Exploring the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

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"A journey of a thousand miles begins with one step"

Lao Tzu, Chinese proverb

Abstract

Limited data exist on the facilitators and barriers to implementing electronic systems for medicines management in hospitals. Whilst numerous studies advocate system use in improved patient safety and efficiency within the health service, their rate of adoption in practice has been slow. The aim of this doctoral research was to explore this under-researched area in three phases.

Phase one

Phase one focused on critically appraising and synthesising the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing electronic prescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting. The review protocol was registered with the Centre for Reviews and Dissemination and conducted according to best practice. Key facilitators included systems improved patient safety and provided better access to patients' drug records and that team leadership and hardware/software availability and reliability were essential for successful implementation. Key barriers consisted of hardware and network problems, altered work practices, and weakened interpersonal communication between healthcare professionals and with patients.

Phase two

This phase employed a qualitative phenomenological design to gain original insight into the perceptions of local key stakeholders towards the facilitators and barriers to implementing prescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using Normalization Process Theory as a theoretical framework. Individual face-to-face semi-structured interviews were conducted in three public hospitals in Ireland with 23 consenting participants: nine nurses; four pharmacists; two pharmacy technicians; six doctors; and two hospital Information Technology managers. Enhanced patient safety and efficiency in healthcare delivery emerged as key facilitators to system implementation, as well as the need to have clinical champions and a multidisciplinary implementation team to promote engagement and cognitive participation. Key barriers included inadequate training and organisational support, and the need for ease and confidence in system use to achieve collective action.

Phase three

A similar qualitative methodology was employed in phase three of this research in order to explore the perceptions of national key stakeholders and eHealth leads towards the facilitators and barriers to system implementation. Sixteen consenting invitees participated: eight hospital leads, four government leads, two regulatory leads, and two academics. Key facilitators included enhanced patient safety, workflow efficiencies, improvements in governance, and financial gains. Perceived barriers included the introduction of new drug errors, loss of patient contact, initial time inefficiencies, and issues with the complexity of integration and standardisation of work processes.

Overall, adequate technology, stakeholder involvement, and organisational leadership and support are required at a national and local level to drive the eHealth agenda forward. Testing at scale, contingency plans, and ongoing evaluations will assist in determining success or otherwise of system implementation.

This research has generated novel findings with many potentially transferable themes identified which extend the evidence base. This will assist organisations to better plan for implementation of medication-related eHealth systems.

Keywords: ePrescribing, robotic pharmacy systems, automated medication storage and retrieval systems, implementation, qualitative, healthcare professionals, barriers, facilitators, hospital, NPT

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I often mention the unique friendliness of any staff member I have encountered in Robert Gordon University from clerical staff to IT staff to the entire School of Pharmacy and Life Sciences faculty. Many thanks for the very positive and fond memories over this period and also over the period of completing a masters in clinical pharmacy which was the backbone to commencing this research. A mention of thanks to all the key stakeholders who participated in the qualitative phases of this research and provided invaluable data for analysis is also important to acknowledge.

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External outputs

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Hogan-Murphy, D., Tonna, A., Strath, A., Steward, D., Cunningham, S. Key stakeholders and eHealth leads' perceptions, experiences, and vision towards the implementation of electronic systems for medicines in hospitals in Ireland: a qualitative study using Normalization Process Theory

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European Society of Clinical Pharmacy Conference Copenhagen 2014

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Foreword

This foreword describes progress towards and during the course of this PhD on exploring facilitators and barriers to implementing electronic systems for medicines in hospitals in Ireland.

The title of this research is influenced by my background, firstly with a degree in psychology and a higher diploma in computer science from University College Cork, followed by a masters in IT from National University of Ireland Galway, a degree in pharmacy from Trinity College Dublin, and a masters in clinical pharmacy from Robert Gordon University. I have been working full-time as a senior antimicrobial pharmacist for the previous eight years, currently in University Hospital Galway. My initial interest in the topic originated from experiencing first-hand the continuous inefficiencies of manual medicines management systems from prescribing to procurement to dispensing to administration having spent most of my 10-year pharmacy career in a hospital setting. This really motivated me to want to contribute to improving medicines delivery and utilise the skills I had acquired academically by combining the qualitative aspect of psychology with the IT aspect of electronic systems for medicines to the overall pharmacy focus. This was an ambition from early in my pharmacy career when I choose as my preregistration project 'A business case for the implementation of an automated medication storage and retrieval system in the Midland Regional Hospital Tullamore'. In addition, having achieved a distinction in the masters in clinical pharmacy, I was encouraged to consider PhD studies. Thereafter I conducted a scoping review on the topic which identified a gap in the literature indicating an area for research. Five years later I have never looked back, again all credit to the support of my experienced supervisory team of whom I had previously worked with during the masters.

My principal supervisor, Dr Scott Cunningham, is a senior lecturer and group leader for Clinical Pharmacy and Pharmacy Practice with research interests spanning pharmacist prescribing, reclassified medicines, and chronic medication services. Dr Antonella Tonna is a lecturer with a key interest in qualitative research. Professor Derek Stewart was my principal supervisor for my master's thesis with a research focus in pharmacy practice development, implementation, and evaluation. With over 100 peer reviewed papers published, his general

interests lie in health services research methodologies. Professor Alison Strath's research interests are rooted in the development of healthcare policy, technology enhanced care, and the provision of a sound evidence base.

I am a member of the Council of Clinical Information Officers which was established in 2015 to provide clinical governance in the delivery of eHealth solutions in Ireland. Its role is primarily advisory and includes participating in several meetings per year with clinical leaders and professionals with successful programme delivery experience. I have also become involved in upgrading our current hospital pharmacy dispensing system to a superior integrated electronic system with a plan to implement ePrescribing in the near future. Other related projects include upgrading our pharmacy medicines information intranet to a new operating system inclusive of data restructuring, and leading on the implementation of automated medication storage and retrieval systems.

As the end of my PhD studies approaches I am certain my involvement with electronic systems for medicines will continue and expand.

