**	**Site 3**
1	Other pharmacists *(49%, n=293)*	Other pharmacists *(33%, n=141)*	Other pharmacists *(51%, n=400)*
2	Doctors *(20%, n=119)*	Multiple healthcare professionals *(24%, n=103)*	Doctors *(18%, n=134)*
3	Multiple healthcare professionals *(14%, n=87)*	Doctors *(21%, n=93)*	Nurses *(15%, n=111)*
4	Other *(17%, n=101)*	Other *(22%, n=97)*	Other *(16%, n=120)*
Total	600 (100%)	434 (100%)	765 (100%)
Most common healthcare professional to initiate communication events with the ward pharmacist			
	Site 1	**Site 2**	**Site 3**
1	Nurses *(73%, n=109)*	Nurses *(34%, n=83)*	Nurses *(62%, n=145)*
2	Doctors *(14%, n=21)*	Pharmacy technicians *(32%, n=77)*	Doctors *(15%, n=37)*
3	Other pharmacists *(7%, n=10)*	Doctors *(28%, n=68)*	Other pharmacists *(12%, n=27)*
4	Other *(6%, n=9)*	Other *(6%, n=15)*	Other *(11%, n=26)*
Total	149 (100%)	243 (100%)	235 (100%)

Table 21: Recipients of pharmacists communication events and communication events initiated by other healthcare professionals with the pharmacist at all three sites

As seen in Table 21, the most common HCP to initiate communication with the ward pharmacist was the nurse at all three sites, followed by doctors at sites 1 and 3 and the pharmacy technician at site 2. The most common channel of communication by other HCPs at all three sites was face-to-face (site 1: *64%*, site 2: *67%*, site 3: *77%*), followed by written communication in the ward diary (site 1: *26%*, site 2: *18%*, site 3: *20%*). The full list of communication channels can be found in appendix V.

Table 22 presents the three most common contents of communication between the ward pharmacist and other HCPs. It also presents the three most common contents of communication between the other HCPs and the ward pharmacist. The table does not add to 100%, as the full list of common communication content can be found in appendix U.

Most common content of communication events initiated by the ward pharmacist			
	Site 1	**Site 2**	**Site 3**
1	Medication review *(19%, n=114)*	Medication review *(19%, n=81)*	Medication supply requests *(15%, n=114)*
2	Medication supply requests *(14%, n=83)*	Discharge update *(13%, n=55)*	Medication review *(13%, n=100)*
3	Remove/amend prescriptions *(12%, n= 70)*	Medication reconciliation /bloods review *(12%, n=52)*	Medication reconciliation /bloods review *(11%, n=86)*
Most common content of communication events initiated by other HCPs			
	Site 1	**Site 2**	**Site 3**
1	Medication supply requests *(41%, n=61)*	Discharge update *(46%, n=111)*	Medication supply requests *(36%, n=85)*
2	Discharge update *(28%, n=41)*	Medication supply requests *(18%, n=44)*	Discharge update *(35%, n=82)*
3	Clinical advice *(10%, n=15)*	Patient handover/update *(13%, n=31)*	Patient handover/update *(10%, n=24)*

Table 22: The content of communication events initiated by the pharmacists and healthcare professionals at the three study sites

Figure 8, Figure 9 and Figure 10 present a visual representation of the communication pathways observed at the three study sites, centring on the pharmacist. The arrow heads illustrate the direction of the communication exchange. The speech bubbles indicate the most common content of the communication the HCP had with the ward pharmacist. The symbols next to the most common channel of communication indicate the location of communication exchange.

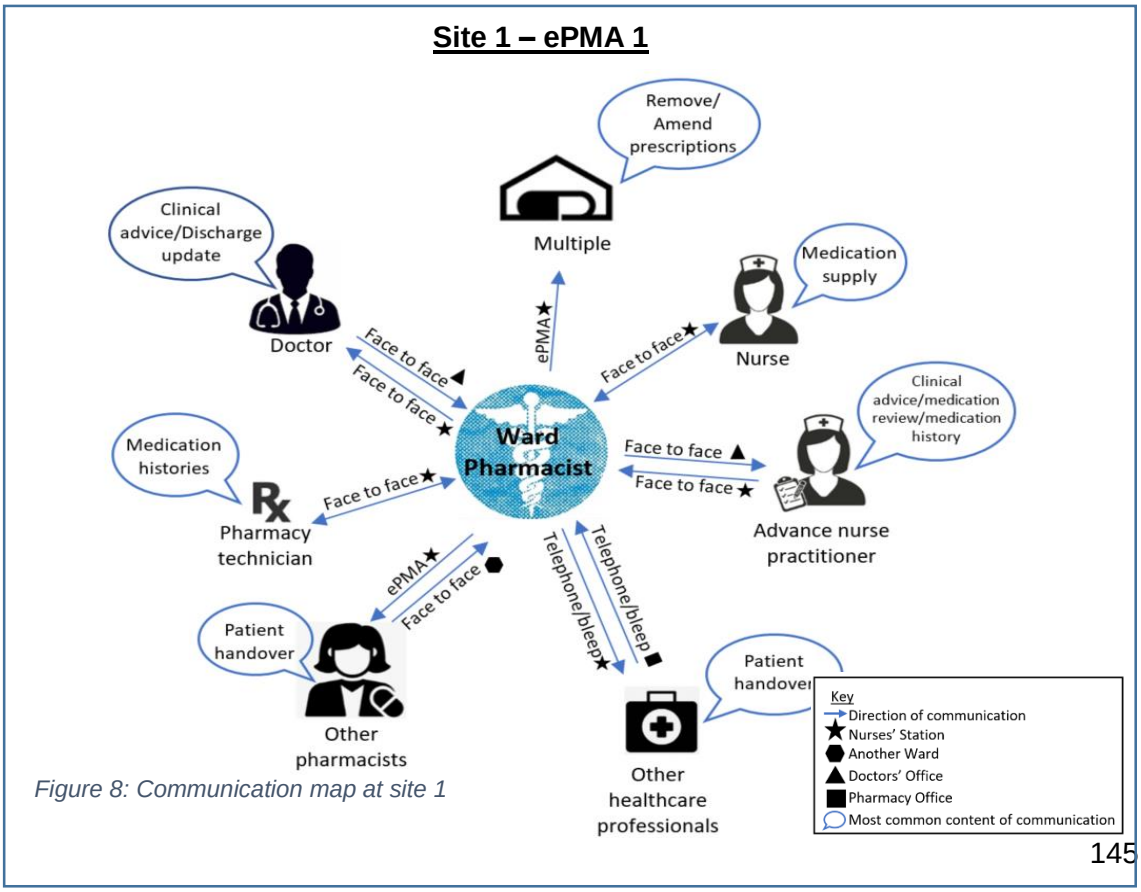

Figure 8: Communication map at site 1

Site 2 – ePMA 2

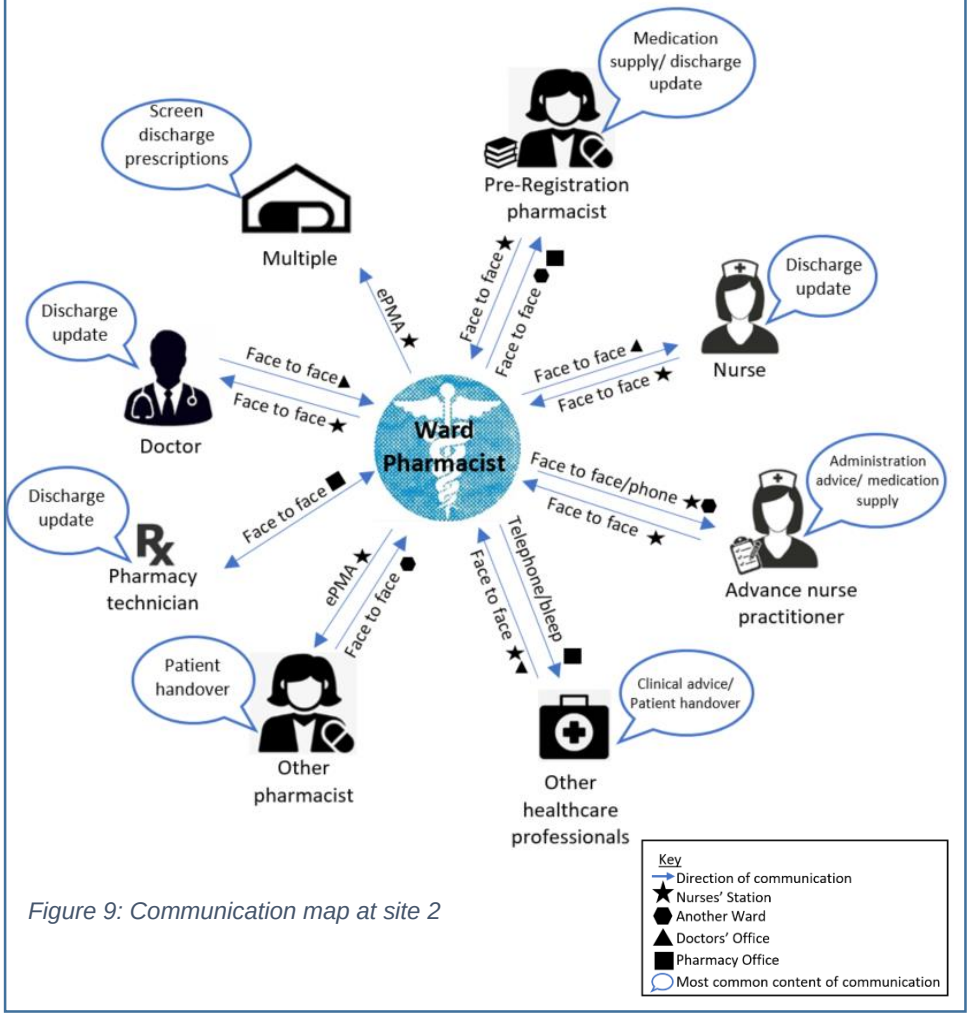

Figure 9: Communication map at site 2

Site 3 – Paper-based site

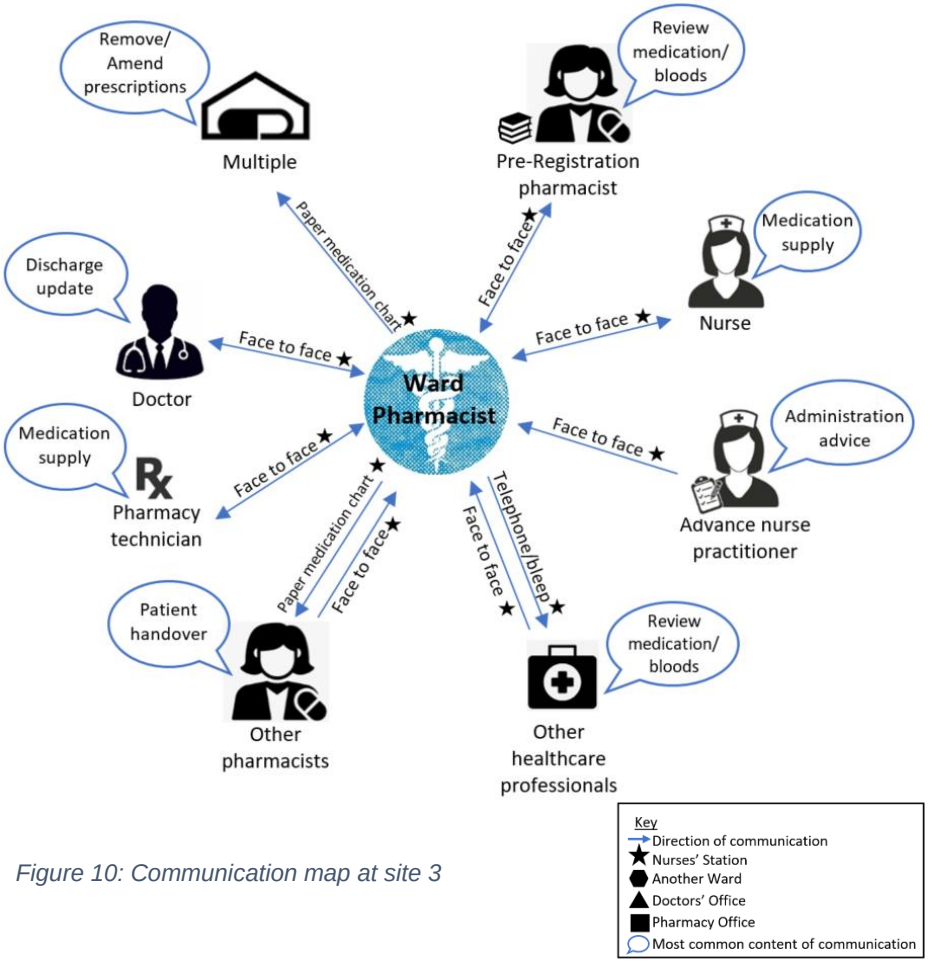

Figure 10: Communication map at site 3

7.5.4 Location of communication exchange

7.5.4.1 Pharmacists with other HCPs

Figure 11 presents the different locations of communication exchanges the ward pharmacists had with other HCPs at each of the study sites.

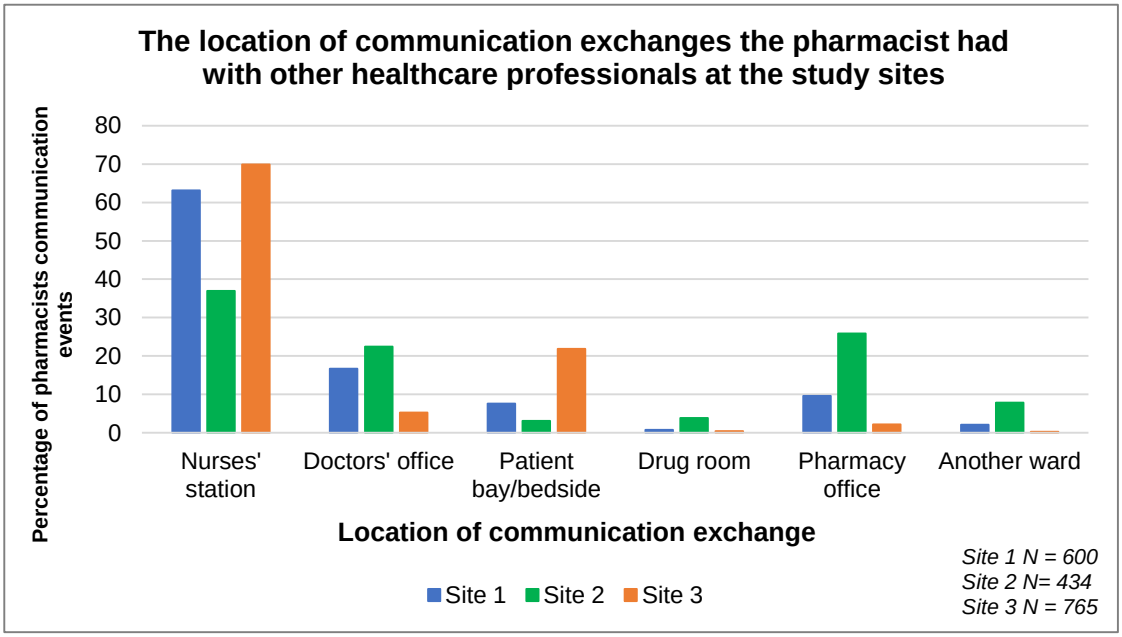

Figure 11: Location of communication exchanges between the pharmacist and other healthcare professionals per site

The graph suggests that the majority of communication exchanges initiated by the pharmacist with other HCPs took place at the nurses' station at all three sites. At all three sites it was noted that the pharmacists would usually try and speak to the nurse in charge to identify the patients who were newly admitted or being discharged. Pharmacists at the ePMA sites worked predominantly at or near the nurses' station as this was where the computers were located. At both the ePMA sites, most pharmacists worked on a fixed computer terminal rather than a computer on wheels (COW). The COWs were often not charged thus the pharmacists had no choice but to stay stationary with the COW by a charging socket or use a fixed computer terminal. There were often challenges with finding a computer that was free to use and working. When the COW was charged, the pharmacists were seen to work by the nurses' station and occasionally in the patient bay areas. At site 2, the pharmacy office was the second most common location for this communication exchange. It was observed that the pharmacy technician would conduct their handover there when the pharmacist arrived at work before the pharmacist went to

the ward. At site 3, when the medication charts were not present at the nurses' station, the pharmacist usually located the charts at the end of the patients' beds. The chi square test could not be applied as some of the predicted values in this data were less than five.

The different locations of communication exchange the ward pharmacists had with other HCPs have been presented in Figure 12, and were grouped into ward-based or non-ward based communication.

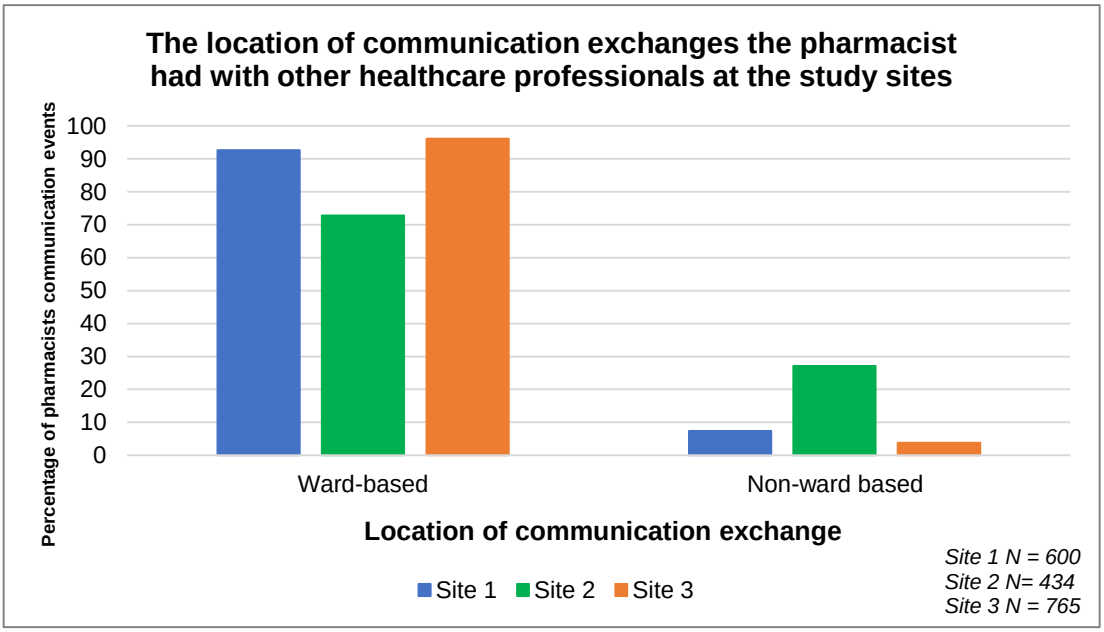

Figure 12: A graph presenting the location of communication exchanges between the pharmacist and other healthcare professionals at each site (condensed data)

Figure 12 shows that the majority of communication events between the pharmacist and other HCPs took place on the ward. Compared to the other sites, site 3 had highest proportion of communication between the pharmacist and other HCPs taking place on the ward. In the field notes, it was documented that the ward pharmacists carried out their clinical work on the ward as the medication charts were only accessible from there. At site 2, almost a third of pharmacists' communication was carried out away from the ward. As mentioned previously, a ward technician was available on each of the wards at the hospital. The pharmacist was able to deal with a number of queries and discharges from the pharmacy office, where they were able to find a computer to access the ePMA system on. The chi square test was carried out on the above data and revealed a

statistically significant difference between the two ePMA and paper sites and the location of communication exchanges pharmacists had with other HCPs (*p<0.001*).

7.5.4.2 Other HCPs with the ward pharmacist

Figure 13 presents the different locations of communication exchanges initiated by other HCPs with their ward pharmacists during the observations at each of the study sites.

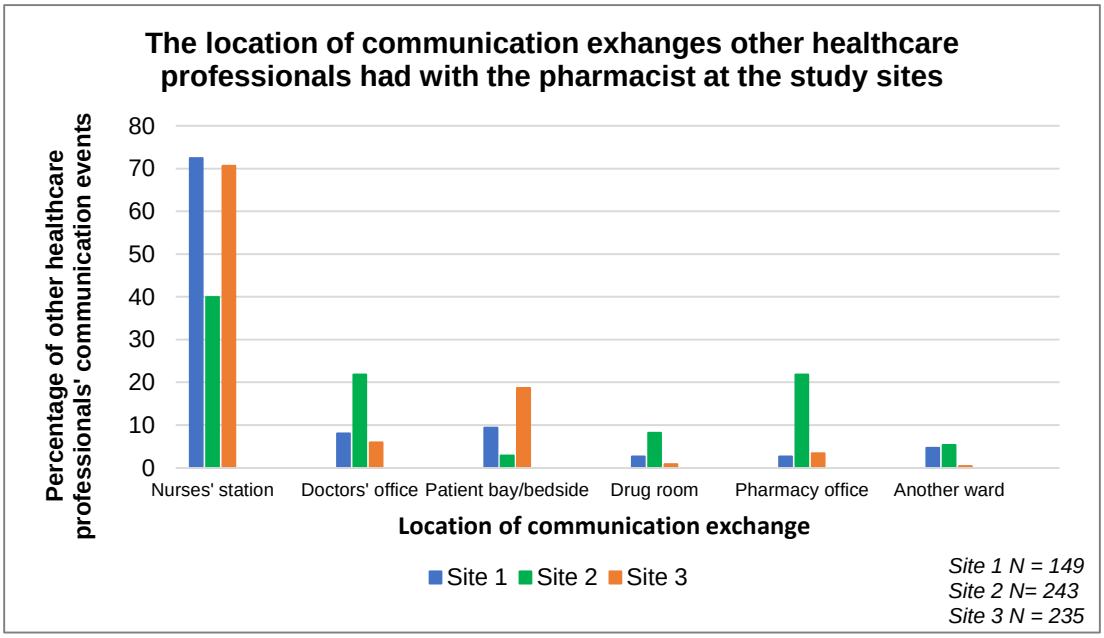

Figure 13: A graph presenting the location of communication exchanges between other healthcare professionals and the pharmacist at each site

Other HCPs communicated with the ward pharmacist most commonly at the nurses' station. Unsurprisingly, as the pharmacists were usually seen to be working at this location, other HCPs instigated communication with the pharmacists there. The next most common location for communication exchange with the pharmacist at site 3 was at the patients' bedside/bay. At site 2, the doctors' office and the pharmacy office were jointly the most second most common location for this communication exchange. At site 1, HCPs initiated communication exchanges with the ward pharmacist over 70% of the time at the nurses' station. The chi square test revealed a statistically significant difference in this data between the two ePMA and paper sites and the location of communication exchanges other HCPs had with their ward pharmacist (*p<0.001*).

As mentioned earlier, the data was condensed to present the data as ward-based communication and not ward-based communication and compared across the sites. The data for HCPs communicating with pharmacists was also presented in Figure 14.

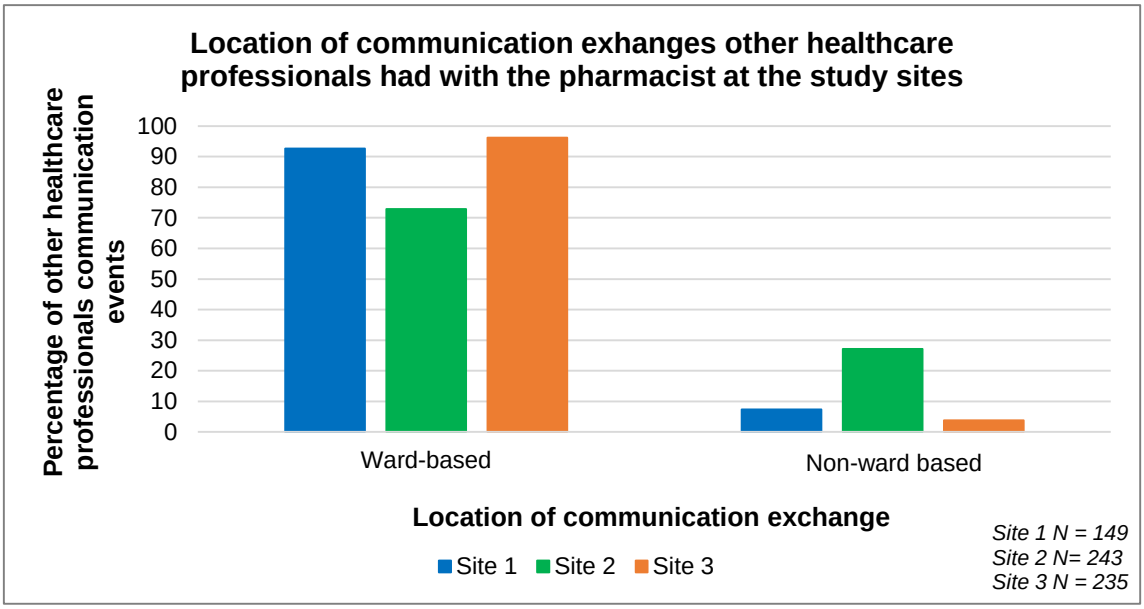

Figure 14: The location of communication exchanges between other healthcare professionals and the pharmacist at the study sites (condensed data)

Figure 14 shows that the majority of communication between other HCPs and the pharmacist occurred while on the ward at all three sites. Almost a third of all the communication initiated by other HCPs at site 2 took place away from the ward. In the field notes it was documented that the pharmacists had face-to-face handovers with the ward technician and were often contacted by phone or bleep by doctors and nurses when the pharmacist was based in the pharmacy office. Less than 10% of all communication initiated by other HCPs with the pharmacist took place away from the ward at sites 1 and 3. The chi square test could not be applied as some of the predicted values were less than five.

7.5.5 Channel of communication exchange

7.5.5.1 Pharmacists with other HCPs

The data in Figure 15 presents the channel of communication the pharmacists used to communicate information to other HCPs at each of the study sites. The data for the channel of communication between the pharmacist with other HCPs was condensed into three categories; verbal, electronic and paper-based communication. The full list of communication channels can be found in appendix V.

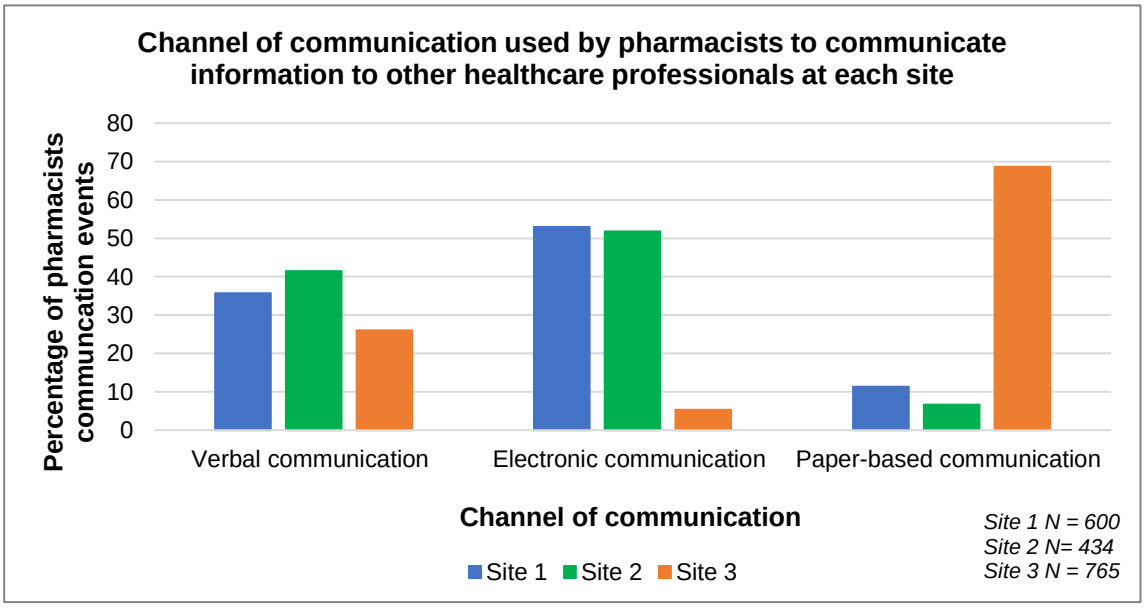

Figure 15: Channel of communication used by pharmacists to communicate with other healthcare professionals at the three sites

Figure 15 shows that just over 50% of communication between the pharmacist and other HCPs took place electronically at sites 1 and 2. At site 3, the most common channel of communication used by pharmacists was paper-based. The least verbal and electronic communication was observed at site 3. In the field notes from the observations at site 3, it was noted that pharmacists were required to review the paper medication charts in order to clinically screen prescriptions. While they screened the prescriptions, they would commonly document changes, add instructions, endorse medication orders, and clarify prescriptions. They also completed all their medication histories on the paper medication charts. The most verbal communication and least paper-based communication took place between pharmacists and other HCPs at site 2. From the field notes it was found that pharmacists only documented in the paper medical notes on three occasions. Paper

medication charts were still used at site 2 to prescribe some medication such as warfarin, and the ward pharmacists are expected to review these. Only one pharmacist was observed to have reviewed the paper medication charts during their ward visit. The second most common channel of communication pharmacists had with other HCPs was verbal communication, either face-to-face or over the phone. The chi square test revealed a statistically significant difference in this data between the two ePMA and paper sites and the channel of communication the pharmacists used other HCPs (*p<0.001*).