Key abbreviations

BCMA	Barcode Medication Administration
CASP	Critical Appraisal Skills Programme
CDS	Clinical Decision Support
CDSR	Cochrane Database of Systematic Reviews
CPOE	Computerised Physician Order Entry
CRD	Centre for Reviews and Dissemination
DARE	Database of Abstracts of Reviews of Effects
DoH	Department of Health
ED	Emergency Department
EHR	Electronic Health Record
eMAR	Electronic Medication Administration Record
ePrescribing	Electronic Prescribing
EC	European Commission
EU	European Union
HIQA	Health Information and Quality Authority
HR	Human Resources
HSE	Health Service Executive
HTA	Health Technology Assessment
ICT	Information and Communication Technologies
IHI	Individual Health Identifier
IPA	International Pharmaceutical Abstracts
IT	Information Technology
JBI	Joanna Briggs Institute
NCHD	Non-Consultant Hospital Doctors
NHS	National Health Service

NPT	Normalization Process Theory
OCIO	Office of the Chief Information Officer
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	Prospective Register of Systematic Reviews
PSI	Pharmaceutical Society of Ireland
RCPI	Royal College of Physicians in Ireland
RCT	Randomised Controlled Trial
RGU	Robert Gordon University
TDF	Theoretical Domains Framework
UK	United Kingdom
USA	United States of America

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Chapter 1: General introduction

1.1 Introduction

This chapter describes eHealth and medicines management in terms of electronic prescribing (ePrescribing), robotic pharmacy systems, and automated medication storage and retrieval systems, and provides an in-depth review of policy documents from Ireland and internationally. After identifying both facilitators and barriers to system implementation and gaps in the literature, the aim and objectives of this research are offered inclusive of its novelty and contribution to original knowledge.

1.2 Search strategy

Google and google scholar were mostly used to retrieve articles and relevant information to be included in this introductory chapter. A wide variety of search terms were combined within each of the three main concepts: implementation, facilitators, and barriers; ePrescribing, electronic dispensing of medicines, and electronic administration of medicines; and hospital setting. The search strategy is summarised in Table 1.1 which was conducted between July 2012 and August 2017.

Table 1.1: Search terms used for retrieving relevant background information

	Search terms (limit English language)
1	eHealth AND/OR electronic prescribing AND/OR automated dispensing systems AND/OR medication storage and retrieval systems AND/OR pharmacy robotics AND/OR electronic dispensing AND/OR electronic administration AND/OR health information technology AND/OR mobile technology
2	Implementation AND/OR adoption AND/OR facilitator AND/OR acceptance AND/OR advantage AND/OR benefit AND/OR barrier AND/OR inhibit AND/OR obstacle AND/OR disadvantage
3	Hospital AND/OR secondary care AND/OR tertiary care AND/OR ward
4	1 + 2 + 3

1.3 Definitions

1.3.1 Patient safety

Patient safety has been defined by the World Health Organization as "*the prevention of errors and adverse effects to patients associated with healthcare"* (1). Emphasis is placed on the system of care delivery that prevents errors, learns from errors that do occur, and is built on a culture of safety that involves healthcare professionals, organisations, and patients (2). Healthcare delivery has become more complex with greater use of new technologies, medicines, and treatment options which requires more decision-making capability and healthcare priorities. Many patient safety initiatives, such as the use of electronic systems for medicines management, have been considered as possible strategies to avoid patient safety errors and improve healthcare processes.

1.3.2 eHealth

Internationally there is widespread investment in eHealth, defined as "*the exploitation of information and communication technologies (ICT) in healthcare to enhance the quality and safety of patient care*" (3). Embedded in the management of delivery processes, eHealth is fundamental to ensure continuous improvements in patient safety and efficiency, and underpins organisational transformation and development (4). Eysenbach states that eHealth represents not only a technical development, but also a mindset, a method of thinking, an attitude, and a commitment to improve healthcare (5). This involves considerable change to working practices and culture.

Successful reform and delivery of healthcare systems is highly dependent on realising the potential of eHealth as a change catalyst. The emphasis for many countries, including Ireland, is on the development of eHealth building blocks such as ePrescribing and electronic health records (EHRs) in order to improve the management of information and reduce medication errors and cost. A properly executed implementation plan must involve all stakeholders and feature strong clinical engagement and a willingness to embrace eHealth systems from the outset (6).

1.3.3 Medicines management

Medicines management in hospitals incorporates the entire process of how medicines are selected, procured, delivered, prescribed, administered, and reviewed to achieve informed and desired patient outcomes. The various components involved in this process are illustrated in Figure 1.1 adopted from the Joint Commission (7).