7.5.5.2 Other HCPs with the ward pharmacist

The data in Figure 16 presents the channel of communication other HCPs used to communicate information to the pharmacist at each of the study sites.

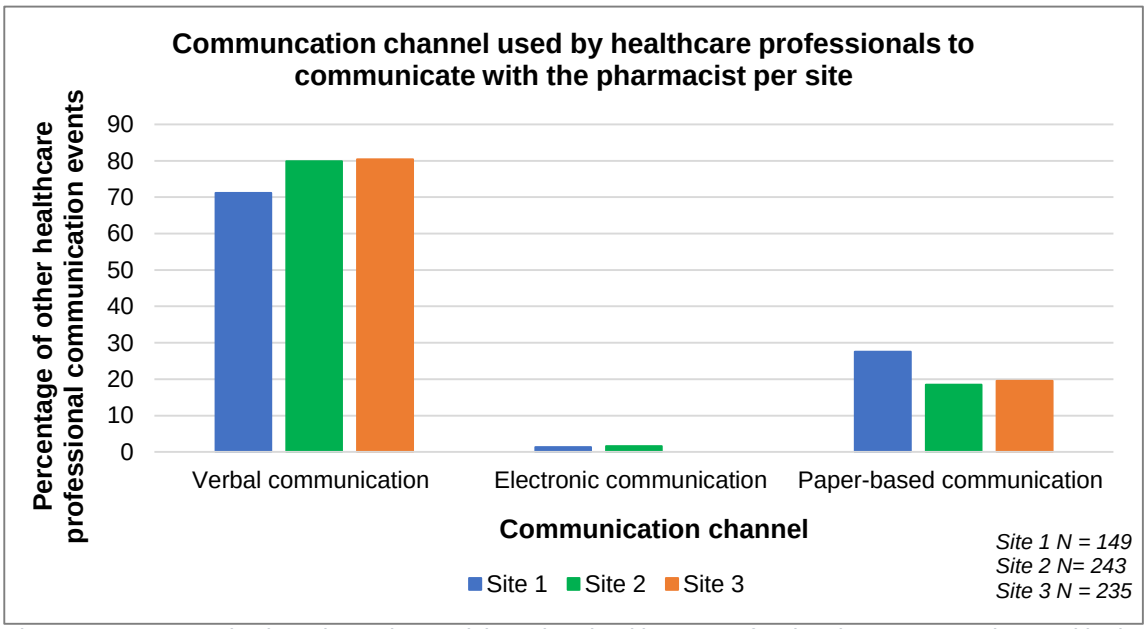

Figure 16: Communication channels used by other healthcare professionals to communicate with the pharmacist

Figure 16 illustrates that over 70% of communication between HCPs and the ward pharmacists were observed to be verbal at all three study sites. The lowest proportion of electronic communication was utilised by HCPs to communicate with the pharmacist at all the sites. Site 1 was observed to have the highest proportion of paper-based communication between the HCPs and the ward pharmacist. A chi square test could not be applied as some of the predicted values were less than five.

7.5.6 Logistic regression

In this study, association between the different prescribing systems (exposure) and the mode of communication as the outcome (synchronous communication) was investigated. All the communication events initiated by the ward pharmacists were summarised in Table 23.

Type of prescribing system (site)	Synchronous communication events, n (%)	Asynchronous communication events , n (%)	Total communication events (%)
ePMA 1 (1)	214 (*36%*)	386 (*64%*)	600 *(100%)*
ePMA 2 (2)	180 (*41%*)	254 (*59%*)	434 *(100%)*
Paper-based (3)	199 (*26%*)	566 (*74%*)	765 *(100%)*

Table 23: Number of synchronous and asynchronous communication events at the three different sites

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P-value	Adjusted OR* (95% CI)	P-value
Type of prescribing				
ePMA 1 (1)	0.63 (0.50 – 0.80)	<0.001	0.62 (0.49 – 0.78)	<0.001
ePMA 2 (2)	0.50 (0.39 – 0.64)	<0.001	0.45 (0.34 – 0.59)	<0.001
Paper-based	Reference		Reference	
**Adjusted for location of communication exchange* *OR: Odds ratio, CI: Confidence interval*				

Table 24: Logistic regression predicting the odds ratio of synchronous communication at the ePMA sites

Table 24 presents the results from the univariate and multivariate logistic regression. The null hypothesis was that there was no difference in the proportion of synchronous and asynchronous communication between ePMA and paper sites. A logistic regression was used to test the hypothesis. The statistical power of a hypothesis test is the probability that the test rejects the null hypothesis when a specific alternative hypothesis is true. The statistical power was set to 80%, requiring a sample size of 1089 communication events per site in order to detect a difference between the two groups (ePMA vs. paper sites). The results from the univariate logistic regression demonstrates that pharmacists at site 1 were 37% less likely to have synchronous communication when compared to the paper-based site. Pharmacists at site 2 were 50% less likely to have synchronous communication when compared to the pharmacists at the paper-based site. When adjusted for location of communication exchange, the results are similar with sites 1 and 2 respectively being 38% and 55% less likely to have synchronous communication

compared to the pharmacists at the paper-based site. These results were all statistically significant ($p < 0.001$).

7.5.7 Patients reviewed by ward pharmacists

During the observations, 6-24 (total of 273), 6-26 (total of 401) and 8-34 patients (total of 445) were present on the observed wards at sites 1, 2 and 3 respectively. The PhD student documented in the field notes each occasion a medication chart was reviewed by the ward pharmacist and noted that 98% (*n= 267*), 66% (*n=263*) and 53% (*n=238*) were reviewed by the ward pharmacists at site 1, 2 and 3 respectively. Figure 17 presents the total number of patients, who had their medication charts reviewed and how many of those patients whose medication charts were reviewed were also seen face-to-face by the pharmacist.

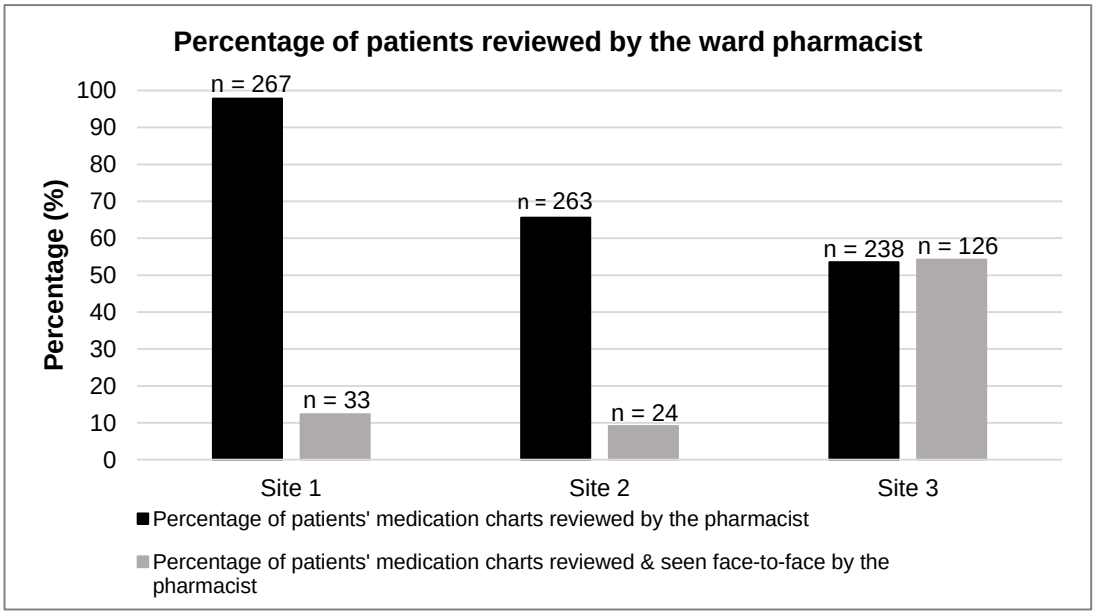

Figure 17: Percentage of patients reviewed by pharmacists during the observations at the three sites

It was observed that the pharmacists working at sites 1 and 2 visited fewer patients face-to-face when reviewing their medication charts (*12%* and *9%* respectively). At site 3, 54% of the medication charts were reviewed face-to-face with the patient. It was noted from the field notes that paper medication charts were often located at the end of the patient's bed at site 3, and the pharmacist would frequently introduce themselves and explain what they were doing to the patient. At both the ePMA sites, pharmacists were observed to work on fixed computer terminals or COWs connected to a power supply

and were not seen to walk into patient bays. The chi square test revealed that a statistically significant result was observed from the data for both patients' medication charts being reviewed by the ward pharmacist at each of the study sites ($p<0.001$) and the proportion of patients were reviewed face-to-face by the ward pharmacist ($p<0.001$).

7.6 Discussion

This study provided a unique insight into ward pharmacists' activities, specifically their communication with other HCPs and how this may differ between ePMA and paper-based prescribing systems. The central aim of this study was to observe ward pharmacists' communication at three sites using different prescribing systems and to explore the nature of any similarities and differences. The ward pharmacists' role and their usual working practices were described from the different observations conducted at each of the sites. In England, hospital clinical pharmacy services typically include daily ward visits, medicines chart reviews, provisions of individualised recommendations on medicine use, and pharmacist attendance on multidisciplinary ward rounds to provide specialist input on medicines management (Wickens et al., 2013, Brock and Franklin, 2007). This was observed at all three sites in this study. Pharmacists at the study sites were observed to regularly communicate with other HCPs on their wards and members of their pharmacy team. The qualitative aspect of the observations provided an important context to the results in this study.

7.6.1 Similarities and differences in communication strategies between sites

The channel, location and content of communication recorded at each of the study sites were found to be similar, but any differences may be explained by the organisational and team structures that existed. The most common HCP the ward pharmacist communicated with were other pharmacists through documentation on the ePMA system or the paper medication chart. When pharmacists at all the study sites were asked to comment on who the documentation was directed to, on the ePMA or paper medication chart, they unanimously stated it was for other pharmacists' information. This was found to be consistent with previous literature that noted pharmacists prefer to document on

the medication chart than in the medical notes (Pullinger and Franklin, 2010). Pharmacists in previous studies have also reported an increase in documentation when using ePMA (Burgin et al., 2014). They attributed this to the ease of documenting on the ePMA system, to add legal protection for themselves, as well as contribute to the clinical team communication. Burgin et al (2014) stated that the senior pharmacists perceived this behaviour was more common among junior pharmacists. They believed that junior pharmacists preferred written documentation, as opposed to verbal communication with other HCPs, due to the ease of note entry and also possibly pharmacists' lack of confidence at approaching members of the medical team (Burgin et al., 2014). In the observations conducted as part of this PhD study, the majority of pharmacists that took part were junior (band 6) to middle grade (band 7) and the results showed that pharmacists at all the study sites communicated through documentation in the ePMA or paper medication chart. The differences in communication strategies among the pharmacist AfC bands were not studied as it was not one of the objectives of this study, but the majority of pharmacists observed in this study were junior to mid-grade. This information would be valuable to feed back during training of junior to mid-grade pharmacists and encouraging them to conduct more verbal communication, as previous research has also advocated the benefits of verbal communication (Burgin et al., 2014, Lindqvist et al., 2019). Further analysis of the results in this study found that when ward pharmacists initiated communication exchanges with other HCPs, they predominately did this through asynchronous communication. Previous literature has stressed the need to continue verbal communication between pharmacists and other HCPs in order to maintain rapport and collaborative relationships (Bedouch et al., 2012). The result from the logistic regression suggested that, compared to the paper-based site, the pharmacists at both ePMA sites were more likely to participate in asynchronous than synchronous communication. Previous literature has suggested that clinical settings using ePMA adopt a more asynchronous approach among HCPs compared to paper-based settings (Beuscart-Zephir et al., 2005). It has been highlighted, in previous work, that pharmacists prefer synchronous communication in situations requiring quick

modifications in an ePMA setting (Bedouch et al., 2012). The pharmacists at the ePMA sites may have become accustomed to working with the system and adopted more asynchronous modes of communication.

The most common content of communication by the ward pharmacists at sites 1 and 2 was conducting medication reviews, which was also the second most common at site 3. This finding is in line with previous research conducted in both Australia and the UK (Westbrook et al., 2019). Westbrook et al (2019) found that there was a reduction in the number of medication supply requests since the implementation of ePMA systems at the two hospitals in Australia and the UK. This is reflected in this study as site 3, the paper site, had the highest proportion of communication related to mediation supply requests by the ward pharmacist. Pharmacists at site 2 were observed to deal with minimal medication supply requests as this task was the responsibility of the ward technician. Furthermore, the ePMA system at site 2 allowed for medication orders to be processed electronically that reduced the workload on the pharmacist leaving them to focus on other tasks. In this study, it was found that the HCP who communicate the most with the pharmacist was the nurse and this was observed to be similar between the two ePMA and paper-based sites. The nurses, including the nurse in charge of the ward, were an integral member of the team who were observed to be an important person to obtain information about patients. As they spent the majority of their time caring of their patients, the pharmacists sought them for information related to the patient such as discharge updates. This was carried out face-to-face as the nurses were based on the ward. The results from this study indicate that pharmacists carried out their work from the ward and conducted most of their work from the nurses' station. This was due to where the computer terminals were located and usually available and often the paper medication charts were found there too. A qualitative study using focus groups with pharmacists in the UK also reported this as a major concern of the removal of paper charts from patients' bedsides and a relocation of pharmacists' work to central computer locations (Burgin et al., 2014). Though the pharmacists conducted their work on the ward, they were seen to

remain static throughout their ward visit, especially at the ePMA sites. At the paper-based site, following the nurses' station, the pharmacists conducted the majority of their work from the patient bay or bedside. As the medication charts were located in this area, the pharmacists were often found by the patient's bedside, providing an opportunity to interact with patients more so than at the ePMA sites. Previous research has highlighted this shift in the location of pharmacists' work as they no longer need to search for the patients' medication charts at their bedsides (Lo et al., 2010, Westbrook et al., 2019). It has also been suggested that working away from the patient's bedside may contribute to fewer interactions with HCPs such as nurses as their communication has often been opportunistic (Lo et al., 2010). Being less visible to other HCPs may be perceived as a barrier to collaborative communication.

The pharmacists' style of working at site 2 was observed to be the most different when compared to the other two sites in this study. This could be due to the team structure on the wards. As mentioned in the results, the role of the pharmacy technician at site 2 was observed to be the most prominent compared to the other two sites. This was because every ward was staffed with technical support who often started work before the pharmacist arrived on to the ward. It was observed, and reflected in the quantitative data, that pharmacists at site 2 were able to complete other tasks such as screening discharge prescriptions and reviewing patients' medications and blood results, while the ward technician was able to complete medication histories, liaise with the ward nurses for patient medication orders and complete patient counselling to reduce the burden on the ward pharmacists. This may also explain why the second most common HCPs to communicated with the ward pharmacist at site 2 was the pharmacy technician. The observed work dynamics between the ward pharmacist and their technician was found to be a fundamental difference among the study sites. Previous literature has advocated and identified the benefits of having technicians on wards to support pharmacist workload (Boughen et al., 2017, Langham and Boggs, 2000). It has been noted that ePMA systems may have increased pharmacists' workload and it has been suggested

that having more ward based technicians would benefit the pharmacists as they would be able to focus on clinical queries and have an opportunity to place themselves in the consultant ward rounds (Mehta and Onatade, 2008). Interestingly, the second most common location for pharmacists' communication at site 2 was away from the ward, specifically the pharmacy office. This may be due to the fact that pharmacists complained of limited hardware on the wards that restricted their productivity and ability to carry out their role. The ward technicians were observed to provide the pharmacists with an update of patients in the pharmacy office and directed the pharmacists to the tasks of highest priority.

Site 2 also had an organisational initiative in place called 'pre-11 discharges' that meant the pharmacists' priority every day was to complete any discharges for patients on their wards. It was noted that all the HCPs working with the pharmacist on the ward provided the pharmacist with updates regarding the status of discharge prescriptions, and likewise the pharmacist would update other HCPs of any delays or queries regarding the discharges. Although this was an important task for the pharmacist to complete at the other two sites involved in this study, it was found that this organisational drive to complete 'pre-11 discharges' directed all the HCPs' efforts, including the ward pharmacists. This could provide an explanation for the ward pharmacist communicating with multiple HCPs as the second most common, following other pharmacists at site 2. During the observations, it was noted that the ward pharmacist had to navigate between different electronic systems in order to complete a discharge prescription. The PhD student did not document the time taken to complete a discharge prescription, but it was perceived to be a time-intensive and error-prone task by both the PhD student and the pharmacists. Navigating through different electronic systems to complete one task can lead to potential miscommunication and duplication of work (Ahmed et al., 2018).

7.6.2 Potential consequences for patient safety

The focus of this study was to observe the communication strategies applied by the ward pharmacist and other HCPs. The communication between the pharmacist and their

patients could not be observed, as this was not the primary focus of the research and was outside the conditions of the ethics approval. However, the total number of the patients present on the ward during the observations, the number of patients who had their medication charts reviewed and the number of patients who had their medication chart reviewed along with a face-to-face review by the ward pharmacist was documented. These results revealed that more medication charts were being reviewed by the ward pharmacists during their ward visit at the sites using ePMA. This result is in line with previous research that concluded that pharmacists are able to review more patients' medication charts, as they were no longer unavailable when patients were in theatre or having investigations (Franklin et al., 2007). There may be some negative implications for patients of these results. The clinical significance of reduced patient contact is unclear, but pharmacists in previous literature have suggested that patients are still an integral part of the medication review process (McLeod et al., 2019). There was a difference noted between the two ePMA sites in this study and the number of medication charts reviewed by the pharmacist. One potential difference between these two ePMA sites may be attributed to the design of the ePMA interface. It was observed that the pharmacists at site 1 were able to navigate the pharmacy dashboard page that displayed all the patients to the pharmacist and were able to click into the medication charts, often working through the list of patients in numerical order of their bed numbers. At site 2, the pharmacists had to consult their paper handover to identify new patients or patients they considered a priority. They would then have to search for the patient on their ePMA system. At site 1, the pharmacists were able to simply see the icon next to the patients' names who required a medication history, medication orders or reviews, unlike site 2 where the pharmacist would have to identify these patients through their paper handover or be told verbally by another HCP such as their technician or by a nurse. There is a potential risk that patients in need of a pharmacist's review could go unseen as both ePMA systems studied did not have the functionality to highlight high risk patients. Another potential reason for differences between sites 1 and 2 could be the accessibility to the patient records. Pharmacists at site 2 had to consult the paper medical

notes and it was observed to take time to search for them whereas, at site 1, the medical notes could be accessed from the ePMA system. Pharmacist at site 1 therefore has easier access to all the patient information from one system.

The results at site 3 reflect the previously known challenge for pharmacists and other HCPs of having to search for paper medication charts (Van Wilder et al., 2016). In this study, at site 3, the pharmacists were observed to struggle to locate patients' medication charts as they were not located at the end of the patients' beds or at the nurses' station. Often the medication charts were being used by other HCPs or the patient and their medication chart were off the ward for a procedure or that the medication chart was simply misplaced. This could account for the lower number of medication charts that were reviewed by the pharmacists at this site compared to the ePMA sites. This study is the first of its kind to describe the number of patients who were reviewed face-to-face by the ward pharmacist at ePMA sites compared to a paper-based site. The pharmacists at the ePMA sites reviewed fewer patients face-to-face compared to the paper-based site. This may be because the majority of paper medication charts were located at the end of the patient's bed, so it was easier to instigate communication with them. It was noted that site 2 had the smallest percentage of patients reviewed face-to-face by the ward pharmacist. This may be due to all the wards at site 2 having a regular ward based pharmacy technician, who often started their ward work before the pharmacist. The technician therefore had an opportunity to see any new or high priority patients face-to-face and hand over to the pharmacist. It was observed that pharmacists at site 1 relied on the electronic medical notes, summary care records and previous discharge letters to gather information regarding their patients. As all the information is available electronically, the pharmacist may have been less motivated to see their patients face-to-face to confirm details. There are implications of this for both the ePMA sites. The perceived visibility of the pharmacist may be reduced for the patients, who may only be visited by a pharmacy technician. Though the pharmacy technician would be able to conduct accurate medication histories and be able to assess a patient's medication

management status, they are not qualified to answer clinical queries that a patient may ask. On the contrary, as the pharmacist is able to review patients remotely, the pharmacist may be able to prioritise the patients who require a face-to-face review and have more targeted conversations with these patients. There is a potential negative impact on pharmacist-patient relationship. It could be interpreted that pharmacists exhibit a one-sided approach when reviewing patients and not providing patients with the opportunity discuss their concerns or opinions on their treatment. The overall reduction in patient contact due to the removal of paper charts and a relocation of pharmacists' work to central computer locations has been highlighted as a concern in previous literature (Burgin et al., 2014, Mehta and Onatade, 2008, Westbrook et al., 2019).

7.7 Implications for practice

As the results showed, there were limitations and challenges observed with all the prescribing systems at each of the study sites. It was recognised by the pharmacists at the ePMA sites that certain new features, if introduced, could reduce the demands of the ePMA system and streamline tasks. Since the observations, site 1 has implemented a feature to allow for electronic medication ordering directly to the pharmacy for dispensing. This is likely to reduce the paper burden, risk of errors and improve the audit trail of medication orders. One of the greatest challenges observed at site 2 was the pharmacists having to use multiple electronic systems as well as paper medical notes to complete their work. Site 2 is now in the process of switching over to an all-in-one electronic system that will include the medical notes, medication chart, patients' investigation results and discharge letters.

Previous studies have suggested to update pharmacy guidelines on specific work process e.g. using ePMA to document queries arising from clinical screening of inpatient medications (McLeod et al., 2019), as it was observed at the ePMA sites pharmacists documented the same queries or notes in different places on the ePMA system. As there is no clear guidance from the hospitals on where pharmacists should document their notes, it was found that pharmacists documented in various places. This could pose a

challenge for other HCPs to find pharmacists' documentation as previously on paper it always be found in the same place. Hospitals using ePMA or in the process of implementing it should therefore focus on updating their clinical pharmacy standards so all pharmacists are confident about where to document information and ensuring that other HCPs are aware of where to find this information.

Pharmacists at sites 1 and 2 struggled to locate COWs that were working or available while on the ward and were often restricted to working on fixed computer terminals. This may also contribute to why pharmacists conducted some of their work in the pharmacy office, away from the ward. In order to overcome this, pharmacists could be allocated a COW or mobile device on the ward specifically for their work. The ward pharmacist would be responsible for maintaining the hardware, whilst having ownership of a device facilitating them to have greater access to both the ePMA system and their patients.

7.8 Implications for research

This study aimed to describe pharmacists' communication with other HCPs and how other HCPs communicated with them. The location, channel and content of communication were identified but the time taken for pharmacists to communicate information or complete certain tasks e.g. discharge letter screening were not documented. It would be important to document how long pharmacists spent in each location and how many communication events they complete there.

As this was the first study of its kind in the UK, the aim was to explore the communication strategies used by ward pharmacists and other HCPs. It was estimated that 15-20 pharmacists would need to be observed to achieve the minimum sample size. The number of participants could not be increased due to constraints at the hospital sites and delays with obtaining ethics approval. Using this work, future researchers could attempt to collect data from more pharmacists or carry out this study over a longer period of time in order to reach the minimum sample size. There is still limited research studying the impact of ePMA system on patient safety and the patients' perspective on ePMA systems in a secondary setting. As the results suggested, fewer patients at the ePMA sites were

seen face-to-face for medication reviews by the ward pharmacist. The consequences of this on patient safety and patient involvement could not be established. It would be useful to study in future work, why and how pharmacists at ePMA sites prioritise patients who need to be seen face-to-face.

7.9 Strengths and limitations

This study is the first of its kind to observe pharmacists and other HCPs' communication across three different prescribing systems in the UK. One PhD student carried out all the observations to ensure consistency in the data collection across the sites.

This study was exploratory in its nature and therefore could not rely on previous literature to support the sample size calculation. However, it is anticipated this study will guide future work in this area. Furthermore, it was not always possible for the PhD student to capture all the written documentation the ward pharmacist being observed reviewed on the paper and ePMA chart. A strength of this study is that it explores the realities of different prescribing systems used in practice. However, this might also limit its generalisability because the observations are grounded in the details of these particular contexts, systems' implementation and maturity. It was also not possible to attain if there were situations where perhaps information should have been communicated but was not. The pharmacists' interactions with their patients on the ward could not be observed, therefore it was not possible to comment on the nature of communication between them.

At site 1, the PhD student noted that pharmacists, who were being observed, would spend less time in the pharmacy office, but on days those pharmacists who were not being observed would stay longer and be seen working through patient records from their desks. The PhD student asked all the pharmacists to work as they usually would, but noted that the pharmacists changed their usual location of working. This was further seen when many of pharmacists were not recognised by the nurses (including the nurse in charge) and the doctors on the ward. Pharmacists may have behaved differently and worked in different locations to where they would have normally conducted their work. Although the PhD student was as unobtrusive as possible to minimise the possibility

influencing the results, the Hawthorne effect cannot be ruled out (Roethlisberger and Dickson, 1939).

7.10 Conclusion

This study provides both quantitative and qualitative findings to aid the mapping of pharmacists' communication with other HCPs. It was found that pharmacists communicated most with other pharmacists and the pharmacists used written documentation on either the electronic or paper-based chart to communicate with other HCPs. On the other hand, the pharmacist communicated with other HCPs face-to-face and other HCPs also communicated with their ward pharmacists predominantly face-to-face. The pharmacists were found to conduct their communication with other HCPs while present on the ward, but centred around the nurses' station. It was also found that pharmacists reviewed fewer patients face-to-face at the ePMA sites, compared to the paper-based site, however, more medication charts were reviewed by the pharmacists at the ePMA sites. There may be negative implications of fewer patients being reviewed face-to-face on the pharmacist-patient relationship, but clearer clinical pharmacy standards could improve and direct pharmacists to the patients who are in most need of their review. In the next chapter, the overall key findings of this PhD will be summarised and discussed.

Chapter 8: Discussion

This chapter will discuss the key findings from this research and provide a high-level comparison with previous literature. The overall strengths and limitations, along with the implications for practice and suggestions for future work will then be addressed at the end of the chapter.

8.1 Summary of key findings

The overall aim of this PhD was to explore the impact of ePMA systems on pharmacists' communication with HCPs and identify areas for improvement. The aim was addressed through qualitative and quantitative research methods.

By conducting a systematic review of the existing literature on the impact of eP on the working practices of HCPs, key under researched areas of interest were identified to further study, as well as important features to take into consideration during the PhD. The systematic review highlighted that the context and implementation of technology plays a crucial role when comparing the same or different prescribing systems, whether studied in one setting or nationally. The design of ePMA systems can also influence users' expectations of its capabilities. Often these systems may be customised and used in specific ways to suit clinical requirements and HCPs' workflows in these settings. Some existing hospital systems have been developed and implemented in specialist clinical settings such as intensive care (Cornford et al., 2010). As the English government strives for all hospitals to uptake a paperless approach to prescribing, there is a need to study the impact of these systems in the inpatient setting, in both medical and surgical specialities. It was identified in the systematic review conducted that, where possible, more than one ePMA system should be studied in order to make some generalisable deductions. Communication has previously been identified as one of the most important contributing factors to medical mishaps (Macrae, 2017, Sutcliffe et al., 2004). Increasingly across healthcare, information systems are being designed and implemented to ensure safety-critical information is communicated effectively and

securely; however, the reliability of these systems and local practices are greatly driven by the fundamental assumptions of the people who are doing the communicating (Macrae, 2017). The systematic review conducted as part of this PhD also highlighted pharmacists as key contributors to the implementation and supporting the ongoing use of eP systems in hospitals, but also revealed under researched areas of their working practices. Furthermore, comparing ePMA systems with paper-based prescribing to observe any similarities or differences, that may exist between them provided a different perspective when trying to understand the benefits of technology.