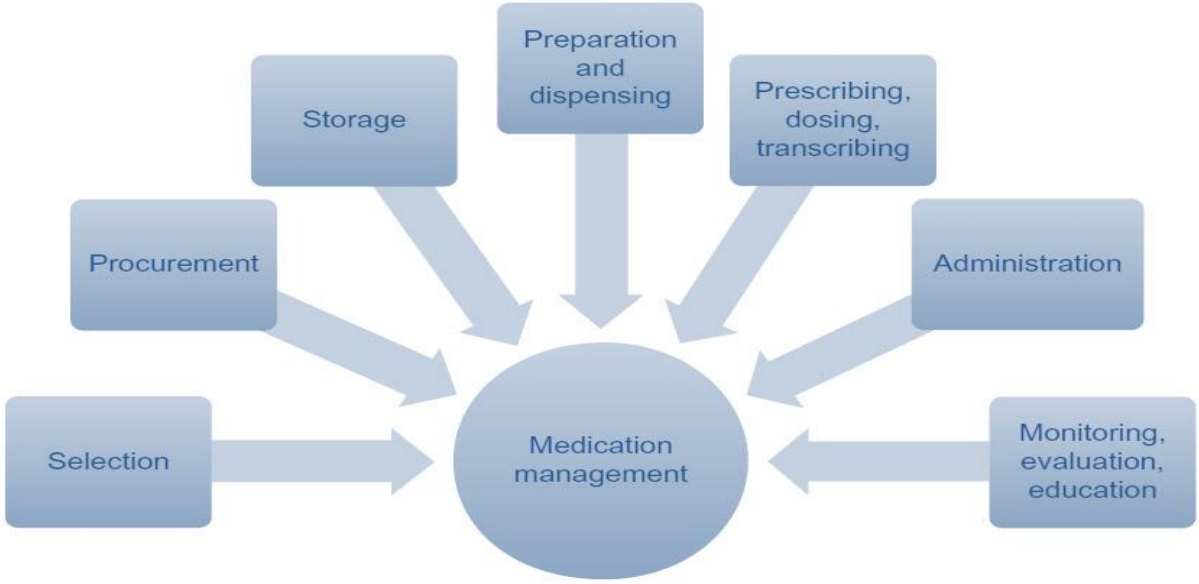

Figure 1.1: Components of medicines management adopted from the Joint Commission (7)

Whilst the use of medications is currently increasing in number and complexity which potentially amplifies medication error risks, systems for prescribing, dispensing, and administering medicines in Ireland have remained largely unchanged over the last few decades (8). For example, the annual cost to the Irish State for medicines is approximately two billion euros, a greater than sixfold increase over the past decade (9)(10).

1.3.4 Medication errors

Medication errors refer to any unintended consequences arising in the medication use process, regardless of whether an injury transpired or whether the potential for injury was present (11)(12). These include mistakes in prescribing, dispensing, and/or administering medication, as well as patient adherence. Most definitions of patient safety and medication errors recognise that organisational factors interact with human factors to facilitate and mitigate medication-related errors (13). Examples are illustrated in Table 1.2 adopted from Black et al (14).

Table 1.2: Examples of medication errors adopted from Black et al (14)

Miscommunication of drug orders due to poor handwriting, confusion between drugs with similar names, misuse of zeroes and decimal points, confusion of metric and other dosing units, and inappropriate abbreviations
Inappropriate drug selection due to incomplete patient data such as contraindications, drug interactions, known allergies, current and previous diagnoses, current and previous therapies, and test results
Miscalculation of drug dosage due to incorrect selection of route of administration, mistakes with frequency or infusion rates
Out-of-date drug information, for example, in reference to alerts, warnings, or information on newly approved drugs
Monitoring failures due to laboratory test results and drug administration monitoring not considered
Inappropriate drug selection due to clinical incompetence

Estimating the true incidence of medication-related errors can be problematic due to the various definitions and methodologies used to detect or measure their occurrence. In addition, many are never discovered, acknowledged, or reported (15). Medication errors in hospitals are highly underreported if healthcare professionals perceive no harm to the patient or the incident is not considered significant enough to report (16)(17)(18)(19).

Prescribing and drug administration processes have traditionally been recognised as accounting for the greatest proportion of all medication errors, independent of whether harm is caused (20)(21)(22)(23)(24). Lewis et al conducted a systematic review in 2009 on the prevalence, incidence, and nature of prescribing errors in hospital inpatients and reviewed 65 studies mostly from the United States of America (USA) and the United Kingdom (UK) (25). These studies excluded ePrescribing systems. They reported a median prescription error rate of seven percent with incorrect dosage being the most common error. Another systematic review by Ross et al in 2009 reviewed 24 studies of non-consultant hospital doctors (NCHDs) and reported an error rate of two to 514 per 1000 items prescribed and four percent to 82% of patient prescription charts reviewed (26). A more recent prospective study by Ashcroft et al in 2015 on the prevalence, nature, severity, and risk factors for prescribing errors in 20 UK

hospitals found a mean error rate of nine percent (27). Error rates for doctors in training were significantly higher than medical consultants and prescribing errors were 70% more likely to occur at the time of hospital admission (27).

The transition between hospital and community settings is prone to medication errors due to incomplete medication records, lack of communication between healthcare providers, missed patient follow-up, inadequate patient education, and the absence of patient involvement in the medicines management process (28). 'Medication reconciliation' performed by nurses, doctors, or pharmacy staff at hospital admission, on the wards, and at transfer and discharge to primary care is an effective strategy for reducing medication errors (29). Researchers have found hospital pharmacists are uniquely positioned to lead and support patients and inter-professional teams with medication reconciliation based on their education and expertise in medicines management (30) resulting in better accuracy and improved clinical and economic outcomes (31)(32)(33)(34)(35)(36). However, this three step process of verifying medication use, identifying variances, and rectifying medication errors at interfaces of care is not provided by pharmacy staff in all hospitals, is limited to within pharmacy opening hours, and is dependent on staff compliments. For example, a survey by Stein et al in 2015 reviewing pharmacy involvement in hospital medication reconciliation programmes across the USA found a mere 53% of hospitals had dedicated pharmacy staff to perform medication reconciliation (37). Barriers include cost, time, inadequate staffing, unreliable patient information, lack of programme ownership by a particular discipline, and difficulty relaying information between hospital and outpatient settings (38). These inefficiencies highlight the need for electronic systems for medicines management.

Systematic reviews of medication administration error prevalence in healthcare settings found their occurrence common (39)(40)(41), with an estimated median of 19% of 'total opportunities for error' in hospitals (39). Specific to causes of medication administration errors in the hospital setting, a systematic review by Keers et al in 2013 identified 54 studies and found error-provoking conditions influencing administration errors included inadequate written communication pertaining to prescriptions, documentation, and transcriptions; problems with

medicines supply and storage relating to pharmacy dispensing errors and ward stock management; high workload; and concerns with ward-based equipment with access and functionality (42). Other issues included patient availability and acuity; staff fatigue and stress; and interruptions and distractions during drug administration (42). The above systematic reviews found ePrescribing and a closed loop ePrescribing, electronic dispensing, and electronic administration system may improve the prescribing process (39)(40)(42).