A qualitative study was therefore conducted, involving focus groups with pharmacists and semi-structured interviews with doctors and nurses to gain their perspective on the impact of ePMA systems on their communication with each other. This was the first study of its kind in the UK that explored these three HCPs' experiences and opinions of the effects of ePMA systems and paper-based prescribing systems on their communication. The focus groups and semi-structured interviews study highlighted that HCPs recognised that ePMA systems were broadly used for documentation and communication. They all believed verbal communication, face-to-face in particular, was the ideal form of communication between HCPs. This was because the HCPs believed verbal communication allowed for more negotiations and discussions for better collaborations regarding patient treatments. They also felt that their current ePMA systems were not sophisticated enough to direct information to other HCPs in a targeted way. Previously on paper, the property of notation provided all HCPs with subliminal communication (Green et al., 2006). The colour of the pen, location, handwriting and type of amendment provided all HCPs with feedback that is no longer available with ePMA systems. Previous literature has referred to this phenomenon as 'scarring' (Green et al., 2006). The authors explained that when words are crossed out on paper, the previous work is still visible whereas electronic systems are 'self-healing' and it may not be possible to see changes (Green et al., 2006). Participants in the focus groups and interviews raised this as an issue with the ePMA systems in that it is not possible for

HCPs to notice feedback from pharmacists they previously identified due to their green coloured pen annotations. This suggests, as mentioned by Green et al, (2006), that some 'scars' are useful to a person working with the document, who therefore receives feedback or advice on their prescription. HCPs in the focus groups and semi-structured interviews study highlighted this as a limitation of the ePMA system and stated that the threshold for providing feedback had been raised since the introduction of these systems. The doctors felt that the pharmacist was less available to answer their queries, hence would only make a conscious effort to contact the pharmacist if they needed additional support. For example, doctors perceived that now if a prescription error was made on an ePMA system, the pharmacist would need to make a self-assessment if the error was substantial enough to be fed back (i.e. verbally) to the original prescriber. Doctors specifically stated they appreciated and learnt from the pharmacists' annotations on the paper medication charts and were able to associate such amendments with the pharmacist. To further add to the challenges, HCPs explained that there are many different places to document on ePMA systems and HCPs may also have different screens from other HCPs on the system. The communication intended for specific HCPs may therefore get 'lost' within the system.

The focus groups and semi-structured interviews sequentially led to exploring the benefits and concerns highlighted by the different HCPs through observations of pharmacists working in clinical practice. These were conducted at the same three hospital sites from the focus group and semi-structured interviews study. The findings suggested that that the ward pharmacists at all three study sites communicated with a variety of HCPs to complete their ward work. The pharmacists, when observed, all completed the majority of their work from the ward but during the observations it was noted that the pharmacists behaved differently as indicated by other HCPs on the wards, especially at site 1. Other HCPs on the wards, where the pharmacists were being observed, failed to recognise the ward pharmacist, which led the observer to believe the pharmacists did not regularly conduct their work from the ward. This corroborated the

concerns raised by the doctors and pharmacists at site 1 in the focus groups and interviews, who had felt the presence of the ward pharmacists had reduced since the introduction of ePMA. The pharmacists at the paper-based site were also concerned about remote clinical screening and contacting prescribers over the phone if they had to work with ePMA in the future. Pharmacists were observed to predominately communicate through documentation on their respective electronic or paper-based prescribing system. They did not document in the medical notes as often as compared to other channels of communication. According to the pharmacists in the focus groups, the pharmacists' choice of communication channel was often dependent on the situation and who the intended recipient was. Previous literature has highlighted that this may be due to traditional and cultural viewpoints regarding the sense of ownership of the medical records (Pullinger and Franklin, 2010). However, the documentation completed by the pharmacists on the medication charts, specifically on the ePMA system, were not necessarily noted by other HCPs, according to the doctors and nurses who were interviewed. Important information documented by the pharmacist regarding patient safety could be missed if not seen and acted upon by other HCPs.

An important finding from the observations was the difference in the number of patients reviewed by the ward pharmacist. More medication charts were reviewed by the pharmacists at the ePMA sites compared to the paper-based site. Furthermore, fewer patients at the ePMA sites were reviewed face-to-face by the ward pharmacist compared to the paper-based site. There may be two contributing factors for this observation. Firstly, with access to all the medication charts through the ePMA system, pharmacists no longer face the challenge of searching for them. Previous literature has highlighted that pharmacists are able to review more charts post-ePMA (Franklin et al., 2007) but has also described an increase in the time taken for pharmacists to review the charts (Franklin et al., 2007, McLeod et al., 2019). The results from the observational study suggest pharmacists across the three study sites spent a similar amount of time completing their ward work; at the paper-based site pharmacists spent more time

completing their clinical work compared to the ePMA sites, but reviewed fewer medication charts. Secondly, the pharmacists may prioritise their work differently when using an ePMA system as they have access to all the patient records. This could have made the pharmacists more efficient reviewing a greater volume of electronic charts compared to the paper-based site. The observational study in this PhD sheds light on the potential impact on the pharmacists' relationship with their patients as they review fewer patients face-to-face.

It was observed that pharmacists at the ePMA sites reviewed fewer patients face-to-face; this may have been because pharmacists completed their work from a fixed computer terminal, often away from the patients' beds. There is a need to study the reasons and motivations behind the small proportion of patients who were reviewed face-to-face by the ward pharmacist at the ePMA sites (12% and 9%) whereas pharmacists at the paper-based site reviewed over 50% of their patients face-to-face. Communication between the ward pharmacist and their patients ensures that they build a rapport (Burgin et al., 2014). The removal of the paper medication charts due to ePMA systems eradicated the physical activity between the pharmacist and their patients, but provided pharmacists' access to all their patients' medication charts. It was noted that pharmacists at the ePMA sites did not have clear guidance on how to approach their ward work since the implementation of their ePMA systems. Previous literature has also highlighted the need for there to be a focus on developing guidance for pharmacists working with ePMA, to ensure the focus remained on the patient and not the computer (Burgin et al., 2014). Furthermore, it was observed that the two ePMA systems studied did not have the ability to draw the pharmacist's attention to high risk patients or patients in need of a review. New research has suggested that pharmacy prioritisation tools integrated into ePMA systems could support pharmacists with prioritising patients in most need of their input (Geeson et al., 2019). This could reduce the workload on the pharmacists and ensure that patients who are in the most need of a pharmacists' review are seen.

Table 25 below summarises the main findings from each of the systematic review and the two empirical studies

Study	Main findings
Systematic review: The impact of electronic prescribing systems on healthcare professionals' working practices in the secondary healthcare setting: a systematic review and narrative synthesis	▪ Four key areas were identified to have been affected by the introduction of electronic prescribing systems: communication, time taken to complete tasks, impact on clinical workflow and workarounds ▪ The review highlighted that positive and negative outcomes may be affected by the context and the way in which technology was implemented ▪ Pharmacists were the least represented healthcare professional group in studies conducted
Study 1: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter- professional communication and electronic prescribing and medication administration systems in an in-patient setting: a focus group & interview study	▪ All participants preferred to communicate with each other face-to-face as this was perceived to create opportunity to engage in collaborative discussions ▪ Pharmacists perceived that their physical ward presence and written communication on medication charts had reduced since the introduction of the electronic prescribing and medication administration system. They also believed their contact with patients had reduced. This was perceived to be because of the limitations with hardware and software ▪ Doctors felt that they were less likely to ask pharmacists questions due to the lack of their physical presence on the ward - this has not been documented in previous literature ▪ Participants suggested electronic messaging centres, targeted alerts and electronic medication orders to better support their communication with other healthcare professionals
Study 2: How have electronic prescribing and medication administration systems affected pharmacists' communication in an inpatient setting? A multi-site observational study	▪ The most common healthcare professionals the ward pharmacist communicated with were other pharmacists through documentation on the electronic prescribing and medication administration system or the paper medication chart ▪ Ward pharmacists initiated communication exchanges with other healthcare professionals predominately through asynchronous communication ▪ More medication charts were being reviewed by the ward pharmacists during their ward visit at the sites using electronic prescribing and medication administration system, however fewer patients were reviewed face-to-face at these sites

Table 25: A summary of the key results from the systematic review and empirical studies

8.2 Comparison with previous literature

Pharmacists in previous studies have expressed their concerns regarding reduced visibility and contact with their patients (Burgin et al., 2014, Mehta and Onatade, 2008), however, there has been little mention of the impact reduced pharmacist presence may have on communication with other HCPs on the ward. One paper from Australia revealed pharmacists believed they were less physically visible on the wards compared to other HCPs and had lesser visibility in documentation (Rixon et al., 2015). The pharmacists in that study were working with paper medication charts and the study did not specify if other HCPs, such as doctors and nurses, or patients and carers also reported the same concerns (Rixon et al., 2015). From the semi-structured interview, conducted as part of this PhD, doctors working with ePMA systems shared their perceptions of reduced pharmacists' visibility both physically and in their documentation. Previous literature has suggested this could lead to poor rapport and lack of a team-based relationship towards patients' care (Coomber et al., 2018). Furthermore, a previous study reported the number of medication charts reviewed by pharmacists before and after ePMA implementation at one hospital and found this not to be statistically significant (Franklin et al., 2007). However, the study did not report the number of patients seen face-to-face during their medication chart review pre- and post-implementation. Furthermore, previous literature has not studied the potential consequences of pharmacists not reviewing patients' medication charts and face-to-face visits. The observational study conducted as part of this PhD shed light on the differences between the number of patients' medication charts reviewed as well as those seen face-to-face with patients. There is still limited knowledge on the benefits and consequences of any differences observed between the number of patients reviewed by the pharmacists face-to-face at ePMA sites and the paper-based site.

8.3 Strengths and limitations

The strength of this PhD was the use of mixed methods to explore the impact of ePMA systems on pharmacists' communication. Mixed methods research combines elements

of qualitative and quantitative research approaches for the purpose of breadth and depth of understanding and corroboration (Hadi et al., 2013). Furthermore, using both qualitative and quantitative research methods combines the strengths of the two methodologies to overcome their respective limitations (Hadi et al., 2013). This body of work involved two hospital sites using different ePMA systems as well as a third site using a paper-based prescribing system. This allowed for some comparisons to be made among the different organisations, team structures and working practices. The focus groups and semi-structured interview study conducted in this PhD allowed for in-depth understanding of HCPs' experiences and opinions of ePMA systems and of their communication with other HCPs. Pharmacists were invited to take part in focus groups that allowed for different perspectives and experiences to be shared and discussed, unpicking the benefits and challenges of utilising ePMA systems to aid communication. Furthermore, by inviting doctors and nurses to take part in semi-structured interviews, additional HCPs' perspective could be included in the data set. Often the limitations with interviews and focus groups are that they are largely not generalisable because studies may have small participant numbers and individual differences. However, interviews and focus group studies gain their strength from their ability to link quantitative findings to previous studies and theories. The method was also clearly documented in the relevant chapters to enhance transparency. Furthermore, each stage of the analysis was overseen by the student's supervisors to reduce the risk of bias. Using focus groups concentrated on pharmacists' perceptions rather than their actions (Blandford et al., 2016), however to overcome this, an observational study was designed to gain a quantitative understanding of pharmacists communication in practice. A common bias in both empirical studies could include social desirability bias. The focus groups, semi-structured interviews and observations all included elements of self-reported data. Social desirability can occur when participants report an answer in a way they deem to be more socially acceptable (Althubaiti, 2016). During the focus groups, interviews and observations, participants may have presented their experiences and performed their work in a way they believed was socially acceptable.

The focus groups and semi-structured interviews provided an insight into how HCPs perceived they communicated with each other using their prescribing systems, the observational study conducted at the same sites aimed to observe how pharmacists communicated with each other and other HCPs in practice. As the focus groups, semi-structured interviews and observations were conducted at the same three sites, this maintained consistency and further added perspective to the experiences shared by participants. All the observations were carried out as planned; however, due to hospital constraints and delays in ethical approval, the minimum sample size for the observational study could not be achieved. As this was an explorative study that had not previously been conducted, it was difficult to be sure of the minimum sample size. Advice was sought from academic supervisors and statisticians in order to minimise this challenge. Although the target number of pharmacists was observed as per the sample size calculation, the target number of communication events were not obtained during the data collection period. A logistic regression was conducted in order to test the null hypothesis. The results of the logistic regression strongly suggested that there was a difference in the proportion of synchronous and asynchronous communication between ePMA and paper sites, therefore rejecting the null hypothesis. The null hypothesis was that there was no difference in the proportion of synchronous and asynchronous communication between ePMA and paper sites. The results therefore suggest there is evidence to suggest that the null hypothesis should be rejected. In order to make more definitive conclusions, more communication events would need to be collected through more observations of pharmacists.

8.4 Implications for practice

This work has identified some suggestions for improvement for pharmacists and other HCPs to consider at the hospitals that took part in the studies. Updating the pharmacy clinical standards, reflecting on the role of the ePMA and clinical pharmacists at the different hospitals, better access to the ePMA system for pharmacists and piloting messaging centres are some of the suggestions for practice.

It was found that the pharmacy clinical standards documentation at both the ePMA sites had not been updated since the implementation of the ePMA systems. Pharmacists receive a verbal induction that includes training on how to use the ePMA system. The ePMA sites studied could benefit from updating their current standard operating procedures (SOPs) for pharmacists and their clinical ward standards. These documents are in place to ensure a safe and effective running of the pharmacy service and allow pharmacy staff to continue to provide the highest quality of care to their patients. Furthermore, SOPs can be used to audit the pharmacy service and the professionals following them. The SOPs for all sites should highlight the expected role of the ward pharmacist, especially since the roll out of ePMA systems, as this has affected their working practices. It should provide guidance on how to review patients, where they are expected to conduct their clinical work and what strategies they may use to communicate high priority and less critical information to other HCPs. This is because results from this research project demonstrated that different hospitals and their individual pharmacists have different ways of working, with little consistency within organisations. Previous literature and the report published by Wachter in 2016, have highlighted the importance of developing the workforce with knowledge of both clinical areas and informatics from the start (Cresswell et al., 2013, Poon et al., 2004, Wachter, 2016). Hospitals that have implemented ePMA systems or are in the process of doing so should focus on developing their workforce to be confident and competent with working with new technology, while providing an efficient pharmacy service. Pharmacists would require education and training of the SOPs to ensure the documentation has been understood and executed. Once the documentation has been reviewed and updated, senior pharmacy managers should use the standards to audit the impact of these on the pharmacy workforce in the short, medium and long term.

The senior lead clinical pharmacists at the ePMA sites received feedback of the findings from all the studies and acknowledged that the pharmacy clinical standards require updating, and expectations of the ward pharmacist need to be clearly disseminated. The

roles of senior clinical and ePMA pharmacists were very different in hospitals as they are managed differently, have different expectations of their role and develop in parallel to each other. Senior clinical pharmacists are involved in the training and development of all hospital pharmacists and other members of the pharmacy team. They are also responsible for providing the appropriate education and training as well as manage team rotas and disseminate important information to the pharmacy department. ePMA pharmacists' roles are centred around the implementation and management of the ePMA system and providing support to other HCPs interacting with the system. There is currently very little overlap between them according to the senior lead pharmacists at the ePMA hospitals. Pharmacy managers should consider integrating the clinical and ePMA pharmacists' roles in the future in order to keep up with the changing dynamics of technology and pharmacy workforce. Incorporating these roles will help provide other pharmacists with leaders who can impart these new skills to teach the workforce how best to combine the ePMA system with their clinical practice. Wachter's report has recommended developing the workforce working with ePMA systems with knowledge of both clinical and informatics in order for these systems and its users to reach its full potential in providing the highest quality of patient care (Wachter, 2016).

ePMA systems have introduced a new channel for communication but its use is not well defined in practice and HCPs will need to work together to streamline their expectations of communication through this channel. Pharmacists expressed challenges with locating functioning hardware to support their work while on the wards at the ePMA sites. A recommendation would be to introduce COWs on every ward that has a pharmacist. Not only would this benefit the pharmacists with greater access to the ePMA system, but also allow them freedom to move around to see and be seen by other HCPs and patients. HCPs at all three sites believed that the ePMA software should also be further developed to allow for a messaging centre to document and send non-urgent communication to other HCPs. There are currently some ePMA systems that can facilitate messaging and

pharmacists could pilot the use of these messaging centres within the pharmacy department before introducing it as a communication tool with other HCPs.

8.5 Future recommendations for ePMA providers

There were two main recommendations that should be fed back to ePMA providers from this body of work. Firstly, HCPs at the three sites expressed a need to introduce an integrated messaging centre into their systems to improve their communication with other HCPs. It would provide them with a central location to document information for other HCPs for low priority information. Furthermore, pharmacists suggested that the messaging centre could be used as an audit trail to ensure their recommendations have been actioned or acknowledged and also as a feedback tool. ePMA system providers could also look to introduce coloured writing to indicate pharmacists' documentation on the electronic medication charts. This would make the pharmacists' recommendations and amendments more visible on the ePMA system.

Secondly, it was observed that pharmacists at site 1 were able to review patients from a dashboard, compared to sites 2 and 3 using their paper handover documentation to assess the patients who required a pharmacists' review. The dashboard would be a helpful tool for sites that currently do not have this in place to aid the ward pharmacists to navigate through their patient lists efficiently. The risk with paper handovers was that they could get lost or not handed over to other pharmacists or other HCPs. With an electronic dashboard, pharmacists are able to update patient records for all HCPs to access, from the ward or remotely if needed. Furthermore, for sites with a dashboard in use, the next stage would be to look to integrate it with a patient prioritisation tool.

8.6 Implications for research

Members of the public, patients and carers suggested that one of the future research priorities should be to explore how communication could be improved among the HCPs within a single organisation (Imperial College London, 2018). This PhD may not answer this question in its entirety; however, it extends the current knowledge of this area. The

difference noted in the percentage of patients' medication charts reviewed compared to the percentage of these patients who had a face-to-face review with their ward pharmacists was a cause for concern, for both pharmacists and patients. Future work should look to explore the impact of ePMA on inpatients experiences. Currently there is limited literature on the perceptions patients have of inpatient ePMA systems and its impact of their relationship with the ward pharmacist (Lau et al., 2019). Previous studies that have considered patients' perspectives have been in the primary care setting or specific clinical settings and often report very limited information on patient attitudes and preferences (Frail et al., 2014, Lau et al., 2019). It would also be important to further look into the pharmacists' criteria to understand which patients they consider for a face-to-face review. Furthermore, it would also be important to study if pharmacy prioritisation tools could be integrated with ePMA systems to support pharmacists' work. With a larger sample size, future work could further investigate if pharmacists of different levels of seniority and experience have a different way of reviewing patients and also look to see if the location, channel and content of communication differs amongst these groups. Furthermore, the implications for patient safety could be further explored among different seniority of pharmacists. This research has highlighted the importance of pursuing further research exploring the impact of ePMA system on patients' communication with pharmacists and other HCPs while inpatient. It would be crucial to study if the changes in HCPs working practices have affected the patient experience and safety as this has not been documented in previous work. As one of the limitations for the observational study was achieving the minimum sample size, future researchers could build on the current research by attempting to collect data from more pharmacists or carry out this study over a longer period of time.

The aim of this thesis was to explore, describe and understand the current perceptions of healthcare professionals relating to how they used ePMA to communicate with other HCPs. The strategies they used to communicate in practice in both, a setting with ePMA and a setting that used paper were observed to gain a holistic understanding of the

communication in a real setting. The focus of this work was to observe communication rather than use a framework such as human factors or human-computer interaction to understand individual tasks. However, future work could look to study a particular task in more detail, such as to study the process of pharmacists completing a medication reconciliation and communicating errors to prescribers. A task analysis framework could be used to understand more precise workflows within ePMA systems that could aid communication among HCPs. Furthermore, human factors or human-computer interaction frameworks could be used to study individual ePMA systems or system users in detail to understand how the system design can aid or hinder communication among healthcare professionals. Frameworks studying the implementation of technology such as implementation science, could be useful for future researchers interested in broadly studying the implementation of specific communication tools within ePMA systems (e.g. clinical dashboards, prioritisation tools) to understand the difference between efficacy (outcome of an intervention under ideal conditions) and effectiveness (outcome of an intervention under normal conditions) when translating evidence-based research into practice in the real world (Villalobos Dintrans et al., 2019).

8.7 Overall conclusion

Previous literature has highlighted that much attention has been devoted to developing electronic patient records, including ePMA and traditional information systems but minimal exploration of what communication systems can be enhanced to support hospital operation (Coiera, 2006). The systematic review highlighted the importance of studying and gaining an understanding of the different contexts in which ePMA systems are implemented as these influence its acceptability and impact on HCPs working practices. Overall, this thesis has extended current knowledge of the impact of ePMA systems on hospital HCPs', in particular pharmacists' communication practices. The systematic review, qualitative study with focus groups and semi-structured interviews and the observations of ward pharmacists across three different English NHS hospitals were the first of their kind in the UK. In addition, the current findings reiterated that

pharmacists perceive that they are restricted by the ePMA systems hardware and software features that have impacted on their physical and written presence in their clinical practice and with their patients. The results of this thesis have been disseminated to all the study sites involved and they have now begun a series of reviews and updates of their clinical pharmacy standards that will directly influence pharmacists' working practices. Further research is required to continue to study different hospital systems, organisations and HCPs to continue to learn and improve the systems that are in use. Importantly, studying the perceptions and potential consequences of patients remains an under-researched area.

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Appendices

Appendix A: PhD outputs

Publications

Mohsin-Shaikh, S., Furniss, D., Blandford, A., Mcleod, M., Ma, T., Beykloo, M. Y. & Franklin, B. D. 2019. The impact of electronic prescribing systems on healthcare professionals' working practices in the hospital setting: a systematic review and narrative synthesis. *BMC Health Serv Res,* 19**,** 742.

Conference abstracts and presentations

Mohsin-Shaikh, S., Furniss, D., Blandford, A., Mcleod, M., Ma, T., Beykloo, M. Y. & Franklin, B. D., The impact of electronic prescribing and medication administration on work practices in secondary care: a systematic review and narrative synthesis. **Poster** showcased at the North West London Symposium, Imperial College London, (September 2017)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D., The impact of electronic prescribing and medication administration on work practices in secondary care: a systematic review and narrative synthesis. **Poster** and **presentation** at ePMA symposium, Cerner Collaboration Centre, (June 2018)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., Mcleod, M., Ma, T., Beykloo, M. Y. & Franklin, B. D., The impact of electronic prescribing and medication administration on work practices in secondary care: a systematic review and narrative synthesis. **Poster** and **presentation** at UCL School of Pharmacy PhD Research day, London (September 2018)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D. Electronic prescribing and medication administration systems: Have they transformed the way in which healthcare professionals communicate? **Presentation** at the Pfizer & PSTRC Medication Safety Workshop: “Medication without Harm”, London (January 2019)

Mohsin-Shaikh, S., Taylor, H., Butterworth, C., Mckenzie S., & Franklin, B. D., The impact of electronic prescribing and medication administration on patients in secondary care: Research perspective. **Workshop** delivered at the GDE/UCL ePMA symposium: Prescribing: safer systems, faster benefits, (November, 2019)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D. Have they transformed the way in which healthcare professionals communicate? **Presentation** the Centre of Medication Safety and Service Quality (CMSSQ) & Health Protection Research Unit (HPRU), London (December 2019)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D., An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter- professional communication and electronic prescribing and medication administration systems: a qualitative study. **Poster** showcased at UCL Doctoral School Research Poster Competition 2020, (February 2020)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D., An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter- professional communication and electronic prescribing and medication administration systems: a qualitative study. Abstract **Poster** selected for the Health Services Research & Pharmacy Practice Conference, Cardiff (April 2020)

Mohsin-Shaikh, S., Furniss, D., Blandford, A., & Franklin, B. D., An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter- professional communication and electronic prescribing and medication administration systems: a qualitative study. **Poster** (conditionally accepted) for the Royal Pharmaceutical Society Research Summit, London (June 2020)

Appendix B: Search strategy

<table>
<tr><th colspan="4">Cochrane (accessed on 19/11/18)</th></tr>
<tr><th colspan="2">MeSH term</th><th>Keywords</th><th>Truncations</th></tr>
<tr><td rowspan="2">Facet 1</td><td>Electronic prescribing</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Medical order entry system</td><td>CPOE (Computerised provider/physician order entry)</td><td>N/A</td></tr>
<tr><td colspan="4">Number of records identified: 123</td></tr>
<tr><th colspan="4">Medline (accessed on 19/11/18)</th></tr>
<tr><th colspan="2">MeSH term</th><th>Keywords</th><th>Truncations</th></tr>
<tr><td rowspan="2">Facet 1</td><td>Electronic prescribing</td><td rowspan="2">▪ Electronic prescribing
▪ CPOE
▪ Medical order entry system
▪ Medication alert system
▪ Computerised physician order entry
▪ Computerised provider order entry</td><td rowspan="2">e*prescri* or electronic prescri* or CPOE or medical order entry system* or medication alert system* or computeri*ed physician order entr* or computeri*ed provider order entr*</td></tr>
<tr><td>Medical order entry system</td></tr>
<tr><td rowspan="3">Facet 2</td><td>Healthcare professionals</td><td rowspan="3">▪ Healthcare professional
▪ Health personnel
▪ Pharmacist
▪ Doctor
▪ Clinician
▪ Physician
▪ Hospital medical staff
▪ Nurse
▪ Hospital nursing staff
▪ Registered nurse</td><td rowspan="3">healthcare professional* or health care professional* or healthcare personnel or health personnel or pharmacist* or doctor* or clinician* or physician* or hospital medical staff or nurs* or hospital nursing staff or registered nurse*</td></tr>
<tr><td>Physician</td></tr>
<tr><td>Pharmacist
Nurse</td></tr>
<tr><td>Facet 3</td><td>Inpatient</td><td>▪ Inpatient
▪ Hospitalised patient
▪ Hospital patient</td><td>inpatient* or hospitali*ed patient* or hospital patient*</td></tr>
<tr><td rowspan="2">Facet 4</td><td>Workflow</td><td rowspan="2">▪ Working practice
▪ Workaround
▪ Workflow
▪ Practice pattern
▪ Communication
▪ Staff time</td><td rowspan="2">work* practice* or workaround* or work flow* or workflow* or practice pattern* or communica* or staff time</td></tr>
<tr><td>Communication, Hospital communication, Interdisciplinary communication</td></tr>
<tr><td colspan="4">Number of records identified: 154</td></tr>
<tr><td colspan="4">EMBASE (accessed on 19/11/18)</td></tr>
</table>

<table>
<tr><th colspan="2">MeSH term</th><th>Keywords</th><th>Truncations</th></tr>
<tr><td rowspan="2">Facet 1</td><td>Electronic prescribing</td><td rowspan="2">▪ Electronic prescribing
▪ CPOE
▪ Medical order entry system
▪ Medication alert system
▪ Computerised physician order entry
▪ Computerised provider order entry</td><td rowspan="2">e*prescri* or electronic prescri* or CPOE or medical order entry system* or medication alert system* or computeri*ed physician order entr* or computeri*ed provider order entr*</td></tr>
<tr><td>Computerised provider order entry</td></tr>
<tr><td rowspan="4">Facet 2</td><td>Health care personnel</td><td rowspan="4">▪ Healthcare professional
▪ Health personnel
▪ Pharmacist
▪ Doctor
▪ Clinician
▪ Physician
▪ Hospital medical staff
▪ Nurse
▪ Hospital nursing staff
▪ Registered nurse</td><td rowspan="4">healthcare professional* or health care professional* or healthcare personnel or health personnel or pharmacist* or doctor* or clinician* or physician* or hospital medical staff or nurs* or hospital nursing staff or registered nurse*</td></tr>
<tr><td>Physician</td></tr>
<tr><td>Pharmacist</td></tr>
<tr><td>Nurse, Staff nurse, Registered nurse</td></tr>
<tr><td>Facet 3</td><td>Hospital patient</td><td>▪ Inpatient
▪ Hospitalised patient
▪ Hospital patient</td><td>inpatient* or hospitali*ed patient* or hospital patient*</td></tr>
<tr><td rowspan="2">Facet 4</td><td>Workflow</td><td rowspan="2">▪ Working practice
▪ Workaround
▪ Workflow
▪ Practice pattern
▪ Communication
▪ Staff time</td><td rowspan="2">work* practice* or workaround* or work flow* or workflow* or practice pattern* or communica* or staff time</td></tr>
<tr><td>Communication, Interpersonal communication</td></tr>
<tr><td colspan="4">Number of records identified: 177</td></tr>
<tr><td colspan="4">CINAHL (accessed on 19/11/18)</td></tr>
</table>

MeSH term		Keywords	Truncations
Facet 1	Electronic order entry	▪ Electronic prescribing ▪ CPOE ▪ Medical order entry system ▪ Medication alert system ▪ Computerised physician order entry ▪ Computerised provider order entry	e*prescri* or electronic prescri* or CPOE or medical order entry system* or medication alert system* or computeri*ed physician order entr* or computeri*ed provider order entr*
Facet 2	Health personnel Physician Pharmacist Nurse	▪ Healthcare professional ▪ Health personnel ▪ Doctor ▪ Clinician ▪ Hospital medical staff ▪ Nurse	healthcare professional* or "health care professional*" or "healthcare personnel" or "physician*" or "clinician*" or "hospital medical staff" or "nurs* or doctor* or pharmacist*
Facet 3	Inpatients	▪ Inpatient ▪ Hospitalised patient ▪ Hospital patient	inpatient* or hospitali*ed patient* or hospital patient*
Facet 4	Workflow	▪ Working practice ▪ Workaround ▪ Workflow	work* practice* or workaround* or work flow* or workflow*
Number of records identified: 539			
Pubmed (accessed on 19/11/18)			
MeSH term			**Keyword**
Facet 1	Electronic prescribing		Electronic prescribing or CPOE or Medical order entry system or Medication alert system or Computerised physician order entry or Computerized physician order entry or Computerised provider order entry or Computerized provider order entry or e-prescribing or e prescribing or eprescribing
	Medical order entry system		
	Health personnel		healthcare professional or health care professional or healthcare personnel or health care personnel or
	Physician		