A review of the literature on the incidence of dispensing errors by James et al in 2009 identified 60 papers and found dispensing errors in hospital pharmacy ranged between 0.02–2.7% (43). A systematic review of the nature of dispensing errors in hospital pharmacies by Aldhwaihi et al in 2016 identified 15 studies with the most frequent errors reported pertaining to dispensing the incorrect medicine, strength, and dosage form (44). The most common factors associated with dispensing errors included high workload; low staffing; mix-up of look-alike/sound-alike drugs; lack of knowledge and experience; distractions and interruptions; and communication problems within the dispensary team (44).

In an Irish context, a collaborative study of medication safety in four Irish hospitals by Kirke et al in 2007 found prescribing was responsible for approximately 50% of overall incident/near miss reports, dispensing 10%, and administration 30% (45). The remaining incidents/near misses included ordering and monitoring of drugs. More recently the first national report on the frequency and nature of adverse events in hospitals in Ireland by Rafter et al in 2016 found the third leading category of adverse events was medication-related (46). These findings were similar to other international studies (47)(48)(49). The Institute of Medicine further estimate at least one medication error per hospital patient occurs each day (50) which would potentially equate to over three million medication errors in Irish public hospitals every year (51).

Medication errors are common, costly, and an important source of iatrogenic harm (14). Detailed analysis and classification of errors in medicines management suggest prevention strategies targeting systems rather than individuals are more likely to prove effective in reducing error rates (24).

1.3.5 Electronic health record

The Health Information Management Systems Society defines an EHR as:

> *"...a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports"* (52).

These records streamline workflow and support other care-related activities directly or indirectly via interfaces including evidence-based clinical decision support (CDS), quality management, and outcomes reporting.

1.3.6 Electronic prescribing

Articles recommending the use of electronically generated prescriptions can be traced back in the literature to the early 1980s (53). Relatively sophisticated systems were employed by the early 2000s to facilitate ePrescribing and CDS. In more recent years, there have been widespread national and international initiatives to implement ePrescribing, these systems having the potential to significantly improve the quality and safety of patient care through facilitating evidence-based prescribing and reducing medication errors (13)(14)(24)(54)(55)(56). ePrescribing can also facilitate extensive improvements in dispensing and administration processes, including shorter process turn-around times, enhanced communication among healthcare professionals, reductions in paperwork, and improved audit trails and drug utilisation reviews (14).

There is no universally agreed definition of ePrescribing, this term having the potential to denote different meanings depending on the context in which it is applied. Various definitions have been put forward by governing bodies internationally for both hospital and community settings. The Centre of Medicare and Medicaid Services in the USA defines the ePrescribing process as:

> "*the transmission, using electronic media, of prescription or prescription-related information between a prescriber, dispenser, pharmacy benefit manager, or health plan, either directly or through an intermediary, including an ePrescribing network...*" (57).

The National Health Service (NHS) Connecting for Health in the UK define ePrescribing 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*" (58).

The Department of Health (DoH) and Ageing's Pharmacy and Government Arrangements in Australia define ePrescribing as:

> "*an electronic prescription which is generated in accordance with a process by which a prescription is electronically generated by a prescriber, authenticated (electronically signed), securely transmitted (either directly or indirectly) for dispensing and supply, and seamlessly integrated into the pharmacy dispensing software...*" (59).

For the purpose of this doctoral research, ePrescribing encompasses the latter definition, a technology framework that facilitates a prescriber to securely generate and transmit prescriptions to a pharmacy dispensing software electronically. This definition was thought to relate the most to the content of this thesis which explores the facilitators and barriers to electronic systems for medicines management with a focus on ePrescribing, robotic pharmacy systems, and medication storage and retrieval systems. ePrescribing systems which integrate with pharmacy systems have also been found to have the greatest benefits to improve patient safety and quality of care through better access to data, exchange of data, and enhanced communication (60).

An illustration of an ePrescribng interface is provided in Figure 1.2.