Facet 2	Pharmacist	health personnel or doctor or physician or clinician or hospital medical staff or pharmacist or nurse or hospital nursing staff or registered nurse
	Nurse	
	Hospital medical staff	
Facet 3	Inpatient	Inpatient or hospitalised patient or hospitalized patient or hospital patient
Facet 4	Workflow	Workflow or work flow or working practice or workaround or practice pattern or communication or staff time
	Communication	
Number of records identified: 483		
Total number of records identified: 1476		

Appendix C: Data extraction table

(In alphabetical order): First author, Country, Year	Study aim(s)	Study design	Setting (Hospital/ward/speciality)	Population (type of healthcare professional)	Sample size	Duration of study	Electronic system used (type/brand if stated)	Comparator	Outcome measure(s)/Main findings
Alsweed, Saudi Arabia, 2014	Explain the impact of computerised provider order entry (CPOE) implementation on nursing workflow, patient safety and medication errors	Cross-sectional survey (Quantitative)	Public hospital, inpatient units	Nurses	96 questionnaires returned (85.7% response rate)	April-May 2012 (4 weeks)	CPOE- Not specified	n/a	CPOE training has an important impact on various facets of clinical work, on the whole participants were satisfied with their workflow after CPOE implementation, those who received good quality training perceived that CPOE use reduced medication errors and improved patient safety
Armada, Spain, 2014	**1)** Evaluate the effects of a CPOE system by detecting prescription errors (frequency, type, severity) **2)** Impact of electronic prescribing (EP) on working conditions and satisfaction of personnel	Longitudinal prospective controlled before-after study (Quantitative)	Tertiary care university centre in Madrid/Intensive care/Acute cardiac care	Doctors and nurses	470 treatment orders, 27 physicians and 20 nursing staff completed questionnaire	Jun - Dec 2013 - 3 sampling stages of 21 consecutive days each	CPOE- Farmatools Dominion; Global Dominion Access SA, Bilbao, Spain	Paper	Most participants rated accessibility to EP program as good to very good but also the overall performance and other 13 aspects regarding CPOE implementation. When asked about workload - 74% of physicians and 17% nurses considered this negative, physicians said it took more time to order and overdependence on technology
Ayatollahi, Iran, 2015	Investigate physicians' and nurses' opinions about the impact of CPOE on their workflow	Cross-sectional survey (Quantitative)	General hospital with 199 beds	Doctors and nurses	101 nurses (69.7%), 3 specialist physicians (18.8%), 10 general	Not specified	CPOE- Not specified	n/a	Positive impact CPOE: patient safety, inter-organisational workflow, working relationship between physicians and nurses, quality of patient

					practitioners (83.8%)				care, nurses were more satisfied with the positive impact of CPOE on their relationship with physicians
Barber, UK, 2007	Formative socio-technical evaluation of a pilot implementation of an integrated electronic prescribing, automated dispensing, barcode patient identification and electronic medication administration record (EMAR) system on one ward	Qualitative observational approach	Surgical ward in a teaching hospital	Doctors, nurses, pharmacists and hospital managers	Interviews with 9 nurses, 5 doctors, 3 pharmacists, 1 hospital manager), 1 focus group consisting of 5 doctors, 5 nurses, 3 pharmacists, 1 hospital manager	Focus group held 9 months after implementation	EPMA (electronic prescribing and medication administration system) - ServeRx	n/a	Summary of findings mapped onto a structured evaluation framework: System function, human perspective and organisational context. Attitudes to the system in the early stages were mixed. Over time, and with experience of making the system work for them, staff attitudes changed to become more balanced and the potential benefits of the system became clearer to most.
Baysari, Australia, 2018	Explore the views of nurses and doctors during the very early stage of implementation of a CPOE system in a pediatric hospital, and then to examine changes in perceptions and reported behaviors over the course of the shakedown period, as use of the CPOE system became routine.	Longitudinal qualitative study	Acute paediatric tertiary hospital, medical and surgical wards	Nurses and doctors	122 (86 nurses, 36 doctors)	6 months	CPOE-Cerner Millennium Powerchart	Paper	Unfamiliarity with the system was perceived as a key attribute to influencing both the time it took to complete tasks and medication safety. CPOE systems had resulted in stress and disuse of the system. During early interviews it was perceived that there was a reduction in patient interaction but the emphasis on reduced patient interaction declined in later interviews. Prescribing and medication administration took longer due to additional steps compared to paper. Due to an increase in time to complete tasks,

									workarounds were introduced.
Bedouch, France, 2012	(1) what are the characteristics of PIs in terms of the drugs involved, DRP description, pharmacists' recommendations and the physicians' acceptance or not? (2) What method(s) do pharmacists use to communicate their PIs when a CPOE system is available? (3) What are the independent predictors of acceptance of the recommendation by the physician?	Prospective cohort study (Quantitative)	Teaching hospital (Grenoble University Hospital), seven medical wards: cardiology (27 beds), geriatrics (40 beds), infectious disease (27 beds), internal medicine (22 beds), nephrology (21 beds), respiratory medicine (18 beds) and rheumatology (27 beds)	Pharmacists	448 pharmacist interventions	10 weeks	CPOE-Cristalnet, CRIH des Alpes, Grenoble, France (home-grown system)	n/a	Physicians accepted 86.6% of pharmacists interventions, time for acceptance was less than 1 hour in 50% of cases, pharmacists preferred face-to-face communications
Beuscart-Z'ephir, France, 2005	Analyse the impact of medication ordering and administration functions of CPOE on doctor—nurse communications and cooperation	Observational and cognitive psychology and ergonomics (mixed methods)	3 French hospitals: 1) 413 bed public hospital, 2) 3000 bed university hospital 3) 825 bed university hospital	Physicians and nurses	site 1: 450 hours of observations, site 2: 80 hours of observations, site 3: 60 hours of observation Number of interviews not specified	Not specified	All sites - CPOE site 1: DxCare, site 2: paper with early CPOE, site 3: complete PICS including MEDASYS DxCare component	paper at site 2	Physicians and nurses cooperation and coordination impacted by CPOE. Physicians and head-nurses staff should be particularly concerned with the necessity of maintaining or imposing time slots dedicated to physician—nurse synchronous oral communications.
Burgin, UK, 2014	To establish the changes that electronic systems	Qualitative – focus groups	Large acute NHS teaching hospital	Pharmacists	20 pharmacists (4-6	The focus groups were	EPMA-Not specified	Paper	Pharmacists highlighted three main overarching themes: reduced patient

	afforded to pharmacist's work practices, and to understand how and why pharmacists in a large UK teaching hospital had responded to these changes.				pharmacists per focus group)	conducted at 1–2 weekly intervals			contact, documentation in electronic patient records and professional representation in the clinical environment had all been impacted by the introduction of an electronic medical record and electronic prescribing and medication administration system
Davies, UK, 2017	Assess the impact of EP system on safety culture	Cross-sectional survey (Quantitative)	Dorset County Hospital - Surgical patients	Clinicians, nurses and pharmacists	82/238 responses (34.5%)	2 weeks (6 weeks after EP implementation)	EP- JAC Medicines management	n/a	Clinicians had more negative responses than positive about the EP system, ease of prescribing but safety and time concerns
Franklin, UK, 2007	Assess the impact of closed-loop electronic prescribing and medication administration (EPMA), automated dispensing and barcode scanning on prescribing and administration errors, confirmation of patient identity and staff time	Uncontrolled before and after design (Quantitative)	Teaching hospital, 28 bed general surgery ward	Doctors, nurses and pharmacists	Ward pharmacist self-reported the time taken to provide a clinical service to the study ward each day for 4 weeks, time taken to carry out each scheduled non-IV drug round was recorded for nurses	3-6 months before and 6-12 months after the intervention	EPMA- ServeRx	paper	Pharmacist took an extra 24 seconds post implementation of EPMA, drug rounds were quicker for nurses but a higher percentage of time was spent on medication related tasks between drug rounds
Holden, USA, 2010	To identify and describe physicians beliefs about the use of electronic medical records and CPOE for inpatient and outpatient care	Semi-structured qualitative research	Two large Midwest US hospitals	Physicians	20 Physicians	Hospital 2 - 7 months of order entry, information re. hospital 1 not specified	CPOE- Commercial EMR (electronic medical records) and	n/a	Use improved the ease of personal performance, information easier to access, having all the information was thought to improve clinical decision making, over-reliance on technology,

	to build an understanding of what factors shape information technology use behaviour in the unique context of health care delivery						system (not specified)		perceived to improve communication between colleagues and nurses
Hollister, USA, 2011	Describes a project designed to increase computerized physician order entry in a community hospital staffed by voluntary and employed physicians	Uncontrolled before and after study (Quantitative)	Greenwich hospital	Physicians	Not specified	December 2008 - May 2009 (unclear when implementation took place)	CPOE- Meditech (Canton Massachusetts) during time of the study was running on the Magic 5.63 version	paper	Time taken for medication orders to be verified by pharmacy reduced. CPOE reduced the total time from medication ordering to patient delivery and thus contributed to improved patient care
Khajouei, Netherlands, 2011	To study the satisfaction of end-users of a computerized physician order entry (CPOE) system concerning ease of use and the effect on users' workflow, efficiency, and medication safety and to seek users' opinions regarding required improvements of the system.	Cross-sectional survey (Quantitative)	Academic medical centre, 1002 bed university hospital, Amsterdam	Physicians and nurses	106/217 physicians and 327/587 nurses responded	Not specified	CPOE- Medicator	n/a	High satisfaction concerning the effect of medicator on their workflow, physicians emphasised that the system facilitated the coordination of activities with nurses, pharmacists and other physicians
Mehta, UK, 2009	Describe how EP has changed the way pharmacy staff in UK hospitals work, establish the perceived	Qualitative study - Interview based via a semi structured interview	7 hospitals	Pharmacists	7 interviews	March - April 2005	EP- 3 hospitals used Meditech system, 2 used the TDS 7000 system and 2	Paper	More prescriptions screened by pharmacists, more time available for pharmacists to have more clinical input on wards and attending more ward rounds, at 3 hospitals

	advantages and disadvantages, establish the benefits to pharmacy department of changing from a manual system to an electronic system of prescribing						used JAC system		pharmacy staff were able to carry out more clinical activities without increasing the amount of time spent at ward level, when short staffed some pharmacist would review medication from dispensary, reduced contact time with patients, 6 hospitals said they had a quicker turnaround time for discharge prescriptions and inpatient items when sent electronically, 3 hospitals said the pharmacy workload increased
Mekhjian, USA, 2002	To evaluate the benefits of CPOE and electronic medication record on the delivery of health care	Uncontrolled before and after design (time and motion study - Quantitative)	Ohio State university health system - academic medical centre that comprises of 4 hospitals	Physicians	46 medication events before CPOE and 70 medication events after CPOE were observed	Pre-EPMA - Jan - Feb 2000, Post-EPMA - May - Jun 2000	CPOE-Invision 24 with graphical user interface (Siemens medical solutions health services Corp)	Paper	Medication turnaround time decreased from 5hr 28 mins to 1hr 51 mins (64% reduction) - two key phases that was improvement were communication of the order to pharmacy and administration of the dispensed medication to the patient
Niazkhani, Netherlands, 2009	To compare the perceived impact of CPOE system on nursing medication practice - questionnaire administered before and after implementation of CPOE	Uncontrolled before and after survey study (Quantitative)	Erasmus University medical centre, 1237 bed academic hospital	Nurses	154/295 nurses (52.2%) pre-implementation and 136/304 nurses (44.7%) post-implementation	Questionnaires sent 2 weeks prior to implementation and sent 5 months after implementation	CPOE-Medicatie/EVS	2 paper based systems (Kardex systema nd TIMED system)	When nurses were asked if they would want to change their current process back to paper they responded that they would prefer to continue on a CPOE system but the Mann-Whitney U test showed nurses believed the CPOE system did not support their work processes more than the paper-based system, 56.7% of respondents commented that the post-CPOE workflow

									had become less efficient, although they were generally satisfied with the system
Niazkhani, Netherlands, 2010	To assess the effects of a CPOE system on inter-professional workflow in the medication process	Qualitative - semi structured interviews	Erasmus University medical centre, 1237 bed academic hospital	Physicians, pharmacists, nurses and a pharmacy technician	23 semi-structured interviews (12 nurses, 8 physicians, 2 pharmacists and 1 pharmacy technician)	November 2006 - June 2007	CPOE-Medicatie/EVS, iSoft Leiden, the Netherlands	n/a	System benefitted physician-pharmacy and nurse-pharmacy while impeding the physician-nurse workflow
Niazkhani, Netherlands, 2011	To evaluate the problems experienced after implementing a CPOE system, their possible root causes and the responses of providers in order to incorporate the system into their daily workflow	Qualitative study - semi structured interviews, artefacts from their daily work, educational material to train physicians and nurses to use the CPOE system	Erasmus University medical centre, 1237 bed academic hospital	Physician, nurses and pharmacists	21 semi-structured interviews with clinicians, 6 physicians and 12 nurses from adult inpatients, 2 pharmacists, 1 senior pharmacy technician	late 2006 - early 2007	CPOE-Medicatie/EVS (version 2.3) and iSoft (now iSofthealth)		Findings based on the 5 stages of medication-use cycle, **Prescribing**: CPOE not accessible by patient bed therefore physicians usually rely on their memory of the list when visiting the patient, doctors make the changes to patient medication and add medicines after the round is complete, as it can take a few hours for orders to be written electronically nurses request the physician to write some medicines on paper as a temporary prescription, **communication**: nurses miss the stickers printed with new prescriptions if not communicated by a physician face-to-face or over the phone, **dispensing**: high medicines returns rate added to pharmacy workload initially but now the nurses have to select the non-stock

									items they want from the pharmacy, **administration:** nurses usually started administering the medication before they received the printed out label, hand changing the labels but no record on CPOE/information not communicated to physician, **monitoring:** issues in the prescribing phase may partly overlap with those in the monitoring phase
Pelayo, France, 2013	To compare the impact of CPOE implementation and of the workplace organizational determinants on the doctor–nurse cooperation and communication processes.	Naturalistic observations supported by handwritten field notes and interviews of those who were observed (Qualitative)	3 hospitals sites - 1 - Academic hospital (825 beds + CPOE system, medication orders functions in use for 6 months), 2 - not academic hospital (618 beds + CPOE system in use for 4 years), 3 - Academic hospital (3500 beds + paper based system)	Doctors and nurses	Study 1 - 60 observations and 49 interviews, study 2 - 194 hours of observations (23 doctors and 25 nurses)	Not specified	CPOE - Hospital 1 and 2 - commercial systems, Hospital 3 – paper based	Paper	Technical system has no significant impact on the cooperative activities within the organisation. CPOE does not cause a different in the dialogues' duration or contents and does not seem to deteriorate the doctor-nurse communications
Pontefract, UK, 2018	The aim of this study is to explore pharmacists and physicians perceptions of their interprofessional communication	Qualitative – focus groups and interviews	Two acute hospitals: the University Hospitals Birmingham NHS Foundation Trust (UHBFT) and Guy's and St	Pharmacists and physicians	Four focus groups were conducted between 2014 and 2015; two uni-professional	Focus groups conducted between 2014-2015	CPOE- Locally developed system – PICS (UHBFT) and commercial CareVue (Critical Care)	Paper	Three predominant themes; increased communication load; impaired decision-making; and improved workflow. New technical role introduced for the pharmacist and stated they were unable to 'fine tune'

	in the context of the technology and whether electronic messaging and CDS has an impact on this.		Thomas' NHS Foundation Trust (GSTH)		focus groups and one mixed focus group were conducted at UHBFT, and one mixed at GSTH.		MedChart (In-patient wards)		prescriptions as they previously could on paper. Technology has removed their power to make 'low risk' amendments. The technology was found to increase the frequency with which the pharmacist needed to intervene with the physician. Face-to-face communicate was preferred.
Saddik, Saudi Arabia, 2014	To explore nurses' perceptions regarding the CPOE and its impact on nurse-physician communication in the medication order process.	Cross-sectional survey (Quantitative)	112 bed hospital	Nurses	174 nurses invited to complete questionnaire - 146 responded (83%)	Not specified	CPOE- Not specified	n/a	Almost all of the nurses perceived that CPOE allowed easier accessibility to patients' medication records and provided complete and legible drug prescriptions. The majority of nurses agreed that more physician contact was required with CPOE and that the physician was always followed up by phone call regarding certain prescriptions. Almost all of the nurses perceived that CPOE supported their work process.
Van Wilder, UK, 2016	To explore how EPMA may affect different aspects of nurses' work, relating to both workload and patient safety	Observational - uncontrolled before and after study (Quantitative)	14 bed medicine for the elderly ward/London teaching hospital	Nurses	20 drug rounds pre-EPMA (22hrs) and 14 drug rounds post-EPMA (18 hrs), 9 different nurses observed pre-EPMA and 11	One month before implementation and continuing until one month after (Feb 2015 - Apr 2015)	EPMA- Commercial system (not specified)	Paper	Overall findings presented in to the work conducted in one study based in the UK suggested that the introduction of an EPMA system did not significantly affect the length of time spent on a drug administration round but altered the distribution of tasks with a doubling of the time spent on

					nurses observed post-EPMA				documentation, zero time spent looking for drug charts post EPMA, documentation time doubled post-EPMA
Weir, USA, 1996	The purpose of this study was to examine nurses perceptions of the impact of POE on three general dimensions - quality of care, communication patterns between physicans and nurses and combined perceptions of control, perceptions of personal competence and the interest in the job	Cross sectional survey (Quantitative)	8 hospitals (4 had POE implemented and 4 used clerking entry of orders)	Full time registered nurses who had worked on that ward for at least 1 year	201 out of 605 surveys returned (33% response rate)	Not specified	CPOE-OE/RR 2.5	Comparing hospitals that have the same computer system but differ in terms of CPOE implementation - allows for a more precise evaluation of the impact of POE itself	Nurses working in POE environments perceived their computer system as having more of a positive benefit to patient care than nurses working with a similar computer system where POE had not been implemented, computer system made them feel more competent at their job, fewer errors, more time with patients, documentation was complete and overall relationship with physicians were improved, some perceptions of decreased control, nurses working in a POE environment reported no difference in their perceived access to physicians than nurses working in a non-POE environment - suggests that computers did not decrease the need to talk to physicians
Wenzer, Denmark, 2006	how medication is enacted at two Danish, internal medical wards	A socio-technical study - observations, interviews and analysis of the user interface and of other documents (Qualitative)	2 internal medical ward in a hospital	Physicians and nurses	48 hours of observations, 6 interviews (2 physicians and 4 nurses)	Not specified	CPOE-Commercial system developed by Systematic, Aarhus, DK	n/a	Login procedures were time consuming - doctors would leave themselves signed in so nurses could make the changes, paper-copies were back up and used on average twice a week for hours as the system was unstable, information not

									clear for patients on discharge via the CPOE print out therefore nurses would write an additional medication guide to help the patient, higher cognitive pressure on physicians and nurses memory skills, system had no CDS, communication between physicians, nurses and patients was not supported but demanded considerably work-around
Westbrook, Australia, 2013	To quantify and compare the time doctors and nurses spent on direct patient care, medication related tasks, and interactions before and after electronic medication management system (eMMS) introduction.	Controlled pre–post, time and motion study using the WOMBAT tool (Quantitative)	400 bed major public hospital	Doctors and nurses	**Baseline** - 30 nurses (3 wards), 133.71 hours, 59 doctors (4 wards), 150.88 hours, **Post** - 40 nurses (2 control and 1 intervention ward), 143.73 hours, 39 doctors (2 control and 2 intervention wards), 205.38 hours	Pre - July 2005 - march 2006 (nurses) and July 2006 - December 2006 (doctors), Post minimum 9 months after intervention for nurses and 14 months for doctors	CPOE-Cerner Millennium Powerorders system	Paper	Implementation of the eMMS was not associated with significant changes in the proportions of time doctors and nurses spent on direct patient care or medication-related tasks, relative to their colleagues on the control wards. Task time redistribution did occur within some specific areas.

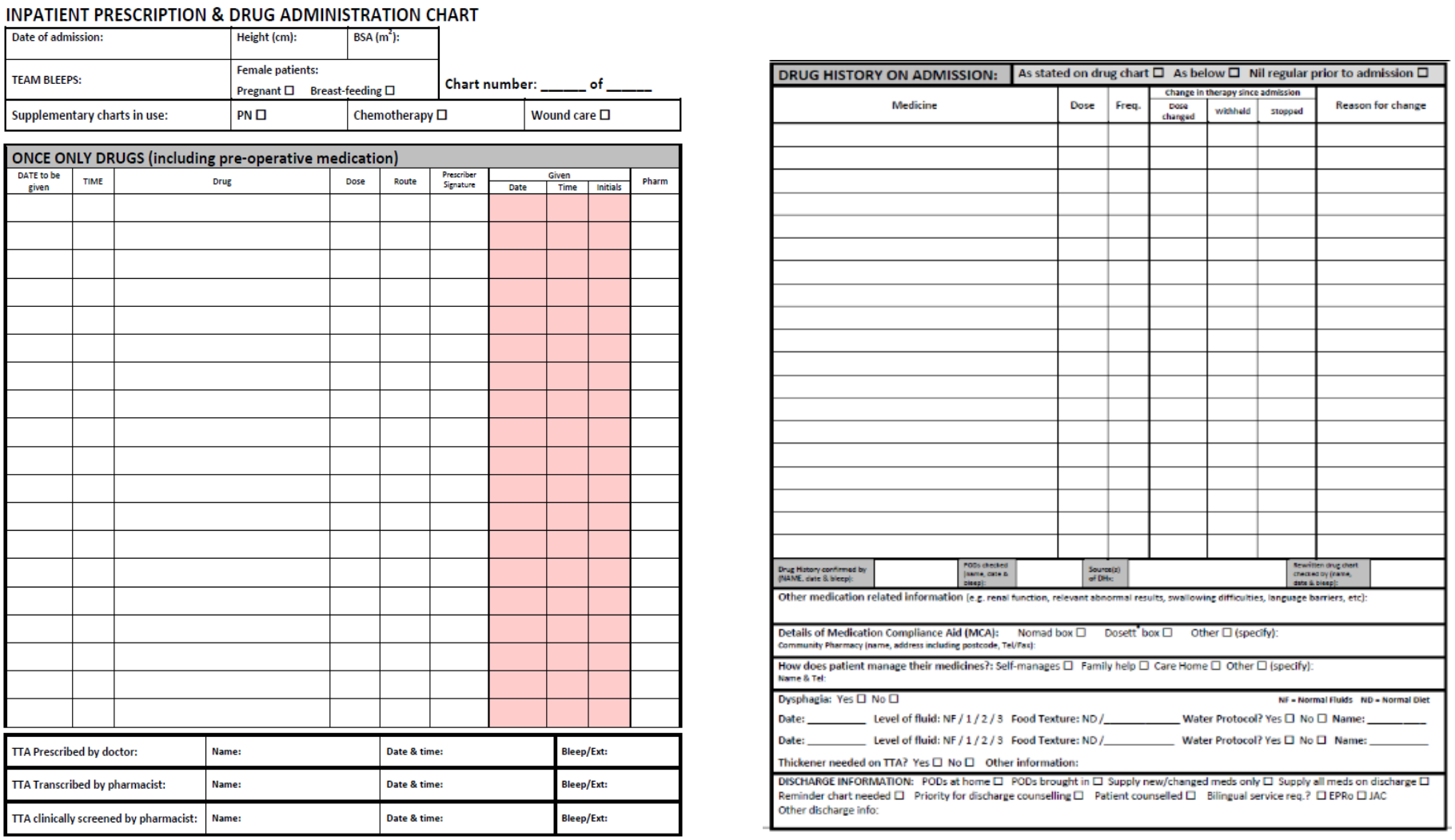
Appendix D: Quality assessment - The Mixed Methods Appraisal Tool (MMAT) version 2018

	1. Qualitative					3. Quantitative non-randomised					4. Quantitative descriptive					5. Mixed methods					Score* (%)
References	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	
Alsweed,2014											Yes	Yes	Yes	Yes	Yes						100
Armada, 2014						No	Yes	Can't tell	Can't tell	Yes											50
Ayatollahi, 2015											Yes	Yes	Yes	Yes	Yes						100
Barber, 2007	Yes	Yes	Yes	Yes	Yes																10
Baysari, 2018	No	Yes	Yes	No	Yes																50
Bedouch, 2012						Yes	Yes	Can't tell	Can't tell	Yes											50
Beuscart-Z'ephir, 2005	Yes	Can't tell	Can't tell	Can't tell	No						Can't tell	Can't tell	Yes	Can't tell	Can't tell	Yes	Yes	No	No	Can't tell	25
Burgin, 2014	Yes	Yes	Yes	Yes	Yes																100
Davies, 2017											Yes	Yes	Yes	No	No						50
Franklin, 2007						Yes	Yes	Yes	Can't tell	Yes											75
Holden, 2010	Yes	Yes	Yes	Can't tell	Yes																75
Hollister, 2011						Can't tell	Yes	Yes	Can't tell	Yes											50
Khajouei, 2011											Yes	No	Yes	Can't tell	Yes						50
Mehta, 2009	Yes	Yes	Yes	Yes	Yes																100
Mekhjian, 2002						Can't tell	Yes	Yes	Can't tell	Yes											50
Niazkhani, 2009						Yes	Yes	Yes	Can't tell	Yes											75
Niazkhani, 2010	Yes	Yes	Yes	Yes	Yes																100
Niazkhani, 2011	Yes	Yes	Yes	No	Yes																75
Pelayo, 2013	Yes	Yes	Yes	Yes	Yes																100

	1. Qualitative					3. Quantitative non-randomised					4. Quantitative descriptive					5. Mixed methods					Score* (%)
References	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	
Pontefract, 2018	Yes	Yes	Yes	Yes	Yes																100
Saddik, 2014											Yes	Yes	Yes	Yes	Yes						100
Van Wilder, 2016						Can't tell	Yes	Yes	Can't tell	Yes											50
Weir, 1996											No	Yes	Yes	No	Yes						50
Wenzer, 2006	Yes	Can't tell	Yes	Can't tell	No																50
Westbrook, 2013						Yes	Yes	Yes	Yes	Yes											100

* meets % of the MMAT criteria

Appendix E: Medication chart from Site 3



INPATIENT PRESCRIPTION & DRUG ADMINISTRATION CHART

Date of admission:	Height (cm):	BSA (m^2):	
TEAM BLEEPS:	Female patients: Pregnant ☐ Breast-feeding ☐		Chart number: _____ of _____
Supplementary charts in use:	PN ☐	Chemotherapy ☐	Wound care ☐

ONCE ONLY DRUGS (including pre-operative medication)

DATE to be given	TIME	Drug	Dose	Route	Prescriber Signature	Given: Date	Given: Time	Given: Initials	Pharm

TTA Prescribed by doctor:	Name:	Date & time:	Bleep/Ext:
TTA Transcribed by pharmacist:	Name:	Date & time:	Bleep/Ext:
TTA clinically screened by pharmacist:	Name:	Date & time:	Bleep/Ext:

DRUG HISTORY ON ADMISSION: As stated on drug chart ☐ As below ☐ Nil regular prior to admission ☐

Medicine	Dose	Freq.	Change in therapy since admission: Dose changed	Change in therapy since admission: withheld	Change in therapy since admission: stopped	Reason for change

Drug History confirmed by (NAME, date & bleep): | PODs checked (name, date & bleep): | Source(s) of DHx: | Rewritten drug chart checked by (name, date & bleep):

Other medication related information (e.g. renal function, relevant abnormal results, swallowing difficulties, language barriers, etc):

Details of Medication Compliance Aid (MCA): Nomad box ☐ Dosett box ☐ Other ☐ (specify):
Community Pharmacy (name, address including postcode, Tel/Fax):

How does patient manage their medicines?: Self-manages ☐ Family help ☐ Care Home ☐ Other ☐ (specify):
Name & Tel:

Dysphagia: Yes ☐ No ☐ NF = Normal Fluids ND = Normal Diet

Date: _____ Level of fluid: NF / 1 / 2 / 3 Food Texture: ND /_____ Water Protocol? Yes ☐ No ☐ Name: _____

Date: _____ Level of fluid: NF / 1 / 2 / 3 Food Texture: ND /_____ Water Protocol? Yes ☐ No ☐ Name: _____

Thickener needed on TTA? Yes ☐ No ☐ Other information:

DISCHARGE INFORMATION: PODs at home ☐ PODs brought in ☐ Supply new/changed meds only ☐ Supply all meds on discharge ☐
Reminder chart needed ☐ Priority for discharge counselling ☐ Patient counselled ☐ Bilingual service req.? ☐ EPRo ☐ JAC
Other discharge info:

VENOUS THROMBOEMBOLISM (VTE) RISK ASSESSMENT

Mandatory completion for all patients (except <18 years old)

Step 1: MOBILITY (please circle)	Surgical inpatient	Medical/Obstetric inpatient + expected to have ongoing reduced mobility	Medical/Obstetric inpatient + NOT expected to have reduced mobility relative to normal state
	Assess for thrombosis and bleeding risk below Go to step 2		Risk assessment now complete Go to step 5

Step 2: THROMBOSIS RISK (score 1 for each risk factor)

Patient related			Admission related	
Previous VTE (personal or family history) (Score 2 points)			Significantly reduced mobility for 3 days or more	
One or more significant medical co morbidities e.g. Heart disease (acute MI within 3 months), Metabolic, Respiratory pathologies, HONK, Endocrine; Acute Infection; Inflammatory conditions (Score 1 for each)			Hip or Knee replacement	
			Hip fracture	
			Surgery + anaesthesia total time > 90mins	
Oestrogen containing contraceptives or hormone therapy (HRT)			Surgery involving Lower limb or Pelvis with surgical time + anaesthesia >60mins	
Pregnant or Puerperium < 6 weeks (See NICE guidelines)			Critical illness requiring admission to ITU/CCU/HDU	
Active Cancer or Cancer therapies, Myeloma/Myeloproliferative disease			Acute surgical admission with inflammatory/intra-abdominal condition	
Acquired or inherited Thrombophilia				
Age > 60 years		Obesity (BMI > 30kg/m^2)		
Dehydration		Varicose veins with Phlebitis	Surgery with significant reduction in mobility	

Step 3: BLEEDING RISK - CONTRAINDICATIONS TO LOW MOLECULAR WEIGHT HEPARIN (LMWH) (score 1 for each risk factor)

Active bleeding		Uncontrolled Systolic Hypertension (230/120mmHg or higher)	
Thrombocytopenia (platelets<75x10^9/l)		Other procedure with high bleeding risk e.g. neurosurgery, spinal surgery or eye surgery	
Acute Stroke in previous month		Untreated inherited bleeding disorders (Von Willebrand's disease, Haemophilia)	
Concurrent use of anticoagulants: NOACs or Vitamin K Antagonists such as warfarin with INR >2		Acquired bleeding disorders	
Lumbar puncture/epidural/spinal anaesthesia within previous 4 hours OR expected within the next 12 hours			

Step 4: ACTION TO BE TAKEN ONCE RISK ASSESSED (tick which applies to patient)

Thrombosis Risk Score	Bleeding Risk Score	Intervention	Admission	Reassessment 1	2	3
0	0	**None needed:** Consider Impulse/Compression device/TEDs in surgical patients				
≥ 1	0	**Prescribe LMWH + TED stockings if appropriate. For obstetric patients *omit* LMWH if delivery likely within 24 hours or if risk of vaginal bleeding**				
≥ 1	≥ 1	**Hold LMWH and review bleeding risk:** Consider Impulse or Compression device /TED stockings & contact Clinical Haematologist				

Step 5:	VTE risk assessed by:		
Risk assessment on admission:	Signature:	Bleep:	Date:
Reassessment: ▪ Surgical patient 24 hrs post op ▪ Medical patient every 7 days ▪ Obstetric patient every 24 hrs OR WHEN CLINICAL CONDITION CHANGES	Signature:	Bleep:	Date:
	Signature:	Bleep:	Date:
	Signature:	Bleep:	Date:

Prescribe LMWH (or if renal impairment, refer to local Hospital Guidelines), impulse / compression device or TEDs on the next page as determined by this risk assessment.

For further information refer to the Trust Guidelines for Management of Thromboembolism in Adults

LOW MOLECULAR WEIGHT HEPARIN (OR UNFRACTIONATED HEPARIN if renal impairment*)

Indication: VTE PROPHYLAXIS ☐ VTE TREATMENT ☐ OTHER: ☐ (specify): _____

Drug		Date	Date	DATE → / TIME↓													
Route S/C	Freq.	Start dose units	Dose change units														
On adm. New																	
Pharmacy		Dr Print Name, Sign & Bleep No.	Dr Print Name, Sign & Bleep No.	*If renal impairment, refer to local Hospital Guidelines													

MECHANICAL THROMBOPROPHYLAXIS

All patients must be risk assessed on admission & reassessed regularly to ensure appropriate prophylaxis is prescribed

Any contraindication? (See Thromboprophylaxis Management Guidelines) Yes ☐ No ☐ Reason if 'Yes': _____

1st choice for mechanical prophylaxis is graduated elastic compression stockings. Nurse to check fitting and skin integrity daily and sign.	DATE → / TIME↓																
Graduated elastic compression stockings R Leg ☐ L Leg ☐ Both legs ☐	Start date	Dr Sign & Bleep No.															
Intermittent pneumatic compression device (IPC)	Start date	Dr Sign & Bleep No.															

FONDAPARINUX FOR ACS (or if renal impairment, refer to local Hospital Guidelines):

Drug Fondaparinux	Dose 2.5mg	Freq. OD	DATE → / TIME↓														
Additional instructions	Start date	Route S/C															
Pharmacy	Dr Print Name, Sign & Bleep No.																

WARFARIN OR OTHER VITAMIN K ANTAGONIST

Patient counselled by (name & date):

Drug	Indication	Give at 18.00	DATE →														
Dose on admission	Target INR		INR														
INR monitored by	Duration		Current Dose														
Yellow book On adm.	New In MCA		Dr's signature														
Pharmacy	Dr Print Name, Sign & Bleep No.		Given by														

DOAC (e.g. RIVAROXABAN, APIXABAN, DABIGATRAN, EDOXABAN)

Patient counselled by (name & date):

Drug	Indication	DATE → / TIME↓															
Dose	Freq. Route	08															
Additional instructions	Duration Start date	12															
		14															
Pharmacy On adm.	New In MCA	18															
Dr Print Name, Sign & Bleep No.		22															

VARIABLE RATE CONTINUOUS INTRAVENOUS INSULIN INFUSION (VRIII)

Actrapid® insulin must be prescribed on the 'Intravenous Infusion Therapy' section of the drug chart (see back of chart)

To prepare, dilute 50 units human Actrapid® insulin to 50ml sodium chloride 0.9%.

Average daily insulin requirements are 0.5-1unit/kg	Capillary Blood Glucose (CBG)	INSULIN SENSITIVE E.g. daily insulin requirements ≤ 24 units	STANDARD RATE First choice in most patients	INSULIN RESISTANT E.g. daily insulin requirements ≥ 100 units	Customised scale E.g. Fixed rate insulin infusion for DKA	Customised scale
*Treat hypoglycaemia and once BG ≥ 4.0mmol/L, restart IV insulin within 20 mins to minimise risk of ketosis	< 4.0	0*	0*	0*		
	4.0 – 8.0	0.5	1	2		
	8.1 – 12.0	1	2	4		
	12.1 – 16.0	2	4	6		
	16.1 – 20.0	3	5	7		
	20.1 – 24.0	4	6	8		
	> 24.0	6	8	10		
Dr Print Name & Sign						
Date & Time						

Check glucose hourly.

Once a patient is eating and drinking switch to regular subcutaneous insulin.

STOPPING IV INSULIN:

Intravenous insulin should be stopped 30 minutes after a dose of subcutaneous insulin has been given.

REGULAR SUBCUTANEOUS INSULIN PRESCRIPTION

Patient has NPSA Insulin Safety Card ☐

INSULIN Name

INSULIN Strength (e.g. 100units/ml)

Route SC

On adm. New

Device: Pen / Vial / Cartridge

Dr Print Name, Sign & Bleep No.

DATE → / TIME ↓

Start Dose | Dose Change | Dose Change | Dose Change

Breakfast / Lunch / Dinner / Night — units

Sign — Pharmacy

DATE

Additional instructions:

Needles to be supplied on discharge? Yes ☐ No ☐

Brand: _____ Size: ____ mm Gauge: ____ G

REGULAR SUBCUTANEOUS INSULIN PRESCRIPTION

Patient has NPSA Insulin Safety Card ☐

INSULIN Name

INSULIN Strength (e.g. 100units/ml)

Route SC

On adm. New

Device: Pen / Vial / Cartridge

Dr Print Name, Sign & Bleep No.

DATE → / TIME ↓

Start Dose | Dose Change | Dose Change | Dose Change

Breakfast / Lunch / Dinner / Night — units

Sign — Pharmacy

DATE

Additional instructions:

Needles to be supplied on discharge? Yes ☐ No ☐

Brand: _____ Size: ____ mm Gauge: ____ G

REGULAR SUBCUTANEOUS INSULIN PRESCRIPTION

Patient has NPSA Insulin Safety Card ☐

INSULIN Name

INSULIN Strength (e.g. 100units/ml)

Route SC

On adm. New

Device: Pen / Vial / Cartridge

Dr Print Name, Sign & Bleep No.

DATE → / TIME ↓

Start Dose | Dose Change | Dose Change | Dose Change

Breakfast / Lunch / Dinner / Night — units

Sign — Pharmacy

DATE

Additional instructions:

Needles to be supplied on discharge? Yes ☐ No ☐

Brand: _____ Size: ____ mm Gauge: ____ G

MRSA COLONISATION REDUCTION

Doctors please sign and annotate times required

DATE →

Drug CHLORHEXIDINE GLUCONATE 4% — Dose 25ml — Daily Body Wash

IF HYPERSENSITIVITY TO CHLORHEXIDINE, USE OCTENISAN

Alternate day shampoo

Pharmacy | Start date | Dr Print Name, Sign & Bleep No.

Drug (Delete as appropriate)

MUPIROCIN 2% NASAL OINTMENT (TDS) for 5 days

OR NASEPTIN® 0.1% CREAM (QDS) for 10 days

Dose: Apply to BOTH nostrils

Time

NASEPTIN® CONTAINS ARACHIS (PEANUT OIL)/CHLORHEXIDINE

Pharmacy | Start date | Dr Print Name, Sign & Bleep No.

ANTIMICROBIAL THERAPY

Prescribe surgical prophylaxis antimicrobials on 'Once Only Drugs' section.
Prescribe long term antimicrobial prophylaxis & anti-tuberculous drugs under 'Regular Prescription'

INITIAL ANTIMICROBIAL PRESCRIPTION(S):

POSSIBLE = Infection is not the most likely diagnosis but you want to use antimicrobial(s) as a precaution
PROBABLE = Infection is the most likely diagnosis but diagnosis and treatment needs to be reviewed daily

Drug	Indication			Drug	Indication		
Category of initial prescription (circle):	POSSIBLE		PROBABLE	Category of initial prescription (circle):	POSSIBLE		PROBABLE
Additional instructions	Dose	Route	Frequency	Additional instructions	Dose	Route	Frequency
Dr Print Name, Sign & Bleep No	Pharmacy		Start Date	Dr Print Name, Sign & Bleep No	Pharmacy		Start Date

DATE→ TIME↓									DATE→ TIME↓								
				Continue until review →									Continue until review →				
		R	R	24-72 hr review	R	R	R	R			R	R	24-72 hr review	R	R	R	R
		E	E	☐ Continue } Re-write below	E	E	E	E			E	E	☐ Continue } Re-write below	E	E	E	E
		V	V	☐ IV to oral }	V	V	V	V			V	V	☐ IV to oral }	V	V	V	V
		I	I	☐ Change }	I	I	I	I			I	I	☐ Change }	I	I	I	I
		E	E	☐ Stop	E	E	E	E			E	E	☐ Stop	E	E	E	E
		W	W	Document decision in notes	W	W	W	W			W	W	Document decision in notes	W	W	W	W

FINAL ANTIMICROBIAL PRESCRIPTION(S):
Document decision in notes

After review of initial antimicrobial prescription with senior / specialist input OR under Consultant direction, the initial antimicrobial prescription may be skipped if the antimicrobial regime is certain

Drug	Indication			Drug	Indication		
Additional instructions	Dose	Route	Frequency	Additional instructions	Dose	Route	Frequency
Reviewed by Micro / ID / Consultant By: Date	Pharmacy		Start Date	Reviewed by Micro / ID / Consultant By: Date	Pharmacy		Start Date
Dr Print Name, Sign & Bleep No	Stop/review date			Dr Print Name, Sign & Bleep No	Stop/review date		

DATE → TIME ↓								DATE → TIME ↓							

Drug	Indication			Drug	Indication		
Additional instructions	Dose	Route	Frequency	Additional instructions	Dose	Route	Frequency
Reviewed by Micro / ID: By: Date	Pharmacy		Start Date	Reviewed by Micro / ID: By: Date	Pharmacy		Start Date
Dr Print Name, Sign & Bleep No	Stop/review date			Dr Print Name, Sign & Bleep No	Stop/review date		

DATE → TIME ↓								DATE → TIME ↓							

REGULAR PRESCRIPTION

NURSING STAFF: If a second check is required (e.g. for ALL parenteral drugs – SC, IM, IV), divide the administration box with a diagonal line to allow for two signatures. Enter time of administration if >60 minutes difference from prescribed time.

			DATE → TIME ↓															
OXYGEN (for adults only)																		
Clinical target oxygen saturation (CIRCLE): 88-92% 94-98% Other: _______				Oxygen for continuous administration. Sign when monitoring oxygen:														
			08															
Starting device:		Flow rate:	12															
			14															
Pharmacy	Start date	Dr Print Name, Sign & Bleep No.	18															
			22															
Drug			08															
Dose	Freq.	Route	12															
Additional instructions		Start date	14															
Pharmacy	On adm. New In MCA		18															
	Dr Print Name, Sign & Bleep No.		22															
Drug			08															
Dose	Freq.	Route	12															
Additional instructions		Start date	14															
Pharmacy	On adm. New In MCA		18															
	Dr Print Name, Sign & Bleep No.		22															
Drug			08															
Dose	Freq.	Route	12															
Additional instructions		Start date	14															
Pharmacy	On adm. New In MCA		18															
	Dr Print Name, Sign & Bleep No.		22															
Drug			08															
Dose	Freq.	Route	12															
Additional instructions		Start date	14															
Pharmacy	On adm. New In MCA		18															
	Dr Print Name, Sign & Bleep No.		22															

PLEASE REWRITE / REVIEW DRUG CHART

REGULAR PRESCRIPTION

NURSING STAFF: If a second check is required (e.g. for ALL parenteral drugs – SC, IM, IV), divide the administration box with a diagonal line to allow for two signatures. Enter time of administration if >60 minutes difference from prescribed time.

DATE → / TIME ↓

Drug

Dose | Freq. | Route

Additional instructions | Start date

Pharmacy | On adm. | New | In MCA

Dr Print Name, Sign & Bleep No.

08 / 12 / 14 / 18 / 22

PLEASE REWRITE / REVIEW DRUG CHART

REGULAR PRESCRIPTION

NURSING STAFF: If a second check is required (e.g. for ALL parenteral drugs – SC, IM, IV), divide the administration box with a diagonal line to allow for two signatures. Enter time of administration if >60 minutes difference from prescribed time.

DATE → / TIME ↓

Drug

Dose | Freq. | Route

Additional instructions | Start date

Pharmacy | On adm. | New | In MCA

Dr Print Name, Sign & Bleep No.

08 / 12 / 14 / 18 / 22

PLEASE REWRITE / REVIEW DRUG CHART

VARIABLE DOSE PRESCRIPTIONS (e.g. steroids, chlordiazepoxide)

For INSULIN, see pages 5 & 6

Drug

DATE → / TIME ↓ | Start Dose | Dose Change | Dose Change

DATE

Route | Freq.

On adm. | New | In MCA

Pharmacy

Dr Print Name, Sign & Bleep No. | Sign | Sign | Sign

PLEASE REWRITE / REVIEW DRUG CHART

Drug

DATE → / TIME ↓ | Start Dose | Dose Change | Dose Change

DATE

Route | Freq.

On adm. | New | In MCA

Pharmacy

Dr Print Name, Sign & Bleep No. | Sign | Sign | Sign

WHEN REQUIRED (PRN) DRUGS

Drug **Sodium Chloride 0.9%**			Dose	Date														
Additional instructions *Pre & post IV administration*		Max. frequency *When needed*	Route ***IV flush***	Time														
				Dose														
Type of IV Line (circle):	Peripheral	Central (CVC)	Other	Route														
Pharmacy	Dr Print Name, Sign & Bleep No.		Start date	Initials														

Drug			Dose	Date														
Additional instructions *Pre & post IV administration*		Max. frequency *When needed*	Route ***IV flush***	Time														
				Dose														
Type of IV Line (circle):	Peripheral	Central (CVC)	Other	Route														
Pharmacy	Dr Print Name, Sign & Bleep No.		Start date	Initials														

Drug			Dose	Date														
				Time														
Additional instructions		Max. frequency	Route	Dose														
Pharmacy	On adm.	New	Start date	Route														
	Dr Print Name, Sign & Bleep No.			Initials														

Drug			Dose	Date														
				Time														
Additional instructions		Max. frequency	Route	Dose														
Pharmacy	On adm.	New	Start date	Route														
	Dr Print Name, Sign & Bleep No.			Initials														

Drug			Dose	Date														
				Time														
Additional instructions		Max. frequency	Route	Dose														
Pharmacy	On adm.	New	Start date	Route														
	Dr Print Name, Sign & Bleep No.			Initials														

Drug			Dose	Date														
				Time														
Additional instructions		Max. frequency	Route	Dose														
Pharmacy	On adm.	New	Start date	Route														
	Dr Print Name, Sign & Bleep No.			Initials														

CODES FOR DRUGS PRESCRIBED BUT NOT ADMINISTERED

When a drug is not given at the prescribed time, record the appropriate number on the chart:

1. Patient away from ward.
2. Patient 'Nil By Mouth' (Refer to Trust Peri-operative Guidelines and patient's notes. Anaesthetist may require some regular drugs to be given prior to procedure).
3. No IV cannula.
4. Patient nauseous / vomiting.
5. Patient refused.
6. Patient self-administering (see Self-Administration Policy)
7. Other – **Please specify in the table below:**

OTHER REASONS FOR DRUG OMISSION

Use this table to document if a missed dose has been agreed by the Prescriber or Pharmacist

Date	Time	Drug	Route	Dose	Missed dose discussed with (state name)		Reason(s) for Omission*	PRINT name & Sign
					Prescriber	Pharmacist		

***NOTE: If a medication is not available, every effort MUST be made to ensure the medication is given as prescribed.**

Contact the ward pharmacist/Pharmacy department during opening hours.

If the Pharmacy is closed, the medicine may be obtained from:

- **Another ward**
- **The Emergency Drug Cupboard (EDC)**
- **Patient's Own Drugs (PODs) – check if the patient has brought in their own medicines and check for suitability for use**
- **Relative – ask a relative if they can bring in the patient's own medicines and check for suitability for use**

If the above measures have been unsuccessful, the Prescriber or On-Call Pharmacist MUST be called.

Site:		ALLERGIES	Patient Details		
Ward:		(State nature & severity of reaction & when reaction occurred if known)	Attach ADDRESSOGRAPH Label		
Consultant:	Weight (kg):	ADVERSE DRUG REACTIONS / INTOLERANCES	Surname	First name	
Specialty:	Date weighed:	(State nature & severity of reaction & when reaction occurred if known)	Hospital no.	NHS no.	
		Source of info: Sign & Date: Allergy band in place ☐	DOB	Age	M/F

VARIABLE RATE INFUSIONS e.g. GTN, dopamine, PCA			Prepared by	Checked by	Time & date started	Time & date stopped	Volume remaining	Unused soln. destroyed by
Drug(s) and diluent		Dose						
Route	Total volume							
Infusion rate	Rate 1	Rate 2						
Start time/date								
Pharmacy	Dr Print Name, Sign & Bleep No.							
Drug(s) and diluent		Dose						
Route	Total volume							
Infusion rate	Rate 1	Rate 2						
Start time/date								
Pharmacy	Dr Print Name, Sign & Bleep No.							
Drug(s) and diluent		Dose						
Route	Total volume							
Infusion rate	Rate 1	Rate 2						
Start time/date								
Pharmacy	Dr Print Name, Sign & Bleep No.							
Drug(s) and diluent		Dose						
Route	Total volume							
Infusion rate	Rate 1	Rate 2						
Start time/date								
Pharmacy	Dr Print Name, Sign & Bleep No.							

INTRAVENOUS (IV) & SUBCUTANEOUS (SC) INFUSION THERAPY

Only prescribe fluids after assessing and documenting the patient's fluid status; can they meet their requirements with oral intake? If the patient is stable, make a fluid plan for 24 hours. Ensure that monitoring is in place, e.g. fluid balance chart, weights and/or daily U&Es. **FOR ADULT PATIENTS:** If the patient is acutely unwell and requires fluid challenges, give 250-500 ml crystalloid rapidly and assess response; call for senior help if >2L has been given. Maintenance fluid requirements are 25-30 ml/kg per day (20-25 ml/kg/day in the elderly) with 1 mmol/kg each of sodium, potassium and chloride; adjust for oral intake and ongoing losses.

DATE	Infusion Fluid or blood / blood component	Drug added & dose No additives to blood products	Final volume to be infused	Route	Duration (hrs/mins) or Rate (ml/hr or mm/hr)	Prescriber's signature	Batch no. & expiry date	Nurses' sign	Start time / Stop time	Volume given	Phar

Appendix F: UCL ethics approval for the focus group and semi-structured interview study

UCL RESEARCH ETHICS COMMITTEE
OFFICE FOR THE VICE PROVOST RESEARCH

3rd May 2018

Professor Bryony Dean Franklin
School of Pharmacy
UCL

Dear Professor Franklin

Notification of Ethics Approval with Provisos
Project ID/Title: 11927/001: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting. A qualitative study.

I am pleased to confirm in my capacity as Joint Chair of the UCL Research Ethics Committee (REC) that I have ethically approved your study until **30th September 2019** on condition that recruitment does not commence until service evaluation approvals from the participating hospital NHS trusts as well as HRA review has been completed.

Ethical approval is also subject to the following conditions:

Notification of Amendments to the Research
You must seek Chair's approval for proposed amendments (to include extensions to the duration of the project) to the research for which this approval has been given. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing an 'Amendment Approval Request Form'
http://ethics.grad.ucl.ac.uk/responsibilities.php

Adverse Event Reporting – Serious and Non-Serious
It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator (ethics@ucl.ac.uk) immediately the incident occurs. Where the adverse incident is unexpected and serious, the Joint Chairs will decide whether the study should be terminated pending the opinion of an independent expert. For non-serious adverse events the Joint Chairs of the Ethics Committee should again be notified via the Ethics Committee Administrator within ten days of the incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Joint Chairs will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

Final Report
At the end of the data collection element of your research we ask that you submit a very brief report (1-2 paragraphs will suffice) which includes in particular issues relating to the ethical implications of the research i.e. issues obtaining consent, participants withdrawing from the research, confidentiality, protection of participants from physical and mental harm etc.

In addition, please:

- ensure that you follow all relevant guidance as laid out in UCL's Code of Conduct for Research: http://www.ucl.ac.uk/srs/governance-and-committees/resgov/code-of-conduct-research
- note that you are required to adhere to all research data/records management and storage procedures agreed as part of your application. This will be expected even after completion of the study.

With best wishes for the research.

Yours sincerely

Dr Lynn Ang
Joint Chair, UCL Research Ethics Committee

Cc: Soomal Mohsin-Shaikh

Amendment Approval Request Form

1	**Project ID Number:** 11927/001	**Name and Address of Principal Investigator:** Soomal Mohsin-Shaikh Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London WC1H 9JP
2	**Project Title:** An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study	
3	**Type of Amendment/s (tick as appropriate)** Research procedure/protocol (including research instruments) ☐ Participant group ☒ Sponsorship/collaborators ☐ Extension to approval needed (extensions are given for one year) ☐ Information Sheet/s ☐ Consent form/s ☐ Other recruitment documents ☐ Principal researcher/medical supervisor* ☐ Other ☐ **Additions to the research team other than the principal researcher, student supervisor and medical supervisor do not need to be submitted as amendments but a complete list should be available upon request **	
4	**Justification** (give the reasons why the amendment/s are needed) Previously, we wanted to compare two hospital sites, one using an electronic prescribing and medication administration (EPMA) system and comparing it to a hospital site using a paper-based prescribing system. We would now like to include one more hospital site using a different EPMA system to allow for our findings to be compared between different EPMA systems and paper-based prescribing systems.	
5	**Details of Amendments** (provide full details of each amendment requested, state where the changes have been made and attach all amended and new documentation) We plan to run the same number of focus groups (3-4 per hospital site) and semi-structured interviews (10 per hospital site) with the same healthcare professionals (pharmacists, doctors and nurses) as proposed in the ethics application. We will also obtain service evaluation approval from the additional site and included it in the HRA application.	
6	**Ethical Considerations** (insert details of any ethical issues raised by the proposed amendment/s) There are no additional ethical implications of this amendment that have not previously been addressed in the application.	
7	**Other Information** (provide any other information which you believe should be taken into account during ethical review of the proposed changes) n/a	

Declaration (to be signed by the Principal Researcher)

- I confirm that the information in this form is accurate to the best of my knowledge and I take full responsibility for it.
- I consider that it would be reasonable for the proposed amendments to be implemented.
- For student projects, I confirm that my supervisor has approved my proposed modifications.

Signature:

Date: 04/05/18

FOR OFFICE USE ONLY:

Amendments to the proposed protocol have been approved by the Research Ethics Committee.

Signature of the REC Chair:

Date: 16/5/2018

Appendix G: Human research authority (HRA) approval for the focus group and semi-structured interview study

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Professor Bryony Dean Franklin
UCL School of Pharmacy
Mezzanine Floor, BMA House, Entrance A
Tavistock Square
WC1H 9JP

Email: hra.approval@nhs.net
Research-permissions@wales.nhs.uk

23 July 2018

Dear Professor Dean Franklin

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study**
IRAS project ID:	**247707**
Protocol number:	**18/0293**
Sponsor	**University College London**

I am pleased to confirm that HRA and Health and Care Research Wales (HCRW) Approval has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

How should I continue to work with participating NHS organisations in England and Wales?
You should now provide a copy of this letter to all participating NHS organisations in England and Wales, as well as any documentation that has been updated as a result of the assessment.

Following the arranging of capacity and capability, participating NHS organisations should formally confirm their capacity and capability to undertake the study. How this will be confirmed is detailed in the "*summary of assessment*" section towards the end of this letter.

You should provide, if you have not already done so, detailed instructions to each organisation as to how you will notify them that research activities may commence at site following their confirmation of capacity and capability (e.g. provision by you of a 'green light' email, formal notification following a site initiation visit, activities may commence immediately following confirmation by participating organisation, etc.).

It is important that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details of the research management function for each organisation can be accessed here.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within the devolved administrations of Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) has been sent to the coordinating centre of each participating nation. You should work with the relevant national coordinating functions to ensure any nation specific checks are complete, and with each site so that they are able to give management permission for the study to begin.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?
The attached document *"After HRA Approval – guidance for sponsors and investigators"* gives detailed guidance on reporting expectations for studies with HRA and HCRW Approval, including:

- Registration of Research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics and is updated in the light of changes in reporting expectations or procedures.

I am a participating NHS organisation in England or Wales. What should I do once I receive this letter?
You should work with the applicant and sponsor to complete any outstanding arrangements so you are able to confirm capacity and capability in line with the information provided in this letter.

The sponsor contact for this application is as follows:

Name: Ms Jessica Broni-Tabi
Tel: 0203 447 2122
Email: randd@uclh.nhs.uk

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **247707**. Please quote this on all correspondence.

Yours sincerely

Kevin Ahmed
Assessor

Telephone: 0207 104 8171
Email: hra.approval@nhs.net

Copy to: *Ms Jessica Broni-Tabi, Sponsor Contact, University College London*
Mrs Soomal Mohsin-Shaikh, R&D Contact, University College London

IRAS project ID	247707

List of Documents

The final document set assessed and approved by HRA and HCRW Approval is listed below.

Document	*Version*	*Date*
Confirmation of any other Regulatory Approvals (e.g. CAG) and all correspondence [UCL REC approval]	1.0	03 May 2018
Confirmation of any other Regulatory Approvals (e.g. CAG) and all correspondence [UCL REC ammendment approval]	1.0	06 May 2018
Confirmation of any other Regulatory Approvals (e.g. CAG) and all correspondence [UCL insurance certificate]	1.0	24 July 2017
HRA Schedule of Events	1.0	23 July 2018
HRA Statement of Activities	1.0	23 July 2018
Interview schedules or topic guides for participants [Appendix 5_DRAFT- Focus group topic guide]	1.0	06 June 2018
Interview schedules or topic guides for participants [Appendix 6_DRAFT- Semi structured interview topic guide]	1.0	06 June 2018
IRAS Application Form [IRAS_Form_12062018]		12 June 2018
Letter from funder [Funding declaration]	1.0	11 May 2018
Letter from sponsor [UCL confirmation letter]	1.0	06 June 2018
Participant consent form [Appendix 3_Consent_Form-DoctorsNurses]	2.0	15 May 2018
Participant consent form [Appendix 4_Consent_Form-Pharmacists]	2.0	15 May 2018
Participant information sheet (PIS) [Doctors/nurses]	4.0	19 July 2018
Participant information sheet (PIS) [Pharmacists]	4.0	19 July 2018
Research protocol or project proposal [JRO_UCL_Protocol]	1.0	14 May 2018
Summary CV for Chief Investigator (CI) [CV for Chief Investigator]	1	19 October 2017
Summary CV for student [CV for Student]	1	25 April 2018

IRAS project ID	247707

Summary of assessment

The following information provides assurance to you, the sponsor and the NHS in England and Wales that the study, as assessed for HRA and HCRW Approval, is compliant with relevant standards. It also provides information and clarification, where appropriate, to participating NHS organisations in England and Wales to assist in assessing, arranging and confirming capacity and capability.