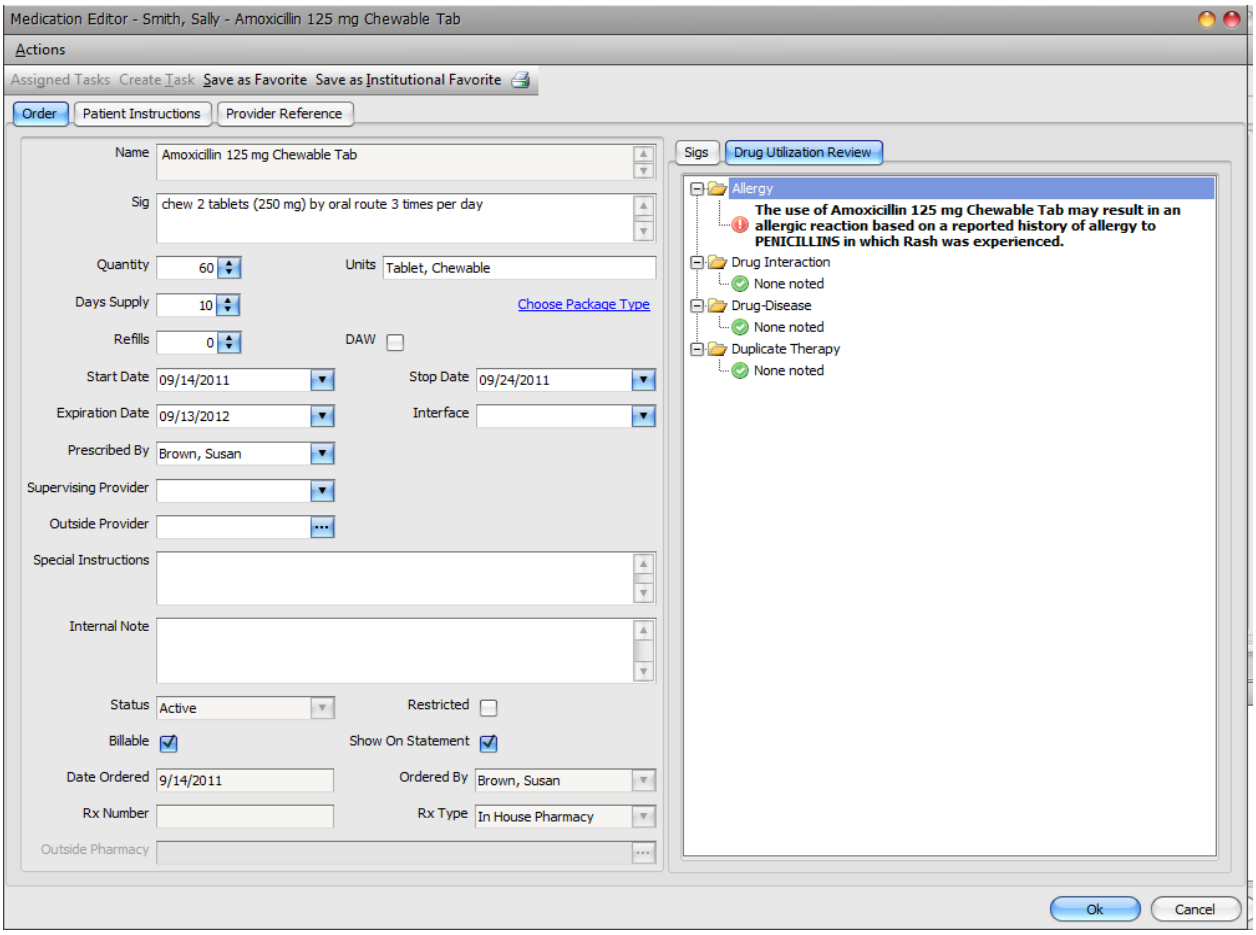

Figure 1.2: Example of the design of an ePrescribing interface

Components that need to be considered when implementing an ePrescribing system are illustrated in Figure 1.3. These comprise the technology itself, the healthcare providers who interact with it, and where this exchange takes place.

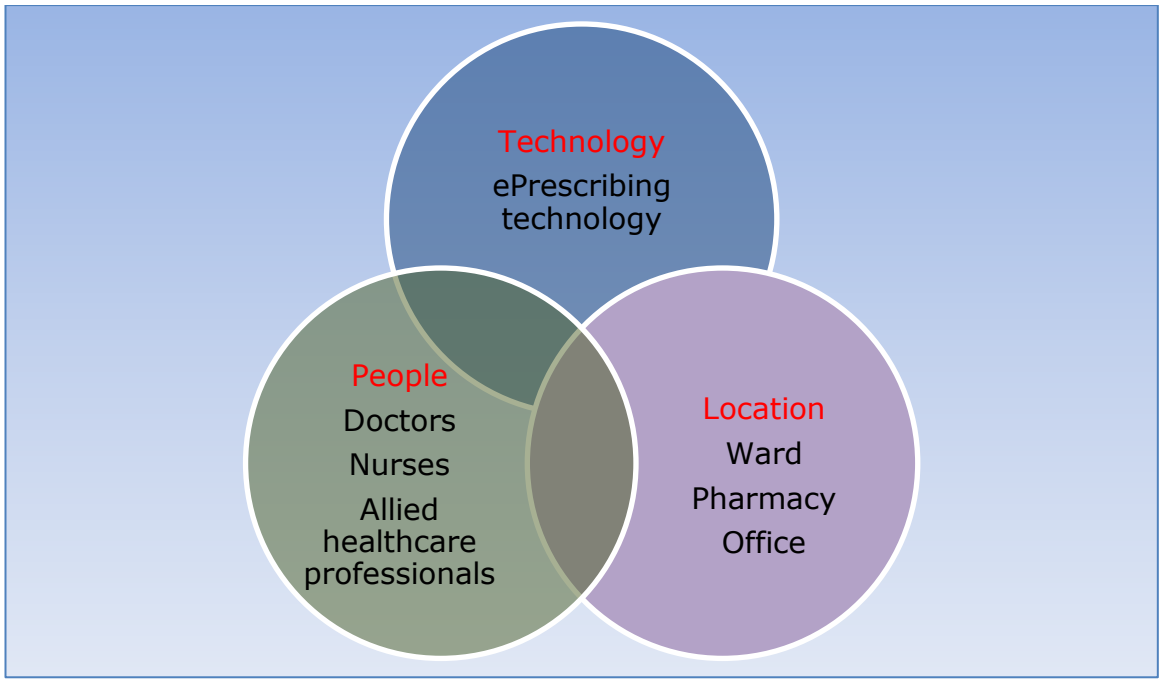

Figure 1.3: Components of an ePrescribing system

Evidence of ePrescribing effectiveness can be found in a UK study by Donyai et al in 2008 which highlighted a significant reduction in both prescribing errors and pharmacists' clinical interventions for hospital inpatients following implementation (60). Another UK study by Shulman et al in 2005 comparing the impact of ePrescribing with handwritten prescribing on the frequency, type, and outcome of medication errors also found medication errors were significantly lower with ePrescribing (61). Franklin et al in 2007 assessed the impact of a closed-loop ePrescribing and automated medication storage and retrieval system on prescribing errors, administration errors, and staff time in a UK hospital and found a reduction in prescribing errors, medication administration errors, and increased confirmation of patient identity before administration (62).

A literature review by Niazkhani et al in 2009 on the impact of ePrescribing on inpatient clinical workflow identified 51 publications with workflow advantages of legible orders, remote accessibility of systems, and shorter order turnaround times (63). Another systematic review by Eslami et al in 2009 on the impact of ePrescribing in hospitalised patients identified 67 articles with overall positivity in the category of adherence to guidelines, cost, organisational efficiency, usability, and satisfaction (63). A study by Mitchell et al in 2004 evaluating an ePresciribing and electronic medication administration record (eMAR) system in a

UK hospital found omissions of patient and drug information were less frequent with system implementation (64).