Assessment criteria

Section	Assessment Criteria	Compliant with Standards	Comments
1.1	IRAS application completed correctly	Yes	No comments
2.1	Participant information/consent documents and consent process	Yes	No comments
3.1	Protocol assessment	Yes	No comments
4.1	Allocation of responsibilities and rights are agreed and documented	Yes	The sponsor has submitted the HRA Statement of Activities and intends for this to form the agreement between the sponsor and study sites. The sponsor is not requesting, and does not require any additional contracts with study sites.
4.2	Insurance/indemnity arrangements assessed	Yes	No comments
4.3	Financial arrangements assessed	Yes	No study funding will be provided to sites, as detailed at Schedule 1 of the Statement of Activities.
5.1	Compliance with the Data Protection Act and data security issues assessed	Yes	No comments
5.2	CTIMPS – Arrangements for compliance with the Clinical Trials Regulations assessed	Not Applicable	No comments

Section	Assessment Criteria	Compliant with Standards	Comments
5.3	Compliance with any applicable laws or regulations	Yes	No comments
6.1	NHS Research Ethics Committee favourable opinion received for applicable studies	Not Applicable	No comments
6.2	CTIMPS – Clinical Trials Authorisation (CTA) letter received	Not Applicable	No comments
6.3	Devices – MHRA notice of no objection received	Not Applicable	No comments
6.4	Other regulatory approvals and authorisations received	Not Applicable	No comments

Participating NHS Organisations in England

This provides detail on the types of participating NHS organisations in the study and a statement as to whether the activities at all organisations are the same or different.
The Chief Investigator or sponsor should share relevant study documents with participating NHS organisations in England and Wales in order to put arrangements in place to deliver the study. The documents should be sent to both the local study team, where applicable, and the office providing the research management function at the participating organisation. If chief investigators, sponsors or principal investigators are asked to complete site level forms for participating NHS organisations in England and Wales which are not provided in IRAS, the HRA or HCRW websites, the chief investigator, sponsor or principal investigator should notify the HRA immediately at hra.approval@nhs.net or HCRW at Research-permissions@wales.nhs.uk. We will work with these organisations to achieve a consistent approach to information provision.

Principal Investigator Suitability

This confirms whether the sponsor position on whether a PI, LC or neither should be in place is correct for each type of participating NHS organisation in England and the minimum expectations for education, training and experience that PIs should meet (where applicable).
A Local Collaborator should be appointed at study sites. GCP training is not a generic training expectation, in line with the HRA statement on training expectations.

IRAS project ID	247707

HR Good Practice Resource Pack Expectations

This confirms the HR Good Practice Resource Pack expectations for the study and the pre-engagement checks that should and should not be undertaken
No Honorary Research Contracts, Letters of Access or pre-engagement checks are expected for local staff employed by the participating NHS organisations. Where arrangements are not already in place, research staff not employed by the NHS host organisation undertaking any of the research activities listed in the research application would be expected to hold Letters of Access if focus groups were held in clinical areas. Letters of Access would not be expected if focus groups were held in non-clinical/administrative buildings.

Other Information to Aid Study Set-up

This details any other information that may be helpful to sponsors and participating NHS organisations in England to aid study set-up.
The applicant has indicated that they do not intend to apply for inclusion on the NIHR CRN Portfolio.

Appendix H: Participant information leaflets for pharmacists and medical & nursing staff

Participant Information Sheet for Pharmacists

UCL Research Ethics Committee Approval ID Number: **11927/001**

INFORMATION SHEET

Title of Study: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Department: University College London (UCL) School of Pharmacy

Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London WC1H 9JP

Name and Contact Details of the Principal Investigators: Prof. Bryony Dean Franklin, UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP, Prof. Ann Blandford, UCL Gower Street, London WC1E 6BT, Dr. Dominic Furniss, UCL Gower Street, London WC1E 6BT

Please read this information sheet carefully.

We are inviting you to take part in a PhD research project being conducted at UCL School of Pharmacy. Before you decide, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Once you have read through the information and asked us if there is anything that is not clear, we invite you to sign the consent form (version 2.0 15/05/18).

There are two parts to this information sheet: Part 1 will inform you about the purpose of this research and what will happen if you choose to take part. Part 2 will give you detailed information about the procedures of the study.

You will be given a copy of this information sheet.

Part 1

Details of the study

We are running a series of focus groups exploring how hospital electronic prescribing and medication administration systems may affect communication between pharmacists and other healthcare professionals such as doctors and nurses. We are interested in hearing about any experiences with electronic prescribing and medication administration at your trust or elsewhere, any experiences with paper-based prescribing system and to explore the barriers and facilitators to communication using each type of system. We will not ask you personally sensitive information, and you do not need to answer any questions that you do not wish to answer.

Why have I been invited?

You are being invited to take part because we are interested in recruiting pharmacists working at NHS hospital trusts within the London area. We are inviting band 6 pharmacists and above to take part in the study and pharmacists of all specialities. We are interested in exploring pharmacists' experiences and perceptions of electronic prescribing and medication administration systems and/or a paper-based prescribing system on pharmacists' communication with each other, doctors and nurses.

Do I have to take part?

No, your participation in this study is entirely voluntary and you may choose not to participate. There will be no penalty or loss of benefits for not choosing to participate. You may also discontinue participation at any time without any consequences. However, once you have attended the focus group, you will not be able to withdraw your data as it may not be possible to identify your contributions in the audio recording.

What will happen to me if I take part and what will I have to do?

If you do choose to take part, we will give you a consent form (version 2.0 15/05/18) to read and sign to confirm your participation. We will hold a focus group discussion session of approximately 45-60 minutes in a meeting room at your hospital trust. There will be about 5 to 8 participants and the discussion will be audio recorded. Your general demographics will be collected (i.e. occupation, years in practice) as part of the field notes. We will ask questions about your experiences and perceptions of electronic prescribing and medication administration systems and/or paper-based prescribing systems (i.e. paper drug charts). Two researchers (PhD students) will guide you through the group discussion by asking questions about your perceptions of electronic prescribing and medication administration systems and their impact on your communication with other pharmacists, doctors and nurses. We will provide refreshments during the focus group.

Will I be recorded and how will the recorded media be used?

Yes, you will be audio recorded during the focus group. The audio recordings will be stored in accordance with the General Data Protection Regulation. Any paper-based information/data from the study (e.g. consent forms) will be stored in a locked cabinet within UCL. The audio recordings will be transcribed by a UCL approved service and analysed by the PhD student. The data will be stored on a UCL computer and will be password protected. Only the research team, made up of the PhD student and their supervisors, will have access to it until the PhD thesis is submitted and passed and all the potential publications have been accepted. Thereafter, all personal data, including the audio recordings will be deleted or destroyed. All the transcriptions and quotes used will be anonymised so the information cannot be traced back to an individual.

What are the possible disadvantages and risks of taking part?

The overall risk of this study is low. We will be running the focus group during normal working hours during training afternoons or lunch times. Collecting data on your experiences and perceptions of electronic prescribing and medication administration systems and/or paper-based prescribing system and the effect on your communication with other pharmacists, doctors and nurses during a group discussion is unlikely to involve any risk. If however, talking about your experiences with an organisation's

electronic prescribing and medication administration system or paper based system causes you to become distressed, the researcher will respond appropriately and terminate the discussion if deemed necessary. Any unexpected discomfort, disadvantages and risks to you or the other participants that arise during the research, should be brought immediately to the researchers' attention.

What are the possible benefits of taking part?

Whilst there are no immediate benefits for those people participating in the research, it is hoped that this work will provide an opportunity for pharmacist colleagues to share their views and feedback about the electronic prescribing and medication administration system and/or paper-based prescribing system which some participants might find useful. There will be refreshments provided for the participants during the focus group.

Part 2

What if something goes wrong?

If you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff you may have experienced due to your participation in the research, UCL complaints mechanisms are available to you.

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact UCL using the details below for further advice and information:

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, Department of Practice and Policy
Tavistock Square, London WC1H 9JP

However, if you feel that your complaint has not been handled to your satisfaction then you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

Will my taking part in this project be kept confidential?

We will keep all the information that we collect about you during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Only the PhD student leading the study and her PhD supervisors will have access to your anonymised data. Anonymised quotations from the focus group may be used in the resulting PhD thesis and any resulting publications based on the research. Every effort will be made to ensure that any information that could identify the participant or hospital trust is removed from any quotes used. Confidentiality cannot be guaranteed for information which might be disclosed by other participants after the focus group has concluded.

Limits to confidentiality

- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.
- Please note that confidentiality will be maintained as far as it is possible, unless during our conversation I hear anything which makes me worried that someone might be in danger of harm, I might have to inform relevant agencies of this.

- Please note that confidentiality may not be guaranteed; due to the limited size of the participant sample.

UCL is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. UCL will keep identifiable information about you for 3 months after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

Your hospital NHS Trust will use your name, and contact details to contact you about the research study to oversee the quality of the study. Individuals from UCL and regulatory organisations may look at your research records to check the accuracy of the research study. The only people in UCL who will have access to information that identifies you will be people who need to contact you to arrange a date to talk to you or audit the data collection process.

What will happen to the results of the research project?

The results from the focus group will be presented in the researcher's PhD thesis, conferences and potential publications. The publications will be disseminated to the participants via the local coordinator (a senior member of the pharmacy clinical services team/research department). Any paper-based information/data from the study (e.g. consent forms) will be stored in a locked cabinet within UCL School of Pharmacy. Data stored on the computer will be password protected and only the research team will have access to it until the PhD thesis is submitted and passed and all the potential publications have been accepted. Thereafter, the audio recordings will be deleted or destroyed.

Data Protection Privacy Notice

The data controller for this project will be UCL. The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer is Lee Shailer and he can also be contacted at data-protection@ucl.ac.uk**.**

Your personal data will be processed for the purposes outlined in this notice. You can provide your consent for the use of your personal data in this project by completing the consent form that has been provided to you.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

Who is organising and funding the research?

This research project is being funded by the UCL Impact scheme/Cerner.

Contact for further information

If you have any further questions relating to this study please do not hesitate to contact the research team.

Soomal Mohsin-Shaikh (PhD student)
UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP

Prof. Ann Blandford (Secondary Supervisor)
UCL, Gower Street, London, WC1E 6BT

Thank you for taking the time to read the information sheet and for considering to take part in this group discussion.

Participant Information Sheet for Medical and Nursing Staff
UCL Research Ethics Committee Approval ID Number: **11927/001**

INFORMATION SHEET

Title of Study: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Department: University College London (UCL) School of Pharmacy

Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London WC1H 9JP

Name and Contact Details of the Principal Investigators: Prof. Bryony Dean Franklin, UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP, Prof. Ann Blandford, UCL Gower Street, London WC1E 6BT, Dr. Dominic Furniss, UCL Gower Street, London WC1E 6BT

Please read this information sheet carefully.

We are inviting you to take part in a PhD research project being conducted at UCL School of Pharmacy. Before you decide, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Once you have read through the information and asked us if there is anything that is not clear, we invite you to sign the consent form (version 2.0 15/05/18).

There are two parts to this information sheet: Part 1 will inform you about the purpose of this research and what will happen if you choose to take part. Part 2 will give you detailed information about the procedures of the study.

You will be given a copy of this information sheet.

Part 1

Details of the study

We are running a series of semi-structured interviews with doctors and nurses exploring how hospital electronic prescribing and medication administration systems may affect communication between your teams and with other healthcare professionals. We are interested in hearing about any experiences with electronic prescribing and medication administration at your trust or elsewhere, any experiences with paper-based prescribing system and to explore the barriers and facilitators to communication using each type of system. We will not ask you personally sensitive information, and you do not need to answer any questions that you do not wish to answer.

Why have I been invited?

You have been invited to take part because we are interested in recruiting doctors (of all grades and specialities) and nurses (band 5 and above) working at NHS hospital trusts within the London area. We are inviting doctors and nurses to take part in the semi-structured interviews exploring your experiences and perceptions of electronic prescribing and medication administration systems and/or a paper-based prescribing system on doctors'/nurses' communication with each other, other healthcare professionals.

Do I have to take part?

No, your participation in this study is entirely voluntary and you may choose not to participate. There will be no penalty or loss of benefits for not choosing to participate. You may also discontinue participation at any time without any consequences. You will be able to withdraw your data up to one week after the semi-structured interview takes place.

What will happen to me if I take part and what will I have to do?

If you choose to take part, we will give you a consent form (version 2.0 15/05/18) to read and sign to confirm your participation. We will hold one semi-structured interview lasting up to one hour in a meeting room at your hospital trust where you will be invited to attend. The interview will be audio recorded. Your general demographics will be collected (i.e. occupation, years in practice) as part of the field notes. We will ask questions about your experiences and perceptions of electronic prescribing and medication administration systems and/or paper-based prescribing systems (i.e. paper drug charts). The researcher will ask you questions about your perceptions of electronic prescribing and medication administration systems and their impact on your communication with pharmacists, doctors and nurses. We will also provide you with refreshments during the interview.

Will I be recorded and how will the recorded media be used?

Yes, you will be audio recorded during the interview. The audio recordings will be stored in accordance with the General Data Protection Regulation. Any paper-based information/data from the study (e.g. consent forms) will be stored in a locked cabinet within UCL. The audio recordings will be transcribed by a UCL approved service and analysed by the PhD student. The data will be stored on a UCL computer and will be password protected. Only the research team, made up of the PhD student and their supervisors, will have access to it until the PhD thesis is submitted and passed and all the potential publications have been accepted. Thereafter, all personal data, including the audio recordings will be deleted or destroyed. All the transcriptions and quotes used will be anonymised so the information cannot be traced back to an individual.

What are the possible disadvantages and risks of taking part?

The overall risk of this study is low. We will be running the semi-structured interview during normal working hours during training afternoons or lunch times. Collecting data on your experiences and perceptions of electronic prescribing and medication administration systems and/or paper-based prescribing system and the effect on your communication with other pharmacists, doctors and nurses during a group discussion is unlikely to involve any risk. If however, talking about your experiences with an organisation's electronic prescribing and medication administration system or paper based system causes you to become distressed, the researcher will respond appropriately and terminate the discussion if deemed necessary. Any unexpected discomforts, disadvantages and risks to you that arise during the research should be brought immediately to the researchers' attention.

What are the possible benefits of taking part?

Whilst there are no immediate benefits for those people participating in the research, it is hoped that this work will provide an opportunity for you to share your views and feedback about the electronic prescribing and medication administration system and/or paper-based prescribing system which some participants might find useful. There will be refreshments provided for you during the semi-structured interview.

Part 2

What if something goes wrong?

If you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff you may have experienced due to your participation in the research, UCL complaints mechanisms are available to you.

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact UCL using the details below for further advice and information:

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, Department of Practice and Policy
Tavistock Square, London WC1H 9JP

However, if you feel that your complaint has not been handled to your satisfaction then you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

Will my taking part in this project be kept confidential?

We will keep all the information that we collect about you during the course of the research will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications. Only the PhD student leading the study and her PhD supervisors will have access to your anonymised data. Anonymised quotations from the focus group may be used in the resulting PhD thesis and any resulting publications based on the research. Every effort will be made to ensure that any information that could identify the participant or hospital trust is removed from any quotes used.

Limits to confidentiality

- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.
- Please note that confidentiality will be maintained as far as it is possible, unless during our conversation I hear anything which makes me worried that someone might be in danger of harm, I might have to inform relevant agencies of this.

UCL is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. UCL will keep identifiable information about you for 3 months after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study more than a week after the interview, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

Your hospital NHS Trust will use your name, and contact details to contact you about the research study to oversee the quality of the study. Individuals from UCL and regulatory organisations may look at your research records to check the accuracy of the research study. The only people in UCL who will have access to information that identifies you will be people who need to contact you to arrange a date to talk to you or audit the data collection process.

What will happen to the results of the research project?

The results from the semi-structured interviews will be presented in the researcher's PhD thesis, conferences and potential publications. The publications will be disseminated to the participants via the local coordinator (a senior member of the pharmacy clinical services team/research department). Any paper-based information/data from the study (e.g. consent forms) will be stored in a locked cabinet within UCL School of Pharmacy. Data stored on the computer will be password protected and only the research team will have access to it until the PhD thesis is submitted and passed and all the potential publications have been accepted. Thereafter, the audio recordings will be deleted or destroyed.

Data Protection Privacy Notice

The data controller for this project will be UCL. The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer is Lee Shailer and he can also be contacted at data-protection@ucl.ac.uk*.*

Your personal data will be processed for the purposes outlined in this notice. You can provide your consent for the use of your personal data in this project by completing the consent form that has been provided to you.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

Who is organising and funding the research?

This research project is being funded by the UCL Impact scheme/Cerner.

Contact for further information

If you have any further questions relating to this study please do not hesitate to contact the research team.

Soomal Mohsin-Shaikh (PhD student)
UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP

Prof. Ann Blandford (Secondary Supervisor)
UCL, Gower Street, London, WC1E 6BT

Thank you for taking the time to read the information sheet and for considering to take part in this interview.

Appendix I: Consent forms for pharmacists and medical & nursing staff

CONSENT FORM FOR PHARMACISTS

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Department: University College London (UCL) School of Pharmacy

Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London WC1H 9JP

Name and Contact Details of the Principal Researchers: Prof. Bryony Dean Franklin, UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP Prof. Ann Blandford, UCL Gower Street, London WC1E 6BT, Dr. Dominic Furniss, UCL Gower Street, London WC1E 6BT

Name and Contact Details of the UCL Data Protection Officer: Lee Shailer, data-protection@ucl.ac.uk

This study has been approved by the UCL Research Ethics Committee: Project ID number: 11927/001

Thank you for considering taking part in this research. The person organising the research must explain 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 whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1	I confirm that I have read and understood the Information Sheet version 2 (09/04/17) for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and would like to take part in a group discussion.	
2	I understand that my participation is voluntary and that I am free to withdraw at any time up until the focus group discussion is complete.	
3	I consent to the processing of my personal information, i.e. my general demographics, consent forms, for the purposes explained to me. I understand that such information will be handled in accordance with all applicable data protection legislation.	
4	I understand that all personal information will remain confidential and that all efforts will be made by the researcher(s) to ensure I cannot be identified.	

		Tick box
5	I understand that confidentiality cannot be guaranteed for information which I might disclose in the focus group but the other participants.	
6	I understand that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications.	
7	I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
8	I understand that the information I have submitted will be published as a report/publication.	
9	I consent to my contribution to the focus group discussion to be audio recorded and understand that the recordings will stored anonymously, using password-protected software. Once the PhD thesis and publications have been successfully accepted the data collected will be destroyed.	
10	I voluntarily agree to take part in this study.	
11	I understand that other authenticated researchers (PhD student, primary and secondary supervisors) will have access to my anonymised data.	

_____	_____	_____
Name of participant	Date	Signature

_____	_____	_____
Researcher	Date	Signature

CONSENT FORM FOR MEDICAL AND NURSING STAFF

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Department: University College London (UCL) School of Pharmacy

Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London WC1H 9JP

Name and Contact Details of the Principal Researchers: Prof. Bryony Dean Franklin, UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP, Prof. Ann Blandford, UCL Gower Street, London WC1E 6BT, Dr. Dominic Furniss, UCL Gower Street, London WC1E 6BT

Name and Contact Details of the UCL Data Protection Officer: Lee Shailer, data-protection@ucl.ac.uk

This study has been approved by the UCL Research Ethics Committee: Project ID number: 11927/001

Thank you for considering taking part in this research. The person organising the research must explain 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 whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1	I confirm that I have read and understood the Information Sheet version 2 (09/04/18) for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and would like to take part in a semi-structured interview discussion.	
2	I understand that I will be able to withdraw my data up to one week after the semi-structured interview.	
3	I consent to the processing of my personal information i.e. my general demographics for the purposes explained to me. I understand that such information will be handled in accordance with all applicable data protection legislation.	
4	I understand that all personal information will remain confidential and that all efforts will be made by the researcher(s) to ensure I cannot be identified.	

		Tick box
5	I understand that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications.	
6	I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
7	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason. I understand that if I decide to withdraw, there will be no penalty or loss of benefits for not choosing to participate.	
8	I understand that the information I have submitted will be published as a report/publication.	
9	I consent to my interview being audio recorded and understand that the recordings will stored anonymously, using password-protected software. Once the PhD thesis and publications have been successfully accepted the data collected will be destroyed.	
10	I voluntarily agree to take part in this study.	
11	I understand that other authenticated researchers (PhD student, primary and secondary supervisors) will have access to my anonymised data.	

Name of participant	Date	Signature
Researcher	Date	Signature

Appendix J: Topic guide for the focus groups with pharmacists

An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Pharmacist focus group questions

Welcome and thank you for taking your time out today to participate in our study. The aim of this focus group is to gain an insight into pharmacists' experiences and opinions of paper **and/or** electronic prescribing and medication administration systems in use and the impact they have had on your communication with other pharmacists, pharmacy technicians, doctors and nurses. As you have already been informed, this discussion will be audio recorded.

The first series of questions are to help introduce you to one another. Can you please share:

1) Number of years qualified
2) Speciality/band
3) Previous/current experience with a paper based/electronic prescribing and medication administration system

The second series of questions are around what methods you currently have available to communicate information between:

1) Pharmacist – pharmacist,
2) Pharmacist – pharmacy technician
3) Pharmacist – doctor,
4) Pharmacist – nurse (and vice versa)

What kind of information would you typically exchange with another…

1) pharmacist,
2) pharmacy technician
3) doctor,
4) nurse

…on a day to day basis and what method of communication do you use for the different information exchanges? *[Prompts – paper vs. electronic, does it depend on what you're communicating or the urgency?]*

How might you use an electronic prescribing and medication administration system to communicate information to other pharmacists and other HCPs such as pharmacy technicians, doctors and nurses? (**For non-EPMA site**)/How do you use the current EPMA system to communicate information with pharmacists and other HCPs such as pharmacy technician, doctors and nurse, and how do they use the system to communicate with you? Are there other uses you could imagine putting it to, or ways that you wish your colleagues would use it (**For EPMA site**)

In your experience (**For EPMA site**) what are the (perceived - **For non-EPMA site**) advantages and disadvantages of using an electronic prescribing and medication administration system to communicate information to other pharmacists and HCPs such as pharmacy technicians, doctors and nurses? **[Get participants to write these on post it notes (different colours for advantages and disadvantages) and share after 5 mins]**

Finally, do you have anything else you would like to share regarding communication between pharmacists, pharmacy technicians, doctors and nurses?

Thank you for taking the time to participate in this focus group.

Appendix K: Topic guide for the semi-structured interviews with medical and nursing staff

An exploration of hospital pharmacists', doctors' and nurses' perceptions of intra- and inter-professional communication and electronic prescribing and medication administration systems in an in-patient setting: a qualitative study

Semi-structured interview questions for medical and nursing staff

Welcome and thank you for taking your time out today to participate in our study. The aim of this interview is to gain an insight into your experiences and opinions on paper **and/or** electronic prescribing and medication administration systems in use and the impact they have had on your communication with pharmacists.

The first series of questions are to gather some information about yourself and your experience with paper/electronic prescribing and medication administration systems.

1) Number of years qualified……
2) Speciality……..……...
3) Previous/current experience with a paper based/electronic prescribing and medication administration system……..…….
4) Do you liaise with a pharmacist for medication related queries? ……
5) Do you liaise with a pharmacy technician for medication related queries?…….

The second series of questions are around methods of communication between you and your pharmacist colleagues.

6) What kind of information would you typically exchange with another doctor and nurse on a day to day basis?
7) What methods are available for you to communicate information to another doctor and nurse?
8) What kind of information would you typically exchange with a pharmacist/pharmacy technician on a day to day basis?
9) What methods are available for you to communicate information to a pharmacist/pharmacy technician?
10) You just listed different types of information and methods you use to communication with a pharmacist/pharmacy technician, why do you choose different method of communication for different information exchanges?
11) How effective do you think these methods are in communicating these information exchanges and why?
12) How could an electronic prescribing and medication administration system be used to communicate information to pharmacists/pharmacy technicians? (**For non-EPMA site**) /How could the current EPMA system be utilised to better communicate information with pharmacists/pharmacy technicians? (**For EPMA site**)
13) What are the (perceived – **for non-EPMA site**) advantages of using an electronic prescribing and medication administration system to communicate information to pharmacists/pharmacy technicians?
14) What are the (perceived – **for non-EPMA site**) disadvantages of using an electronic prescribing and medication administration system to communicate information to pharmacists/pharmacy technicians?

Finally, do you have anything else you would like to share regarding your communication with pharmacists (or using an EPMA system as a method to communicate with pharmacists/pharmacy technician – **for EPMA site**)?

Thank you for taking the time to participate in this interview.

Appendix L: NHS ethics approval for the observational study with pharmacists

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow and Clyde

Mrs Soomal Mohsin-Shaikh
UCL School of Pharmacy
Mezzanine Floor, BMA House, Entrance A
Tavistock Square
WC1H 9JP

West of Scotland REC 5
West of Scotland Research Ethics Service
West Glasgow Ambulatory Care Hospital
Dalnair Street
Glasgow
G3 8SJ

Date 20 December 2018

Direct line 0141 232 1809
E-mail WoSREC5@ggc.scot.nhs.uk

Please note: This is an acknowledgement letter from the REC only and does not allow you to start your study at NHS sites in England until you receive HRA Approval

Dear Mrs Mohsin-Shaikh

Study title: How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study
REC reference: 18/WS/0239
Protocol number: 18/0527
IRAS project ID: 249203

Thank you for your e-submission made on 19 December 2018. I can confirm the REC has received the documents listed below and that these comply with the approval conditions detailed in our letter dated 14 December 2018.

Documents received

The documents received were as follows:

Document	*Version*	*Date*
Other [Ward poster]	1.0	18 December 2018
Participant consent form [Participant consent form]	2.0	18 December 2018
Participant information sheet (PIS) [Participant information leaflet]	2.0	18 December 2018

Approved documents

The final list of approved documentation for the study is therefore as follows:

Document	*Version*	*Date*
Confirmation of any other Regulatory Approvals (e.g. CAG) and all	1.0	25 July 2018

correspondence [UCL insurance certificate]		
IRAS Application Form [IRAS_Form_28112018]		28 November 2018
Other [Ward poster]	1.0	18 December 2018
Participant consent form [Participant consent form]	2.0	18 December 2018
Participant information sheet (PIS) [Participant information leaflet]	2.0	18 December 2018
Research protocol or project proposal [UCL JRO protocol]	1.0	15 November 2018
Summary CV for Chief Investigator (CI) [CV for Chief Investigator]		19 October 2017
Summary CV for student [CV for student]		25 April 2018

You should ensure that the sponsor has a copy of the final documentation for the study. It is the sponsor's responsibility to ensure that the documentation is made available to R&D offices at all participating sites.

18/WS/0239 **Please quote this number on all correspondence**

Yours sincerely

Sharon Macgregor
REC Manager

Copy to: Professor Bryony Dean Franklin, University College London
Pushpsen Joshi, Unverisity College London

Lead Nation England: HRA.Approval@nhs.net

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow and Clyde

Mrs Soomal Mohsin-Shaikh
UCL School of Pharmacy
Mezzanine Floor, BMA House, Entrance A
Tavistock Square
WC1H 9JP

West of Scotland REC 5
West of Scotland Research Ethics Service
West Glasgow Ambulatory Care Hospital
Dalnair Street
Glasgow
G3 8SW

Date 08 March 2019

Direct line 0141 232 1804
E-mail WoSREC5@ggc.scot.nhs.uk

Dear Mrs Mohsin-Shaikh

Study title:	**How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study**
REC reference:	**18/WS/0239**
Protocol number:	**18/0527**
Amendment number:	**AM01**
Amendment date:	**05 March 2019**
IRAS project ID:	**249203**

The above amendment was reviewed by the Sub-Committee in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Copies of advertisement materials for research participants [Ward Poster]	2.0	14 February 2019
Notice of Substantial Amendment (non-CTIMP)	AM01	05 March 2019
Participant information sheet (PIS)	1.0	14 February 2019

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

Working with NHS Care Organisations

Sponsors should ensure that they notify the R&D office for the relevant NHS care organisation of this amendment in line with the terms detailed in the categorisation email issued by the lead nation for the study.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our Research Ethics Committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

18/WS/0239:	**Please quote this number on all correspondence**

Yours sincerely

On behalf of
Dr Stewart Campbell
Chair

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Pushpsen Joshi, University College London*
Professor Bryony Dean Franklin

West of Scotland REC 5

Attendance at Sub-Committee of the REC meeting on 15 March 2019

Committee Members:

Name	*Profession*	*Present*	*Notes*
Dr Stewart Campbell	Consultant Physician & Gastroenterologist (CHAIR)	Yes	
Dr James Dale	Consultant Rheumatologist	Yes	
Mrs June Russell	Retired (Research Chemist)	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Mrs Rose Gallacher	Assistant Co-ordinator

Appendix M: Confidentiality advisory group (CAG) approval for the observational study with pharmacists

NHS
Health Research Authority

Skipton House
80 London Road
London
SE1 6LH

Telephone: 020 79722557
Email: HRA.CAG@nhs.net

26 February 2019

Professor Bryony Dean Franklin
Professor of Medication Safety
UCL
UCL School of Pharmacy
Mezzanine Floor, BMA House, Entrance A
Tavistock Square
WC1H 9JP

Dear Professor Dean Franklin

Application title:	**How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study**
CAG reference:	**19/CAG/0006**
IRAS project ID:	**249203**
REC reference:	**18/WS/0239**

Thank you for your research application, submitted for approval under Regulation 5 of the Health Service (Control of Patient Information) Regulations 2002 to process confidential patient information without consent. Approved applications enable the data controller to provide specified information to the applicant for the purposes of the relevant activity, without being in breach of the common law duty of confidentiality, although other relevant legislative provisions will still be applicable.

The role of the Confidentiality Advisory Group (CAG) is to review applications submitted under these Regulations and to provide advice to the Health Research Authority on whether an application should be supported, and if so, any relevant conditions. This application was considered at the CAG meeting held on 24 January 2019. The application was considered under the Precedent Set Category 10: Incidental disclosures of identifiable information made to an applicant who is observing practices and procedures within a health and social care setting.

Health Research Authority Support decision

The Health Research Authority, having considered the advice from the Confidentiality Advisory Group as set out below, has determined the following:

1. The application to cover the disclosure of confidential patient information in the presence of the named Student Investigator during observations of Pharmacists working within Imperial College Healthcare NHS Trust, London North West University Healthcare NHS Trust and Whittington Hospital NHS Hospital NHS Trust is fully supported, subject to compliance with the standard and specific conditions of support.

Please note that the legal basis to allow access to the specified confidential patient information without consent is now in effect.

This letter should be read in conjunction with the outcome letter dated 04 February 2019.

Context

Purpose of application

This application from University College London set out the purpose of medical research which aims to explore how pharmacists communicate with each other and wider healthcare professionals in an inpatient setting and how electronic prescribing and medication systems may affect this.

During the study, the Student Investigator will observe pharmacists on general medical and surgical wards in three NHS hospital Trusts. Two of the participating Trusts will use differing electronic prescribing and medication administration systems and the third site will operate a paper-based prescribing system. The Student Investigator will follow pharmacists during the course of their daily duties, including prepping for wards rounds, time on the ward and any follow-up activities. Observations will be recorded on a paper data collection form. The observer will follow-up any queries identified around the observation with the pharmacists to gain a greater understanding. During the course of the observations, patient bed number will be recorded to enable the communications relating to the same patient to be clustered for follow-up and analysis.

Up to 20 pharmacists will be observed at each participating Trusts in order to collect information on the required number of communication events, which has been calculated as 1,089 events per Trust. It estimated that the observations will last up to four hours per day, across 20 working days per site.

Confidential patient information is not required for the purposes of the project analysis and will not be recorded during the observation field work. However, as the observer will be shadowing pharmacists during the course of their daily activities, there is a risk that the observer may be exposed to confidential patient information for which there is no established lawful basis, under the common law duty of confidentiality, for the individual to receive.

A recommendation for class 5 and 6 support was requested to cover activities as described in the application.

Confidential patient information requested

Cohort

The pharmacist observations will be undertaken on general medical and surgical wards within the three participating Trusts: Imperial College Healthcare NHS Trust, London North West University Healthcare NHS Trust and Whittington Hospital NHS Hospital NHS

Trust. The patient cohort would involve all inpatients resident within the participating wards during the course of the staff observations.

No direct patient identifiers would be recorded as the focus of the study is the pharmacists; however, it is stated that patient bed number would be retained to enable communications relating to the same patient to be clustered.

Confidentiality Advisory Group advice

A Sub-Committee of the CAG considered the applicant's response to the request for further information detailed in the provisionally supported outcome in correspondence.

1. **Explain what wider patient benefit could be achieved from the study's findings.**

The applicant explained that poor communication among health care professionals is well known to affect the quality and safety of patient care, with a recent systematic review they had undertaken, which has been submitted for publication, concluding that electronic systems can have a significant effect on the nature and quality of such communication.

The importance of this issue was also highlighted in a recent priority setting partnership led by the NIHR Imperial Patient Safety Translational Research Centre in partnership with the James Lind Alliance. This set out to identify the most pressing questions for research which, if addressed, could improve the safety of care of adults with complex health needs. Patients, carers and health and social care professionals were involved at all stages of this process. The applicant explained that, of the many hundreds of research questions which were put forward to the group, one of the most important research questions identified was "how can communication be improved among the healthcare professionals within a single organisations who are all involved in a patient's care?".

The applicant explained that the proposed study aimed to shed light on this issue through identifying the differences in communication strategies between different electronic systems and a paper based system. The study would identify any potential consequences of any difference in communication strategies on patient safety, and make recommendations as needed to improve patient care.

The Sub-Committee received the additional information and raised no further queries in this area.

2. **Provide further detail around what information would be read out loud by the pharmacists when operating computers or reviewing paper drug charts.**

The applicant explained that the original application form stated that, 'The observer may ask the pharmacist to talk out loud when using the computer or drug chart so that the observer can record the pharmacist's communication accurately on the data collection form'. It was further explained that this related only to, for example, where the pharmacist switches between patient records on the computer and it may not be clear to the observer that the pharmacist has switched to documenting their communications for a different patient. In this situation, the observer may ask the pharmacist what the relevant bed number is. Or in a paper system, the pharmacist may write an instruction on the paper drug chart regarding administration advice, and the observer may want to clarify who the communication is targeted at. It was clarified that observer would request that the observed pharmacists do not read out any confidential information such as patients' names.

The Sub-Committee received the clarification and raised no further issues in this area.

3. **Clarify what protocol has been put in place to reduce the risk of wider disclosures of confidential patient information during the observations.**

It was confirmed that the observer would only need to observe the pharmacist during the study and would not need access to any additional documents. The applicant reiterated that the pharmacist would be asked not to read out any confidential information such as patients' names. The observer would work to place themselves out of direct view of the computer screens or paper drug charts when undertaking an observation, to reduce the risk of wider disclosure.

The Sub-Committee received the response and raised no further issues in this area.

4. **Provide an estimate of the number of patients that may form the basis of the staff observations.**

The applicant confirmed that the patients were not the subject of interest in the study as the focus was to observe the pharmacists' interactions with other healthcare professionals. The number of patients that may form the basis of staff observations would be dependent on the size and complexity of the ward. However, from pilot work (2 pharmacists' observations), the applicants had found that 24 patients were physically present on each ward and the pharmacist reviewed all 24 electronic drug charts while conducting their clinical duties. In both pilot observations, one patient was seen face-to-face by the pharmacist on each ward and the observer stood outside the bay when the pharmacist spoke to these patients.

On the basis of this information, the applicant estimated that the observed pharmacist would talk to between 1-5 patients at each hospital during the course of the proposed study. The observer would stand outside the patient's bed or bay during this discussion in the line with the methodology employed in the pilot study.

The Sub-Committee received the response and raised no further queries in this area.

5. **Assurance is required that patient bed number was a sufficient data item to link information related to an individual patient collected during the various staff observations for analysis.**

The applicant confirmed that during the pilot observations, collecting the patient's bed number sufficed. Observations on each ward would last only around 2-4 hours and it was unlikely that a significant number of patients would move beds during that time. It was further explained that a statistician was also consulted at UCL who confirmed that this would be the only piece of information needed to carry out the planned statistical analyses.

The Sub-Committee received the assurance from the applicant and raised no further issues in this area.

6. **Some patient and public engagement activity should be undertaken to seek views around the proposed study and the potential disclosure of confidential patient information during the staff observations. Provide feedback on the activity undertaken and the views provided. If the responses given were negative, the CAG would take this into account when considering whether support should continue, or whether further actions are necessary.**

The applicant explained that eight members of a patient and public advisory group relating to the Centre for Medication Safety and Service Quality at Imperial College Healthcare NHS Trust were invited to feed back their views on the proposed study. The session was held in early February.

At the session, researchers introduced themselves, summarised the research question, methodology, the issue of potential incidental disclosure of patient information during staff observations, and the proposed opt-out approach, and invited views on our proposed approach, a draft ward poster and a draft patient information leaflet from attendees.

An overview of the outputs from the session was provided for review, which were all supportive of the proposal and the methodology.

The Sub-Committee received the information and raised no further issues in this area.

7. **Patient notification and dissent – the following points should be addressed:**
   a. **The ward poster should be revised to provide a clearer overview of the full scope of the staff observations which would be carried out,**

An updated document was provided which addressed the points raised.

The Sub-Committee received the document and raised no further issues.

   b. **A brief information leaflet should be produced to support the information included within the poster. If it is determined that this cannot be produced, a strong justification should be provided to support this decision,**

A brief information leaflet was provided.

The Sub-Committee received the document and raised no further issues.

   c. **It is recommended that the documents are reviewed as part of the patient engagement activity to ensure these are deemed appropriate.**

The applicant confirmed that both the ward poster and patient information leaflet were reviewed by the patient and public advisory group and their feedback was incorporated.

The Sub-Committee received the assurance and raised no further issues in this area.

Confidentiality Advisory Group advice conclusion

The CAG agreed that the minimum criteria under the Regulations appeared to have been met and that there was a public interest in projects of this nature being conducted, and therefore advised recommending support to the Health Research Authority, subject to compliance with the specific and standard conditions of support as set out below.

Specific conditions of support (Final)

1. Favourable opinion from a Research Ethics Committee (**Confirmed – 14 December 2018**).
2. Confirmation from the IGT Team at NHS Digital of suitable security arrangements via Information Governance Toolkit (IGT) submission (**Confirmed – Imperial College Healthcare NHS Trust, London North West University Healthcare NHS Trust and Whittington Hospital NHS Hospital NHS Trust all have published satisfactory reviewed grades on V14.1, 2017/18**).

As the above conditions have been met, this letter provides confirmation of final approval. I will arrange for the register of approved applications on the HRA website to be updated with this information.

Annual review

Please note that your approval is subject to submission of an annual review report to show how you have met the conditions or report plans, and action towards meeting them. It is also your responsibility to submit this report on the anniversary of your final approval and to report any changes such as to the purpose or design of the proposed activity, or to security and confidentiality arrangements. An annual review should be provided no later than **26 February 2020** and preferably 4 weeks before this date. If at any stage you no longer require support under the Regulations as you will cease processing confidential patient information without consent you should inform the Confidentiality Advice Team of this in writing as soon as possible.

Reviewed documents

The documents reviewed at the meeting were:

Document	*Version*	*Date*
CAG application from (signed/authorised) [CAG_Form_ReadyForSubmission]		29 November 2018
Covering letter on headed paper [Covering letter_IRAS ID 249203]		15 February 2019
Other [research-registration-form]		
Other [DRAFT - Data collection form - study 2]		
Other [Consent-Form-Pharmacists observations]	2	18 December 2018
Other [19CAG0006 CAT Advice Form SMS]		14 January 2019
Patient Information Materials [Participant-Information-Sheet-Pharmacists obs]	2	08 December 2018
Patient Information Materials [Information leaflet_IRAS ID 249203_V1]	1	15 February 2019
Patient Information Materials [Ward poster_IRAS ID 249203_V2]	2	15 February 2019
Research protocol or project proposal [Observational Protocol_- IA-authorised]	1	15 November 2018
Written recommendation from Caldicott Guardian (or equivalent) of applicant's organisation [Letter of Support Soomal Mohsin-Shaikh]		28 November 2018

Membership of the Committee

The members of the Confidentiality Advisory Group who were present at the consideration of this item or submitted written comments are listed below.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R & D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

Yours sincerely

Miss Kathryn Murray
Senior Confidentiality Advisor

On behalf of the Health Research Authority

Email: HRA.CAG@nhs.net

Enclosures:	*List of members who considered application* *Standard conditions of approval*
Copy to:	WoSREC5@ggc.scot.nhs.uk hra.approval@nhs.net

Confidentiality Advisory Group Sub-Committee Meeting in Correspondence

Group Members:

Name	*Present*	*Notes*
Ms Sophie Brannan	Yes	Lay Member
Dr Tony Calland MBE	Yes	Chair
Dr. Liliane Field	Yes	
Mr. Myer Glickman	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Miss Kathryn Murray	Senior Confidentiality Advisor

NHS
Health Research Authority

Standard conditions of support

Support to process confidential patient information without consent, given by the Health Research Authority, is subject to the following standard conditions of support.

The applicant and those processing the information will ensure that:

1. The specified confidential patient information is only used for the purpose(s) set out in the application.
2. Confidentiality is preserved and there are no disclosures of information in aggregate or patient level form that may inferentially identify a person, nor will any attempt be made to identify individuals, households or organisations in the data.
3. Requirements of the Statistics and Registration Services Act 2007 are adhered to regarding publication when relevant, in addition to other national guidance.
4. All staff with access to confidential patient information have contractual obligations of confidentiality, enforceable through disciplinary procedures.
5. All staff with access to confidential patient information have received appropriate ongoing training to ensure they are aware of their responsibilities.
6. Activities remain consistent with the General Data Protection Regulation and Data Protection Act 2018.
7. Audit of data processing by a designated agent is facilitated and supported.
8. The wishes of patients who have withheld or withdrawn their consent are respected.
9. Any significant changes (for example, people, purpose, data flows, data items, security arrangements) must be approved via formal amendment prior to changes coming into effect.
10. An annual review report is submitted to the CAG every 12 months from the date of the final support letter, for the duration of the support.
11. Any breaches of confidentiality around the supported flows of information should be reported to CAG within 10 working days of the incident, along with remedial actions taken / to be taken. This does not remove the need to follow national/legal requirements for reporting relevant security breaches.

Appendix N: Human research authority (HRA) approval for the observational study with pharmacists

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Prof Bryony Dean Franklin
UCL
Mezzanine Floor, BMA House, Entrance A
Tavistock Square
London
WC1H 9JP

Email: hra.approval@nhs.net
Research-permissions@wales.nhs.uk

13 March 2019

Dear Prof Dean Franklin

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study**
IRAS project ID:	**249203**
Protocol number:	**18/0527**
REC reference:	**18/WS/0239**
Sponsor	**University College London**

I am pleased to confirm that HRA and Health and Care Research Wales (HCRW) Approval has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

How should I continue to work with participating NHS organisations in England and Wales?
You should now provide a copy of this letter to all participating NHS organisations in England and Wales, as well as any documentation that has been updated as a result of the assessment.

Following the arranging of capacity and capability, participating NHS organisations should formally confirm their capacity and capability to undertake the study. How this will be confirmed is detailed in the '*summary of assessment*' section towards the end of this letter.

You should provide, if you have not already done so, detailed instructions to each organisation as to how you will notify them that research activities may commence at site following their confirmation of capacity and capability (e.g. provision by you of a 'green light' email, formal notification following a site initiation visit, activities may commence immediately following confirmation by participating organisation, etc.).

It is important that you involve both the research management function (e.g. R&D office) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details of the research management function for each organisation can be accessed here.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within the devolved administrations of Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) has been sent to the coordinating centre of each participating nation. You should work with the relevant national coordinating functions to ensure any nation specific checks are complete, and with each site so that they are able to give management permission for the study to begin.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?
The document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

I am a participating NHS organisation in England or Wales. What should I do once I receive this letter?
You should work with the applicant and sponsor to complete any outstanding arrangements so you are able to confirm capacity and capability in line with the information provided in this letter.

The sponsor contact for this application is as follows:

Name: Ms Jessica Broni-Tabi
Tel: 0203 447 2122
Email: uclh.randd@nhs.net

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **249203**. Please quote this on all correspondence.

IRAS project ID	249203

Yours sincerely

Kelly Rowe
Assessor

Email: hra.approval@nhs.net

Copy to: *Ms Jessica Broni-Tabi, UCL JRO, Sponsor contact*
Pushpsen Joshi, University College London, lead NHS R&D contact

IRAS project ID	249203

List of Documents

The final document set assessed and approved by HRA and HCRW Approval is listed below.

Document	*Version*	*Date*
Confirmation of any other Regulatory Approvals (e.g. CAG) and all correspondence [UCL insurance certificate]	1.0	25 July 2018
Copies of advertisement materials for research participants [Ward Poster]	2.0	14 February 2019
HRA Schedule of Events [Validated SOE]	1.0	06 November 2018
HRA Statement of Activities [Validated SOA]	1.0	06 November 2018
IRAS Application Form [IRAS_Form_28112018]		28 November 2018
Letter from funder [UCL funding declaration]	1.0	13 September 2018
Letter from sponsor [UCL confirmation letter]	1.0	23 October 2018
Notice of Substantial Amendment (non-CTIMP)	AM01	05 March 2019
Participant consent form [Participant consent form]	2.0	18 December 2018
Participant information sheet (PIS) [Participant information leaflet]	2.0	18 December 2018
Participant information sheet (PIS)	1.0	14 February 2019
Research protocol or project proposal [UCL JRO protocol]	1.0	15 November 2018
Summary CV for Chief Investigator (CI) [CV for Chief Investigator]		19 October 2017
Summary CV for student [CV for student]		25 April 2018

IRAS project ID	249203

Summary of assessment

The following information provides assurance to you, the sponsor and the NHS in England and Wales that the study, as assessed for HRA and HCRW Approval, is compliant with relevant standards. It also provides information and clarification, where appropriate, to participating NHS organisations in England and Wales to assist in assessing, arranging and confirming capacity and capability.

Assessment criteria

Section	Assessment Criteria	Compliant with Standards	Comments
1.1	IRAS application completed correctly	Yes	No comments
2.1	Participant information/consent documents and consent process	Yes	HRA Approval incorporates substantial amendment 1.
3.1	Protocol assessment	Yes	No comments
4.1	Allocation of responsibilities and rights are agreed and documented	Yes	A statement of activities has been submitted and the sponsor is not requesting and does not expect any other site agreement to be used.
4.2	Insurance/indemnity arrangements assessed	Yes	No comments
4.3	Financial arrangements assessed	Yes	No application for external funding has been made. The statement of activities confirms there are no funds available to sites from the sponsor.
5.1	Compliance with the Data Protection Act and data security issues assessed	Yes	No comments
5.2	CTIMPS – Arrangements for compliance with the Clinical Trials Regulations assessed	Not Applicable	No comments
5.3	Compliance with any applicable laws or regulations	Yes	No comments

Section	Assessment Criteria	Compliant with Standards	Comments
6.1	NHS Research Ethics Committee favourable opinion received for applicable studies	Yes	No comments
6.2	CTIMPS – Clinical Trials Authorisation (CTA) letter received	Not Applicable	No comments
6.3	Devices – MHRA notice of no objection received	Not Applicable	No comments
6.4	Other regulatory approvals and authorisations received	Yes	Section 251 support received dated 26/02/2019

Participating NHS Organisations in England and Wales

This provides detail on the types of participating NHS organisations in the study and a statement as to whether the activities at all organisations are the same or different.
Participating NHS organisations will conduct all study activities as per protocol. The activities may be undertaken by external researchers at site. The Chief Investigator or sponsor should share relevant study documents with participating NHS organisations in England and Wales in order to put arrangements in place to deliver the study. The documents should be sent to both the local study team, where applicable, and the office providing the research management function at the participating organisation. Where applicable, the local LCRN contact should also be copied into this correspondence. If chief investigators, sponsors or principal investigators are asked to complete site level forms for participating NHS organisations in England and Wales which are not provided in IRAS, the HRA or HCRW websites, the chief investigator, sponsor or principal investigator should notify the HRA immediately at hra.approval@nhs.net or HCRW at Research-permissions@wales.nhs.uk. We will work with these organisations to achieve a consistent approach to information provision.

Principal Investigator Suitability

This confirms whether the sponsor position on whether a PI, LC or neither should be in place is correct for each type of participating NHS organisation in England and Wales, and the minimum expectations for education, training and experience that PIs should meet (where applicable).
A local collaborator is expected at participating NHS organisations. GCP training is not a generic training expectation, in line with the HRA/HCRW/MHRA statement on training expectations.

IRAS project ID	249203

HR Good Practice Resource Pack Expectations

This confirms the HR Good Practice Resource Pack expectations for the study and the pre-engagement checks that should and should not be undertaken
Where arrangements are not already in place, research staff not employed by the NHS host organisation undertaking any of the research activities listed in the research application would be expected to obtain a Letter of Access based on standard DBS checks and occupational health clearance.

Other Information to Aid Study Set-up

This details any other information that may be helpful to sponsors and participating NHS organisations in England and Wales to aid study set-up.
The applicant has indicated that they do not intend to apply for inclusion on the NIHR CRN Portfolio.

Appendix O: Participant information leaflet for the observational study

Participant Information Sheet for Pharmacists

INFORMATION SHEET

Title of Study: How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study
Department: University College London (UCL) School of Pharmacy
Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, BMA House, Entrance A, Tavistock Square, London, WC1H 9JP
Name and Contact Details of the Principal Investigators: Prof. Bryony Dean Franklin, UCL School of Pharmacy, BMA House, Tavistock Square, London, WC1H 9JP; Prof. Ann Blandford, UCL Gower Street, London, WC1E 6BT; Dr. Dominic Furniss, UCL Gower Street, London, WC1E 6BT

This study was approved by West of Scotland Research Ethics Committee (ref 18/WS/0239)

Please read this information sheet carefully.

We are inviting you to take part in a research project being conducted through UCL School of Pharmacy. Before you decide, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Once you have read through the information and asked us if there is anything that is not clear, we invite you to sign the consent form (Version 2.0, dated 18 December 2018).

There are two parts to this information sheet: Part 1 will inform you about the purpose of this research and what will happen if you choose to take part. Part 2 will give you detailed information about the procedures of the study.

You will be given a copy of this information sheet.

Part 1: Purpose of the research

Details of the study

We are running a series of observations of pharmacists' activities, exploring how they communicate while carrying out their clinical duties. We are interested in understanding if there are differences in communication strategies between hospitals using electronic versus paper prescribing and medication administration systems. We would like to observe the communication exchanges pharmacists have with other healthcare professionals (e.g. doctors, nurses) as well as with patients. We will not ask you personally sensitive information. The observer will not interfere with your daily work, but will tactfully intervene in the unlikely event that a significant clinical issue is noticed.

Why have I been invited?

You are being invited to take part because you are a pharmacist working at one of the NHS hospital trusts taking part in this study. We are inviting all pharmacists working as a ward pharmacist on general medical or surgical wards to take part in the study.

Do I have to take part?

No, your participation in this study is entirely voluntary. There will be no penalty or loss of benefits for not choosing to participate. You may also discontinue participation at any time during the observation without giving a reason and any consequences. However, once the observation has been completed, you will not be able to withdraw your anonymised data.

What will happen to me if I take part and what will I have to do?

If you do choose to take part, we will give you a consent form (Version 1.0 dated 28 November 2018) to read and sign to confirm your participation. The observer, who is a trained pharmacist studying for her PhD, will accompany you while you undertake your clinical duties on your wards. We will ask for your general demographic information (gender, years qualified, band and previous experience with paper and electronic prescribing and medication administration systems). General information about the ward in the observation will also be collated such as specialty, number of beds and number of patients on the ward during the observation. The observation will last for the whole of your ward visit for that day. The observer may ask you to talk through some of your tasks out loud during the observation. You will be requested to introduce the observer to other healthcare professionals and patients on the ward if appropriate.

Will I be recorded and how will the recorded media be used and stored?

No audio or video recording will be used. The observer will record the data describing the nature of any communication exchanges and associated field notes on paper data collection forms. At the end of the observation, the observer may ask for further information about one or more of your communication exchanges to clarify details or ask how you felt about them. This information will be documented as part of the field notes. The data collection forms will be stored in accordance with the General Data Protection Regulation. All paper-based information/data from the study (e.g. consent forms, data collection forms) will be stored in a locked cabinet at UCL. The data from the data collection forms will be transferred onto Excel spreadsheets and will be stored on a password protected UCL computer. The information documents as part of the field notes will be typed up electronically and saved on password protected UCL computer. Only the research team will have access to it until the PhD thesis is submitted and passed and all the potential publications have been accepted. The data used will be anonymised so the information cannot be traced back to an individual. Thereafter, the anonymous raw data will be stored electronically at UCL for 10 years. The consent forms, paper data collection forms and field notes will be retained for three months after the completion of the PhD and subsequently destroyed.

What are the possible disadvantages and risks of taking part?

The overall risk of this study is low. We will be conducting the observations during normal working hours. The observations will not involve any change in practice. If the observation causes you to become distressed, the observer will respond appropriately and terminate the observation if necessary. Any unexpected discomfort, disadvantages and risks to you or others that arise during the research should be brought immediately to the observer's attention.

What are the possible benefits of taking part?

While there are no immediate benefits for the pharmacists participating in this research, it is hoped that this work will help to understand how new technologies are affecting the work of pharmacists.

Part 2: Procedure of the study

What if something goes wrong?

If you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff due to your participation in the research, UCL complaints mechanisms are available to you.

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact UCL using the details below for further advice and information:

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, Department of Practice and Policy
Tavistock Square, London, WC1H 9JP

However, if you feel that your complaint has not been handled to your satisfaction then you can contact the Chair of the UCL Research Ethics Committee – ethics@ucl.ac.uk

Will my taking part in this project be kept confidential?

We will not be collecting personally identifiable information for this study. You will not be able to be identified in any ensuing reports or publications. Only the PhD student leading the study and her PhD supervisors will have access to your anonymised data. Anonymised data may be used in the resulting PhD thesis and any resulting publications based on the research. Every effort will be made to ensure that any information that could identify the participant or their hospital trust is removed from the resulting thesis and publications. However, please note the limits to confidentiality below.

Limits to confidentiality

- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.
- Confidentiality will be respected subject to legal constraints and professional guidelines.
- Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this was the case we would inform you of any decisions that might limit your confidentiality.
- Confidentiality may be limited and conditional and the observer has a duty of care to report to the relevant authorities any possible harm/danger to the participant or others.

UCL is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. UCL will keep identifiable information about you for 3 months after the study has finished. Your anonymous data being stored at UCL securely for 10 years after the study is complete and will then be destroyed.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. You may choose to discontinue your participation at any time without any consequences, however, once the observation has been completed, you will not be able to withdraw that data. To safeguard your rights, we will use the minimum amount of personally-identifiable information as possible.

Your NHS hospital trust will use your name, and contact details to contact you about the research study and to oversee the quality of the study. Individuals from UCL and regulatory organisations may look at your research records to check the accuracy of the research study. The only people in UCL who will have access to information that

identifies you will be people who need to contact you to arrange a date to observe you or audit the data collection process.

What will happen to the results of the research project?

The results from the observations may be presented in the researcher's PhD thesis, at a conference and/or a peer-reviewed research paper.

Data Protection Privacy Notice

The data controller for this project will be UCL. The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer is Lee Shailer and he can also be contacted at data-protection@ucl.ac.uk**.**

Your personal data will be processed for the purposes outlined in this notice. You can provide your consent for the use of your personal data in this project by completing the consent form that has been provided to you.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

It's important for you to be aware that if you are taking part in research, or information about you is used for research, your rights to access, change or move information about you are limited. This is because researchers need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from a study, the sponsor will keep the information about you that it has already obtained. They may also keep information from research indefinitely.

Who is organising and funding the research?

This research project is being funded by the UCL Impact scheme/Cerner.

Contact for further information

If you have any further questions relating to this study please do not hesitate to contact the research team.

Soomal Mohsin-Shaikh (PhD student)
UCL School of Pharmacy, Tavistock House, Tavistock Square, London, WC1H 9HR

Prof. Bryony Dean Franklin (Primary Supervisor)
UCL School of Pharmacy, Tavistock House, Tavistock Square, London, WC1H 9HR

Prof. Ann Blandford (Secondary Supervisor)
UCL, Gower Street, London, WC1E 6BT

Thank you for taking the time to read the information sheet and for considering to take part in this observation.

Appendix P: Consent form for the observational study

CONSENT FORM FOR PHARMACISTS

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: How have electronic prescribing and medication administration systems transformed pharmacists' communication in an inpatient setting? A multi-site observational study

Department: University College London (UCL) School of Pharmacy

Name and Contact Details of the Researcher: Soomal Mohsin-Shaikh, Research Department of Practice and Policy, UCL School of Pharmacy, Mezzanine Floor, Tavistock House, Entrance A, Tavistock Square, London, WC1H 9HR

Name and Contact Details of the Principal Researchers: Prof. Bryony Dean Franklin, UCL School of Pharmacy, Mezzanine Floor, Tavistock House, Entrance A, Tavistock Square, London, WC1H 9HR, Prof. Ann Blandford, UCL Gower Street, London, WC1E 6BT, Dr. Dominic Furniss, UCL Gower Street, London WC1E 6BT

Name and Contact Details of the UCL Data Protection Officer: Lee Shailer, data-protection@ucl.ac.uk

This study was approved by West of Scotland Research Ethics Committee (ref 18/WS/0239)

Thank you for considering taking part in this research. The person organising the research must explain 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 whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1	I confirm that I have read and understood the Information Sheet Version 2.0 (18/12/18) for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and would like to take part in the observation.	
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without reason, up until the observation is complete.	
3	I consent to the processing of my demographic information and written consent forms, for the purposes of this study. I understand that such information will be handled in accordance with all applicable data protection legislation.	
4	I understand that my personal information will remain confidential and that all efforts will be made by the researcher(s) to ensure that I cannot be identified.	
5	I understand the potential risks of participating in this study.	
6	No promise or guarantee of benefits have been made to encourage me to participate.	