From a time efficiency perspective, prescription monitoring and alterations were reduced to less than 10% in a UK hospital with system implementation which facilitated pharmacists to spend 70% of their time on direct patient care (65). This is a significant advancement considering the report *A Spoonful of Sugar: Medicines Management in NHS Hospitals*, published by the Audit Commissioner in 2001 found pharmacists only contributed 5-20% of their time to direct clinical care (66). A USA study by Murray et al in 1998 found pharmacists spent 46% more time problem solving and 34% less time filling in prescriptions with system implementation (67). Other studies have also demonstrated an increase in time for direct and indirect patient care and a reduction in pharmacist interventions for prescriptions (68)(69). The main advantages of implementing ePresribing for the benefit of key stakeholders are summarised in Table 1.3 adopted from the Health Information and Quality Authority (HIQA) (70).

Table 1.3: Benefits of ePrescribing for key stakeholders adopted from HIQA (70)

Receiver	Benefits
Patients	▪ Reduced transcription errors ▪ Improved legibility and precision of prescriptions ▪ Accuracy and speed of dispensed prescriptions through more efficient processes
Doctors, nurses, other prescribers	▪ Reduced interruptions from pharmacies querying prescriptions and fewer prescriptions returned to prescribers for non-compliance with legal or subsidy requirements ▪ Better clinical decision-making leading to safer and higher quality of care through timely access to patient information
Pharmacy staff	▪ Use of a common list of medicines in both prescriber and pharmacy systems to improve efficiency ▪ Improved quality of prescription information and a reduction in time spent contacting prescribers to clarify or correct prescriptions ▪ Ability to download prescription details facilitating efficiency with less potential for error
Organisations	▪ Improved health information flow efficiency and a reduction in duplicate prescribing ▪ Efficiency gains enabling pharmacists to provide other patient-centered services ▪ Improved consistency with the adoption of ePrescribing standards ▪ Better understanding and control of policies, processes, and mechanisms that ensure the privacy of ePrescribing

Even with such potential benefits, digital transformation in health service delivery is not realised in many countries. The *Prescription for Excellence* report by the Scottish Government in 2013 states ePrescribing and related CDS has only been implemented in a select few acute hospitals in Scotland and not to its full potential (71). Based on the *European Hospital Survey: Benchmarking Deployment of eHealth Services (2012-2013)* report published by the European Commission (EC) in 2014, Ireland lags behind many European states with ePrescribing implementation (Table 1.4) (72). No Irish hospital in the public sector and only a small number of UK hospitals have introduced hospital-wide integrated ePrescribing systems between prescribers and dispensers (73).

Table 1.4: European hospital survey: benchmarking deployment of eHealth services (2012-2013) adopted from the EC (72)

Country	ePrescribing	CDS
Denmark	94%	56%
Estonia	100%	42%
Sweden	85%	27%
Finland	81%	27%
Hungary	95%	23%
Iceland	67%	33%
Netherlands	69%	19%
Greece	94%	7%
Austria	16%	26%
Belgium	46%	22%
Luxembourg	67%	67%
Croatia	27%	36%
Spain	67%	35%
Italy	51%	25%
United Kingdom	20%	9%
Portugal	93%	15%
Norway	33%	0%
Czech republic	45%	35%
France	39%	24%
Germany	9%	24%
Romania	84%	22%
Ireland *(Leader)*	**9% *(Estonia: 100%)***	**9% *(Luxembourg: 67%)***
Malta	0%	0%
Slovakia	21%	9%
Lithuania	13%	22%
Cyprus	8%	8%
Poland	17%	12%
Latvia	5%	11%
Bulgaria	21%	6%
Slovenia	0%	17%

Contributory factors to implementation delay may be due to financial constraints, lack of product offerings to deliver benefit, and regulatory barriers. Beyond those challenges, prescribers have also been slow to embrace new systems that require changes in workflow and investment in training. A perception that systems are technically challenging, that other systems need to be in place before these systems are rolled out, or that the culture change required for adoption into clinical practice is too complex can lead to resistance (73)(74). However, drawing on the understanding and experiences of hospitals who have

implemented ePrescribing in England, the report *Electronic prescribing in hospitals: challenges and lessons learnt* published by the NHS Connecting for Health in 2009 conveys ePrescribing is achievable and beneficial with careful planning and a multidisciplinary team effort (73).

1.3.7 Robotic pharmacy systems

Core to pharmacy work is a modern and effective pharmacy system from tracking stocked medicines through to patient dispensing and ward delivery. Robotic pharmacy systems automate routine tasks performed in pharmacy and have been shown to reduce the incidence of dispensing errors, improve the speed and efficiency of the dispensing process, and optimise pharmacy space (75).

An illustration of a robotic pharmacy system is provided in Figure 1.4.