7	I understand that I will not benefit financially from this study or from any possible outcome it may result in the future.	
8	I understand that data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any reports or publications.	
9	I understand that my information may be subject to review by responsible individuals from the University and regulators for monitoring and audit purposes.	
10	I will comply with the local information governance toolkit recommended by the organisation.	
11	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researcher(s) undertaking this study.	
12	I understand that the information from the observation will be published as a report/publication.	
13	I consent to being observed completing my routine clinical work and understand that the data collected will be stored anonymously, using password-protected software or in a designated locked cabinet at UCL.	
14	I understand that the researcher will only intervene if a significant clinical issue is noticed.	
15	I understand my signed consent form will be stored securely at UCL for 3 months after the study is complete and will then be destroyed.	
16	I consent to my anonymous data being stored at UCL securely for 10 years after the study is complete and will then be destroyed.	
17	I am aware of who I should contact if I wish to lodge a complaint.	
18	I understand that other authenticated researchers (PhD student, primary and secondary supervisors) will have access to my anonymised data.	

Name of participant	Date	Signature

Researcher	Date	Signature

UCL
SCHOOL OF PHARMACY

A study to find out how pharmacists in hospital communicate with one another and with other healthcare professionals

How have electronic prescribing systems transformed pharmacists' communication in an inpatient setting - A multi-site observational study

Patient information leaflet

THANK YOU

NHS Whittington Health NHS Trust
Putting patients at the HEART of everything we do
NHS London North West University Healthcare NHS Trust
Imperial College Healthcare NHS Trust

A pharmacist is conducting a research study on this ward. Please read the following information and ask us if there's anything that isn't clear, or if you'd like more information.

What is the purpose of this study?

We're looking at the work of pharmacists when they support patients who are staying in hospital. We want to know how they communicate with other pharmacists and with doctors and nurses, and whether having prescriptions on computers instead of on paper makes any difference.

Is the study confidential?

Yes. All information collected will be kept strictly confidential. No patient details are being recorded. Please also be assured that in the unlikely event that this research identifies any safety concerns, we will take appropriate action.

What will happen in this study?

The researcher will be observing the ward pharmacist while they are working on this ward. This will take place during normal working hours. It also includes any preparation work that they do before coming onto the ward.

The research pharmacist will write down on a standard paper form a summary of where each information exchange took place, the healthcare professional involved in the exchange, the method used by the pharmacist to exchange information (i.e. face-to-face, telephone) and a brief note on the theme of the communication (e.g. medication advice, medication history query). The data from the forms will then be transferred onto a computer spreadsheet for statistical analysis. No details of any patients will be written down or recorded in any other way.

Can I ask for the pharmacist not to be observed when they are talking to me?

Yes. It's possible the researcher may overhear you talking to your pharmacist. If you want to avoid this possibility, just tell the researcher or a member of staff at any time that you don't want the researcher observing. The researcher will then place themselves well out of earshot.

Who is organising this study?

The research is being carried out at University College London, School of Pharmacy as part of a PhD project. All proposals for research involving human subjects are reviewed by an ethics committee before they can proceed. This study was reviewed and approved by West of Scotland Research Ethics Committee (ref 18/WS/0239).

Thank you for your time. Please ask us if you would like more information (our contact details can be found overleaf.

Contact for further information

If you would like any further information on any aspect of the study, then do not hesitate to contact us.

Mrs Soomal Mohsin-Shaikh (PhD student)

UCL School of Pharmacy, Mezzanine Floor, Tavistock House,

Tavistock Square, London WC1H 9HR

Prof. Bryony Dean Franklin (Chief investigator/Primary supervisor)

UCL School of Pharmacy, Mezzanine Floor, Tavistock House,

Tavistock Square, London WC1H 9HR

Telephone: 020 7874 1280

Appendix R: Ward poster for the observational study

How have electronic prescribing systems transformed pharmacists' communication in an inpatient setting?

A multi-site observational study

Research Ethics Committee Approval Number: 18/WS/0239, IRAS number: 249203
Version 2.0, 15 February 2019

UCL

We are conducting a research study on this ward. Please read the following information and ask us if there is anything that is not clear or if you would like more information. All proposals for research involving human subjects are reviewed by an ethics committee before they can proceed. This study was reviewed and approved by West of Scotland Research Ethics Committee (ref:18/WS/0239)

What is the purpose of this study?

We would like to find out how pharmacists communicate with each other and with other healthcare professionals such as doctors and nurses in hospital. We want to know if having prescriptions on computers instead of on paper makes any difference.

What will happen?

A researcher, a trained pharmacist studying for a PhD, will be observing the ward pharmacist while they are working on the ward. This will include any preparation work before coming onto the ward, as well as their tasks on the ward. The researcher will record a summary of the communication exchanges that occur between the pharmacist and other doctors and nurses on a paper data collection form. No patient details will be recorded. During the observation on the ward, it is possible that the researcher may overhear you talking to the pharmacist.

Can I ask for the pharmacist not to be observed when they are talking to me?

Yes, If you do not want the researcher to observe the pharmacist if they speak to you, please do let the researcher or a member of ward staff know. The researcher will then place themselves well out of earshot.

Is the study confidential?

Yes. All information collected will be kept strictly confidential. No patient details will be collected in this study. Please also be assured that in the unlikely event that this research identifies any safety concerns, we will take appropriate action.

Thank you for your time. Please ask us if you would like more information (our contact details can be found below).

Contact for further information

If you have any further questions relating to this study please do not hesitate to contact the research team. You may also request the research team or ward pharmacist for an information leaflet for further information.

Mrs Soomal Mohsin-Shaikh (PhD student)
UCL School of Pharmacy, Mezzanine Floor, Tavistock House,
Tavistock Square, London WC1H 9HR
Email:

Prof. Bryony Dean Franklin (Chief investigator/Primary supervisor)
UCL School of Pharmacy (address as above)
Telephone: 020 7874 1280
Email:

Imperial College Healthcare NHS Trust | Whittington Health NHS Trust | Putting patients at the HEART of everything we do | London North West University Healthcare NHS Trust

Appendix S: Pharmacists demographics for the observational study at the three study sites

	Pharmacist number	Years qualified	Agenda for change (AfC) band	Gender	Speciality	Independent prescriber	Previous electronic prescribing and medication administration experience	Observed twice in the study
Site 1	1	4	7	F	Rotational	×	No – paper	✓
	2	3	6	F	Rotational	×	Cerner only	×
	3	5	8a	M	Cardiology	✓	No – paper	✓
	4	3	7	M	Clinical	×	No – paper	×
	5	2	6	M	Rotational	×	No – paper	×
	6	10	8b	M	Clinical commissioning	×	No – paper	×
	7	7	8b	M	Gastroenterology	×	Cerner at another Trust	×
	8	3	7	F	Medicines optimisation	×	JAC	×
	9	7	8a	M	Rheumatology	×	Cerner at another Trust	×
	10	25	8a	M	Cardiology	✓	No – paper	×
	11	21	8b	F	Surgical	✓	No – paper	×
	12	5	8a	F	Vascular surgery	×	No – paper	×
	13	4	7	F	Rotational	×	Escribe	×
	14	5	6	F	Rotational	×	No – paper	×
	15	0.6	6	F	Rotational	×	Cerner only	×

	Pharmacist number	Years qualified	Agenda for change (AfC) band	Gender	Speciality	Independent prescriber	Previous electronic prescribing and medication administration experience	Observed twice in the study
Site 1	16	0.6	6	F	Rotational	×	Cerner only	×
	17	2	6	F	Rotational	×	Cerner only	×
	18	14	8a	F	Specialist medicine	✓	No – paper	×
Site 2	1	0.6	6	F	Rotational	×	No – paper	✓
	2	18	8b	F	Surgical	✓	No – paper	×
	3	2	6	F	Rotational	×	Escribe & paper	✓
	4	3	7	F	Rotational	×	JAC	×
	5	6	7	F	Rotational	×	No – paper	×
	6	6	7	F	Rotational	×	No – paper	✓
	7	2	6	F	Rotational	×	JAC at another Trust	✓
	8	20	7	F	Medication safety	×	No – paper	×
	9	8	8b	M	Medicine	×	No – paper	✓
	10	20	8a	M	Respiratory	×	No – paper	×
	11	10	8a	F	Medicine for the elderly	×	No – paper	×
	12	1	6	F	Rotational	×	No – paper	×
Site 3	1	3	6	F	Rotational	×	No – paper	×
	2	36	7	F	Surgical	×	No – paper	×
	3	6	7	F	Rotational	×	Last word	×
	4	5	7	F	Rotational	✓	Cerner	×
	5	4	7	F	Gastroenterology	×	No – paper	×
	6	3	7	M	Rotational	✓	JAC	×
	7	8	6	M	Rotational	×	No – paper	×

	Pharmacist number	Years qualified	Agenda for change (AfC) band	Gender	Speciality	Independent prescriber	Previous electronic prescribing and medication administration experience	Observed twice in the study
Site 3	8	20	8a	M	Stroke & medicine for the elderly	✓	No – paper	×
	9	3	7	M	Rotational	×	No – paper	×
	10	24	8a	F	HIV and Sexual health	✓	No – paper	×
	11	1	6	F	Rotational	×	No – paper	×
	12	2	6	F	Rotational	×	No – paper	×
	13	1	6	F	Rotational	×	No – paper	×
	14	2	6	M	Rotational	×	No – paper	×
	15	3	6	M	Rotational	×	No – paper	×
	16	3	7	F	Medicines information	×	Sunrise	×
	17	9	8a	F	Gastroenterology & nutrition	✓	No – paper	×
	18	4	7	F	Rotational	×	No – paper	×
	19	4	7	F	Rotational	×	Cerner	×
	20	12	8b	F	Gastroenterology	✓	No – paper	×

Appendix T: Ward demographics for the observational study at the three study sites

	Medicine (M) /Surgery (S)	Ward speciality	Ward-based pharmacy technician present	Ward observed more than once	Number of patients on the ward during the observation	Number of patients reviewed by pharmacist	Number of patients seen face-to-face by pharmacist	No. of communication events
Site 1	M	Respiratory	×	×	22	22	0	25
	M	Gastroenterology	×	✓	14	14	0	45
					10	10	0	15
	M	Medicine for the elderly	×	×	11	11	4	30
	M	Cardiology	×	×	6	6	3	29
	M	Cardiology	×	×	19	13	2	34
	S	General surgery	×	×	16	16	2	38
	M	Cardiology	✓	×	7	7	4	53
	S	Ear, nose, throat & Plastic surgery	×	✓	8	8	3	29
					9	9	2	30
	M	Gastroenterology	×	×	12	12	4	38
	S	General surgery	✓	✓	10	10	2	62
					11	11	1	35
	S	Vascular surgery	✓	×	21	21	2	64
	S	Orthopaedic surgery	✓	×	24	24	1	41
	M	Infectious diseases/Medicine for the elderly	✓	×	19	19	0	40
	M	Respiratory	✓	×	18	18	0	30
	S	General surgery	×	×	14	14	2	28
	M	Endocrinology	×	✓	12	12	0	35
					10	10	1	48
	Total				**273**	**267*(98%)***	**33 *(12%)***	**749**

	Medicine (M) /Surgery (S)	Ward speciality	Ward-based pharmacy technician present	Ward observed more than once	Number of patients on the ward during the observation	Number of patients reviewed by pharmacist	Number of patients seen face-to-face by pharmacist	No. of communication events
Site 2	S	General surgery – non-elective	×	✓	6	6	0	37
	S	General surgery –elective	✓	✓	25	4	1	38
					23	11	4	46
	S	General surgery – upper + lower gastroenterology	✓	✓	18	18	1	63
					16	11	2	36
					18	15	0	23
	M	Medicine for the elderly	✓	✓	26	8	0	37
					25	10	0	41
	M	Medicine for the elderly	✓	✓	25	25	1	38
					21	21	1	41
					19	19	3	22
	M	Gastroenterology	✓	✓	21	21	2	49
					16	5	0	14
					15	15	2	19
	M	Medicine for the elderly	✓	✓	24	24	1	25
					20	20	0	17
	M	Cardiology	×	✓	16	4	0	25
	M	Respiratory	✓	✓	21	6	1	19
					23	9	3	57
					23	11	2	30
	Total				**401**	**263 *(66%)***	**24 *(9%)***	**677**

	Medicine (M) /Surgery (S)	Ward speciality	Ward-based pharmacy technician present	Ward observed more than once	Number of patients on the ward during the observation	Number of patients reviewed by pharmacist	Number of patient's seen face-to-face by pharmacist	No. of communication events
Site 3	S	General surgery	×	×	28	13	8	65
	M	Cardiology	✓	✓	27	14	3	50
					24	15	5	94
	M	Endocrinology & Rheumatology	✓	×	34	17	9	56
	M	Gastroenterology	×	×	14	14	12	27
					12	8	3	32
	M	Stroke & medicine for the elderly	✓	×	34	13	8	76
	S	Vascular surgery	×	×	10	5	2	19
	M	Stroke & medicine for the elderly	×	×	34	33	24	77
	M	Respiratory	✓	×	33	13	10	93
	M	Infectious diseases	×	×	15	15	5	64
	S	Orthopaedic	×	×	32	17	5	69
	M	Care of the elderly	✓	×	34	10	1	46
	S	Maxillofacial & Ear, Nose and Throat (ENT)	×	✓	8	6	3	16
					10	8	6	34
	S	Urology	×	✓	16	4	3	30
					16	7	6	32
	M	Intestinal failure	✓	✓	19	10	6	76
					20	2	3	16
	M	Stroke & medicine for the elderly	×	×	25	14	7	28
	Total				**445**	**238 *(53%)***	**129 *(54%)***	**1000**

Appendix U: The content of communication events initiated by the ward pharmacists with other healthcare professionals at the three sites (table a – c) and the content of communication events initiated other healthcare professionals initiated with the ward pharmacist (table d – f) at the three study sites

Site 1													
Communication recipients of ward pharmacist vs. Content of communication													
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Screening a discharge prescription	Total
Nurse	6	34	2	16	0	0	4	0	13	0	0	0	75
Doctor	0	11	52	6	35	0	3	6	4	2	0	0	119
Other pharmacist	73	6	1	2	24	114	24	3	6	0	40	0	293
Pharmacy technician	4	2	0	0	0	0	3	0	0	0	0	0	9
Other healthcare professional	0	0	0	1	0	0	5	0	1	0	0	0	7
Advance nurse practitioner	0	1	5	1	1	0	1	1	0	0	0	0	10
Pre-registration pharmacist	1	1	0	0	0	0	0	0	0	0	0	0	2
Multiple	0	0	0	0	0	0	0	60	0	11	0	16	87
Total	**83** *(13.8%)*	**54** *(9.0%)*	**60** *(10.0%)*	**26** *(4.3%)*	**60** *(10.0%)*	**114** *(19.0%)*	**40** *(6.7%)*	**70** *(11.6%)*	**24** *(4.0%)*	**13** *(2.2%)*	**40** *(6.7%)*	**16** *(2.7%)*	**600** ***(100%)***

Table a - Content of communication events initiated by the ward pharmacists at site 1

Site 2													
Communication recipients of ward pharmacist vs. Content of communication													
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Screening a discharge prescription	Total
Nurse	1	16	1	3	2	0	2	0	8	0	0	0	33
Doctor	1	9	28	3	40	0	0	7	4	0	0	0	93
Other pharmacist	20	1	10	0	8	81	18	0	3	0	0	0	141
Pharmacy technician	14	27	0	0	0	0	6	0	9	0	0	0	56
Other healthcare professional	0	1	0	0	0	0	3	0	0	0	0	0	4
Advance nurse practitioner	0	0	0	0	1	0	0	0	1	0	0	0	2
Pre-registration pharmacist	1	1	0	0	0	0	0	0	0	0	0	0	2
Multiple	0	0	0	0	0	0	0	42	2	9	0	50	103
Total	**37** *(8.5%)*	**55** *(12.7%)*	**39** *(9.0%)*	**6** *(1.4%)*	**52** *(12.0%)*	**81** *(18.7%)*	**29** *(6.7%)*	**49** *(11.3%)*	**27** *(6.2%)*	**9** *(2.0%)*	**0** *(0.0%)*	**50** *(11.5%)*	**434** ***(100%)***

Table b - Content of communication events initiated by the ward pharmacists at site 2

Site 3													
Communication recipients of ward pharmacist vs. Content of communication													
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Screening a discharge prescription	Total
Nurse	4	19	0	67	3	0	0	2	16	0	0	0	111
Doctor	0	8	38	3	59	0	0	15	11	0	0	0	134
Other pharmacist	104	30	5	0	22	100	48	0	30	0	61	0	400
Pharmacy technician	2	1	0	0	1	0	7	0	6	0	0	0	17
Other healthcare professional	0	1	0	0	0	0	6	0	1	0	0	0	8
Advance nurse practitioner	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre-registration pharmacist	4	0	1	0	1	0	0	0	0	0	0	0	6
Multiple	0	0	0	0	0	0	0	49	2	4	0	34	89
Total	**114** *(14.9%)*	**59** *(7.7%)*	**44** *(5.8%)*	**70** *(9.2%)*	**86** *(11.2%)*	**100** *(13.1%)*	**61** *(8.0%)*	**66** *(8.6%)*	**66** *(8.6%)*	**4** *(0.5%)*	**61** *(8.0%)*	**34** *(4.4%)*	**765** ***(100%)***

Table c - Content of communication events initiated by the ward pharmacists at site 3

Site 1												
Communication initiated by other healthcare professional with the ward pharmacist vs. Content of communication												
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Total
Nurse	58	31	5	8	2	0	2	0	3	0	0	109
Doctor	0	8	8	2	2	0	1	0	0	0	0	21
Other pharmacist	2	2	1	0	1	0	0	0	4	0	0	10
Pharmacy technician	1	0	0	0	0	1	2	0	0	0	0	4
Other healthcare professional	0	0	0	0	0	0	0	0	1	0	0	1
Advance nurse practitioner	0	0	1	0	1	0	1	0	1	0	0	4
Pre-registration pharmacist	0	0	0	0	0	0	0	0	0	0	0	0
Total	**61** *(40.9%)*	**41** *(27.5%)*	**15** *(10.1%)*	**10** *(6.7%)*	**6** *(4.0%)*	**1** *(0.7%)*	**7** *(4.7%)*	**0** *(0.0%)*	**8** *(5.4%)*	**0** *(0.0%)*	**0** *(0.0%)*	**149** ***(100%)***

Table d - Content of communication events initiated by other healthcare professionals with the ward pharmacist at site 1

Site 2												
Communication initiated by other healthcare professional with the ward pharmacist vs. Content of communication												
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Total
Nurse	32	47	0	3	0	0	1	0	0	0	0	83
Doctor	0	42	10	1	11	1	0	1	2	0	0	68
Other pharmacist	0	0	1	0	0	0	0	0	8	0	0	9
Pharmacy technician	10	21	1	1	6	0	17	1	20	0	0	77
Other healthcare professional	0	0	1	0	0	0	0	0	1	0	0	2
Advance nurse practitioner	1	0	0	1	0	0	0	0	0	0	0	2
Pre-registration pharmacist	1	1	0	0	0	0	0	0	0	0	0	2
Total	**44** *(18.1%)*	**111** *(45.7%)*	**13** *(5.3%)*	**6** *(2.5%)*	**17** *(7.0%)*	**1** *(0.4%)*	**18** *(7.4%)*	**2** *(0.8%)*	**31** *(12.8%)*	**0** *(0.0%)*	**0** *(0.0%)*	**243** ***(100%)***

Table e - Content of communication events initiated by other healthcare professionals with the ward pharmacist at site 2

Site 3												
Communication initiated by other healthcare professional with the ward pharmacist vs. Content of communication												
	Medication supply request	Discharge update	Clinical advice	Administration advice	Medication reconciliation /bloods review	Medication review	Medication history	Remove/ amend prescription	Patient handover/ update	Prescribe medication	Medication endorsement	Total
Nurse	71	50	3	9	3	0	2	1	6	0	0	145
Doctor	1	22	12	0	0	0	0	0	2	0	0	37
Other pharmacist	1	8	1	0	2	0	1	0	14	0	0	27
Pharmacy technician	12	2	0	0	0	0	4	1	2	0	0	22
Other healthcare professional	0	0	0	0	2	0	0	0	0	0	0	2
Advance nurse practitioner	0	0	0	1	0	0	0	0	0	0	0	1
Pre-registration pharmacist	0	0	0	0	1	0	0	0	0	0	0	1
Total	**85** ***(36.2%)***	**82** ***(34.9%)***	**16** ***(6.8%)***	**10** ***(4.2%)***	**9** ***(3.8%)***	**0** ***(0.0%)***	**7** ***(3.0%)***	**2** ***(0.9%)***	**24** ***(10.2%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**235** ***(100%)***

Table f - Content of communication events initiated by other healthcare professionals with the ward pharmacist at site 3

Appendix V: The channel of communication used by the ward pharmacists to initiate communicate events with other healthcare professionals at the three study sites (table a – c) and the channel of communication used by other healthcare professionals to initiate communicate events with the ward pharmacist (table d – f) at the three study sites

Site 1											
Communication recipients of ward pharmacist vs Communication channel											
	Face-to-face	Written communication on electronic drug chart	Written communication in medical notes	Telephone/bleep	Transcription sheet	Communication diary/board	Whatsapp message	Email	Fax	Discharge letter	Total
Other pharmacist	7	213	0	8	57	0	1	0	6	1	293
Doctor	86	6	4	23	0	0	0	0	0	0	119
Multiple	0	70	0	0	0	0	0	0	0	17	87
Nurse	61	9	1	4	0	0	0	0	0	0	75
Advance nurse practitioner	10	0	0	0	0	0	0	0	0	0	10
Pharmacy technician	9	0	0	0	0	0	0	0	0	0	9
Other healthcare professional	1	0	0	5	0	0	0	1	0	0	7
Pre-registration pharmacist	0	0	0	0	0	0	0	0	0	0	0
Total	**174** ***(29.0%)***	**298** ***(49.6%)***	**5** ***(0.8%)***	**40** ***(6.7%)***	**57** ***(9.5%)***	**0** ***(0.0%)***	**1** ***(0.2%)***	**1** ***(0.2%)***	**6** ***(1.0%)***	**18** ***(3.0%)***	**600** **(100%)**

Table a - Most common recipients of the ward pharmacists' communication events at site 1

Site 2												
Communication recipients of ward pharmacist vs. Communication channel												
	Face-to-face	Written communication on electronic drug chart	Written communication on paper drug chart	Written communication in medical notes	Telephone/ bleep	Transcription sheet	Communication diary/board	Whatsapp message	Email	Fax	Discharge letter	Total
Other pharmacist	2	107	0	0	10	20	0	0	1	0	1	141
Doctor	57	17	0	2	17	0	0	0	0	0	0	93
Multiple	0	48	5	1	0	0	0	0	0	0	49	103
Nurse	21	2	0	0	9	0	1	0	0	0	0	33
Advance nurse practitioner	1	0	0	0	1	0	0	0	0	0	0	2
Pharmacy technician	41	0	0	0	14	0	0	0	0	0	0	56
Other healthcare professional	0	0	0	0	4	0	0	0	0	0	0	4
Pre-registration pharmacist	2	0	0	0	0	0	0	0	0	0	0	2
Total	**125** ***(28.8%)***	**174** ***(40.1%)***	**5** ***(1.2%)***	**3** ***(0.7%)***	**55** ***(12.7%)***	**20** ***(4.6%)***	**1** ***(0.2%)***	**0** ***(0.0%)***	**1** ***(0.2%)***	**0** ***(0.0%)***	**50** ***(11.5%)***	**434** **(100%)**

Table b - Most common recipients of the ward pharmacists' communication events at site 2

Site 3											
Communication recipients of ward pharmacist vs. Communication channel											
	Face-to-face	Written communication in medical notes	Telephone/bleep	Transcription sheet	Whatsapp message	Email	Fax	Discharge letter	Written communication on paper drug chart	In-house electronic system	Total
Nurse	49	0	1	0	0	0	0	0	61	0	111
Doctor	79	4	3	0	0	0	0	0	48	0	134
Other pharmacist	26	0	11	76	1	0	26	0	255	5	400
Pharmacy technician	16	0	1	0	0	0	0	0	0	0	17
Other healthcare professional	1	0	6	0	0	1	0	0	0	0	8
Pre-registration pharmacist	6	0	0	0	0	0	0	0	0	0	6
Multiple	0	2	0	0	0	0	0	34	53	0	89
Total	**177** ***(23.1%)***	**6** ***(0.8%)***	**22** ***(2.9%)***	**76** ***(10.0%)***	**1** ***(0.1%)***	**1** ***(0.1%)***	**26** ***(3.4%)***	**34** ***(4.4%)***	**417** ***(54.5%)***	**5** ***(0.7%)***	**765** ***(100%)***

Table c - Most common recipients of the ward pharmacists' communication events at site 3

Site 1											
Communication initiated by other healthcare professionals with the ward pharmacist vs Communication channel											
	Face-to-face	Written communication on electronic drug chart	Written communication in medical notes	Telephone/bleep	Transcription sheet	Communication diary/ board	Whatsapp message	Email	Fax	Discharge letter	Total
Nurse	68	0	0	3	0	38	0	0	0	0	109
Doctor	19	0	2	0	0	0	0	0	0	0	21
Other pharmacist	1	2	1	6	0	0	0	0	0	0	10
Advance nurse practitioner	4	0	0	0	0	0	0	0	0	0	4
Pharmacy technician	4	0	0	0	0	0	0	0	0	0	4
Other healthcare professional	0	0	0	1	0	0	0	0	0	0	1
All/unclear	0	0	0	0	0	0	0	0	0	0	0
Pre-registration pharmacist	0	0	0	0	0	0	0	0	0	0	0
Total	**96** ***(64.4%)***	**2** ***(1.4%)***	**3** ***(2.0%)***	**10** ***(6.7%)***	**0** ***(0.0%)***	**38** ***(25.5%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**149** ***(100%)***

Table d - Most common healthcare professionals to initiate a communication event with the ward pharmacists at site 1

Site 2												
Communication initiated by other healthcare professionals with the ward pharmacist vs Communication channel												
	Face-to-face	Written communication on electronic drug chart	Written communication in medical notes	Telephone/ bleep	Transcription sheet	Communication diary/board	Whatsapp message	Email	Fax	Discharge letter	In-house electronic system	Total
Nurse	39	0	0	12	0	32	0	0	0	0	0	83
Doctor	42	1	1	13	0	11	0	0	0	0	0	68
Other pharmacist	5	1	1	2	0	0	0	0	0	0	0	9
Advance nurse practitioner	2	0	0	0	0	0	0	0	0	0	0	2
Pharmacy technician	70	0	0	5	0	0	0	1	0	0	1	77
Other healthcare professional	2	0	0	0	0	0	0	0	0	0	0	2
All/unclear	0	0	0	0	0	0	0	0	0	0	0	0
Pre-registration pharmacist	2	0	0	0	0	0	0	0	0	0	0	2
Total	**162** ***(66.7%)***	**2** ***(0.8%)***	**2** ***(0.8%)***	**32** ***(13.2%)***	**0** ***(0.0%)***	**43** ***(17.7%)***	**0** ***(0.0%)***	**1** ***(0.4%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**1** ***(0.4%)***	**243** ***(100%)***

Table e - Most common healthcare professionals to initiate a communication event with the ward pharmacists at site 2

Site 3											
Communication initiated by other healthcare professionals with the ward pharmacist vs Communication channel											
	Face-to-face	Written communication in medical notes	Telephone/bleep	Transcription sheet	Communication diary/board	Email	Fax	Discharge letter	Written communication on paper drug chart	In-house electronic system	Total
Nurse	98	0	1	0	46	0	0	0	0	0	145
Doctor	36	0	1	0	0	0	0	0	0	0	37
Other pharmacist	20	0	7	0	0	0	0	0	0	0	27
Pharmacy technician	22	0	0	0	0	0	0	0	0	0	22
Other healthcare professional	2	0	0	0	0	0	0	0	0	0	2
Advance nurse practitioner	1	0	0	0	0	0	0	0	0	0	1
Pre-registration pharmacist	1	0	0	0	0	0	0	0	0	0	1
All/unclear	0	0	0	0	0	0	0	0	0	0	0
Total	**180** ***(76.6%)***	**0** ***(0.0%)***	**9** ***(3.8%)***	**0** ***(0.0%)***	**46** ***(19.6%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**0** ***(0.0%)***	**235** **(100%)**

Table f - Most common healthcare professionals to initiate a communication event with the ward pharmacists at site 3