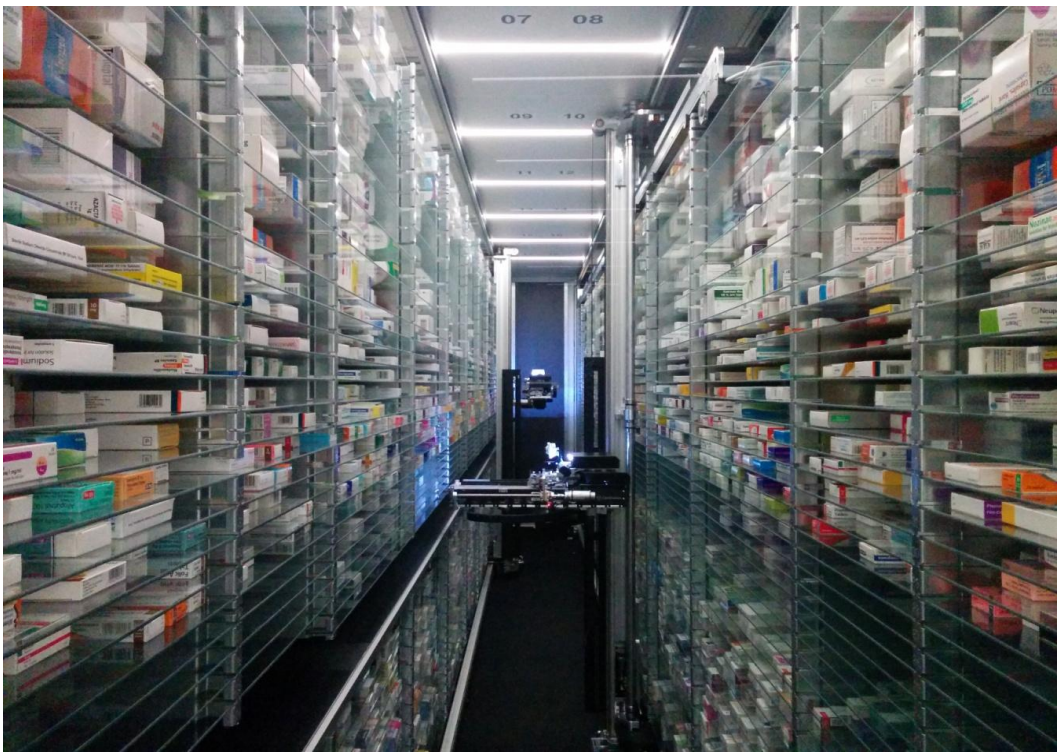

Figure 1.4: Example of the design of a robotic pharmacy system

Components that need to be considered when implementing a robotic pharmacy system are illustrated in Figure 1.5.

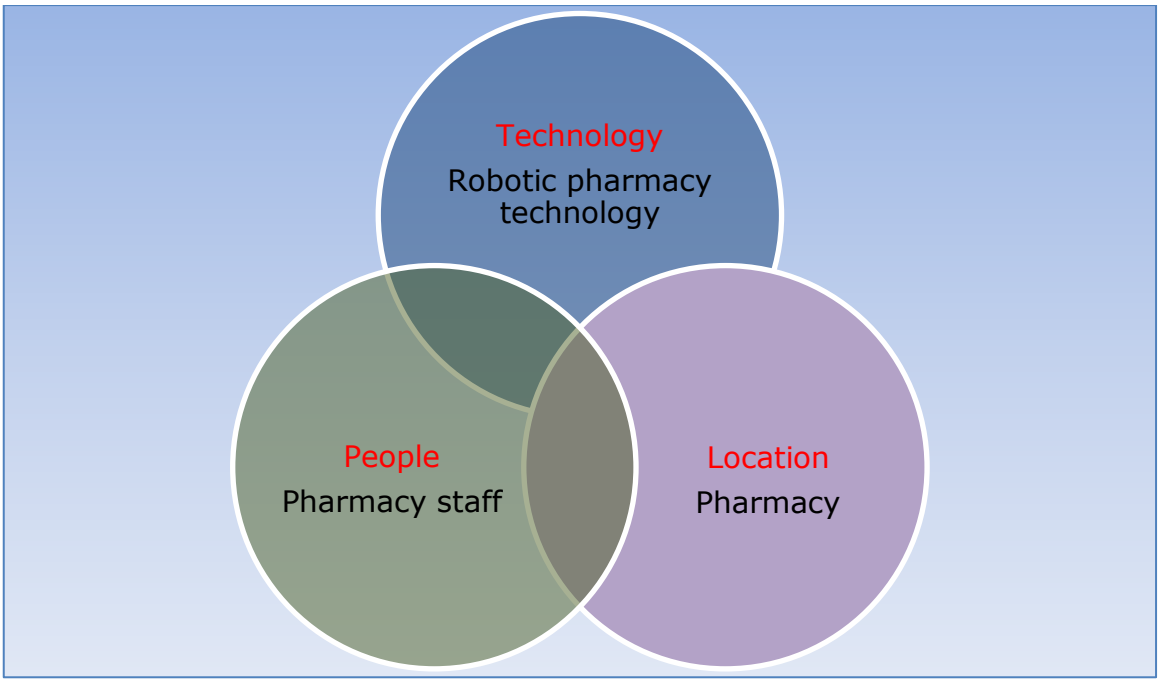

Figure 1.5: Components of a robotic pharmacy system

Since publication of *A Spoonful of Sugar: Medicines Management in NHS Hospitals* which advocates the use of automation to transform pharmacy services (66), a number of UK hospitals have installed robotic pharmacy systems (76). In the USA, a national survey of hospital pharmacy practice in 2011 found robotic systems were used in 11% of hospitals (77). Similarly, a European survey of 30 countries on hospital pharmacy in 2010 identified the implementation of robotic dispensing in seven percent of hospitals, mainly in The Netherlands, Portugal, and Spain (78). On a national level, a baseline study of hospital pharmacy in Ireland published by the Pharmaceutical Society of Ireland (PSI) in 2012 reported one public hospital had invested in robotic dispensing (8). However, considerable interest has been expressed in the acquisition and implementation of robotic dispensing systems across other hospitals nationally (8) and to date two public hospitals out of 48 have utilised such technology. Technology was viewed by pharmacists as having the capacity to decrease workload and allow for the development of more clinical pharmacy services (8). In particular, this view was expressed by pharmacists who had worked in the UK and had extensive experience using robotic dispensing systems. In another survey conducted in the USA on hospital technology by Schumock et al in 1999, pharmacists considered medication safety to be one of the most important issues facing pharmacy services (79). Significant investment in technology will be required over the

coming years to assist hospital pharmacies in delivering services both safely and efficiently.

1.3.8 Automated medication storage and retrieval systems

Hospital pharmacies have traditionally provided medications for patients by dispensing and delivering medications which are stored in medication cabinets or carts on the wards. Automated medication storage and retrieval systems provide computer-controlled storage, dispensing, and tracking of medications and have been recommended as a potential mechanism to improve efficiency and patient safety (80). These systems are also described as unit-based cabinets, automated dispensing devices, automated distribution cabinets, or automated dispensing machines (81). Approximately 97% of USA hospitals and 11% of European hospitals have adopted automated medication storage and retrieval systems mainly for ease and accuracy of the medication administration process (78)(80). In Ireland, five public hospitals have systems implemented on hospital wards. An example of the design of these systems is provided in Figure 1.6.

Figure 1.6 Example of the design of an automated medication storage and retrieval system

Components that need to be considered when implementing a medication storage and retrieval system are illustrated in Figure 1.7.

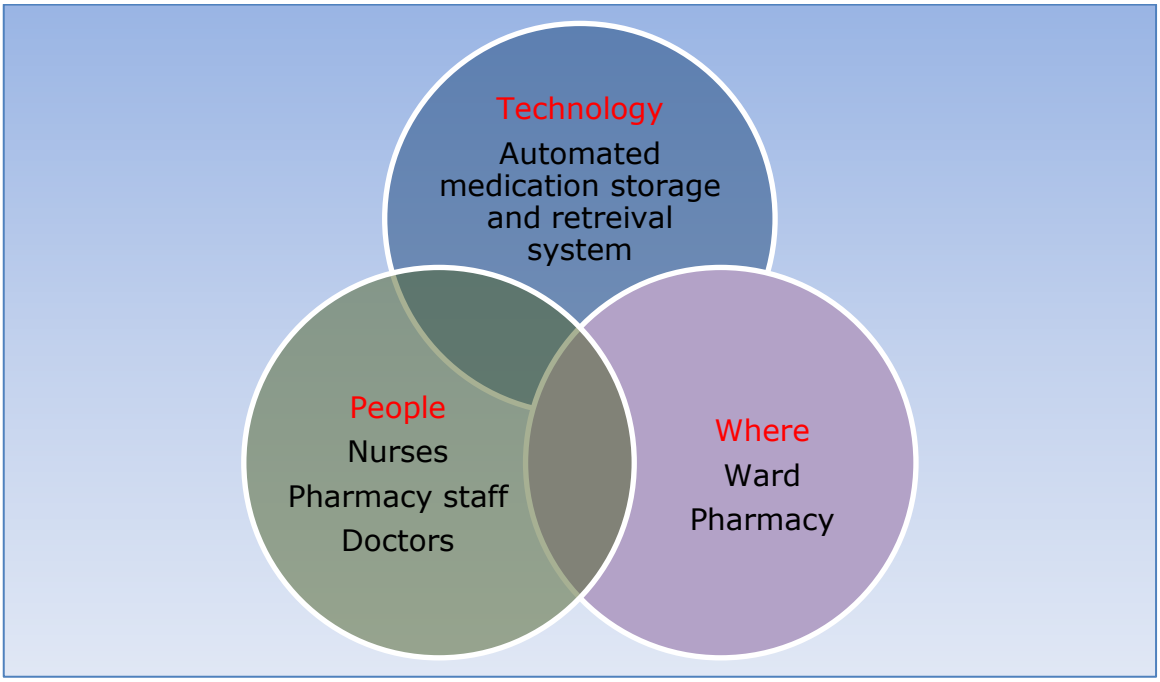

Figure 1.7: Components of a medication storage and retrieval system

It has been reported that automating the storage and retrieval of medicines can enhance first-dose availability and facilitate the timely administration of medications by increased accessibility on the wards during and outside of pharmacy opening hours (82). However, several reviews on system impact have demonstrated a lack of evidence of an increase in medication safety attributable to stand-alone systems without the integration of an EHR or ePrescribing system (82)(83)(84)(85)(86)(87). A number of reports have identified medication errors created by these systems and time delays in drug administration to patients (82)(85)(88). This suggests automated medication storage and retrieval systems may promote a safer medicines management system if they are part of an overall strategy that includes ePrescribing systems with CDS and preferably an EHR.

1.4 Overview of the current medicines management system in hospitals in Ireland

Prescribers in hospitals in Ireland routinely hand write prescriptions onto a medication chart which is also utilised by pharmacists to screen and supply medication, by nurses to review and record administration times of medicines, and by other healthcare professionals as required. Whilst the use of patient's own medication is not routinely recommended in the hospital setting in Ireland due to its associated risks, few hospitals have developed a drug formulary which leads to pharmacy ordering, stocking, and supplying large quantities of medicines at a substantial cost. Hospitals in Ireland also rely on manual distribution systems where requisition books with a hand written list of medications are received in the pharmacy department from each ward and are then generally dispensed in bulk supply to the wards and not per patient name. In addition to being labour-intensive and costly, this leads to nurses over ordering medications, overcrowding of medications in the nursing presses, added time spent locating drugs or re-ordering drugs, and returns to pharmacy of medicines not required or out of date. Other significant concerns include transcription errors, illegible written requests, delays or omissions in the delivery of doses, 'borrowing' of patients' medications, inaccurate drug charges, and no tracking of drugs and drug wastage.

Medication reconciliation led by pharmacy staff is also delivered haphazardly despite the publication of a Health Service Executive (HSE) *Report of the National Acute Medicine Programme* in 2010 which states medication reconciliation is immediately mandated on patient arrival into hospital or as soon as possible (89). The PSI's *Future Pharmacy Practice in Ireland – meeting patients' needs* report published in 2016 promotes medication reconciliation but recognises resourcing currently does not allow for this mandate (90).

Limitations of the current medicines management system were highlighted in a five-year review of national clinical incidents, claims, and costs between 2010 and 2014 published by the States Claims Agency in 2017 (91). They found medication-related incidents, which included incorrect dosage, missed medication, and incorrect or not reconciled medication on admission/transfer/discharge accounted for 15% of the ten most common clinical

incidents in Ireland (91). Recommendations for implementation of an EHR and ePrescribing system with CDS nationally were proposed.

There are known problems with this system and errors can occur at any stage of the medication management cycle posing a significant safety risk for patients. A summary of the inefficiencies involved in manual medicines management systems in hospitals is illustrated in Figure 1.8 adopted from eHealth Ireland (92).

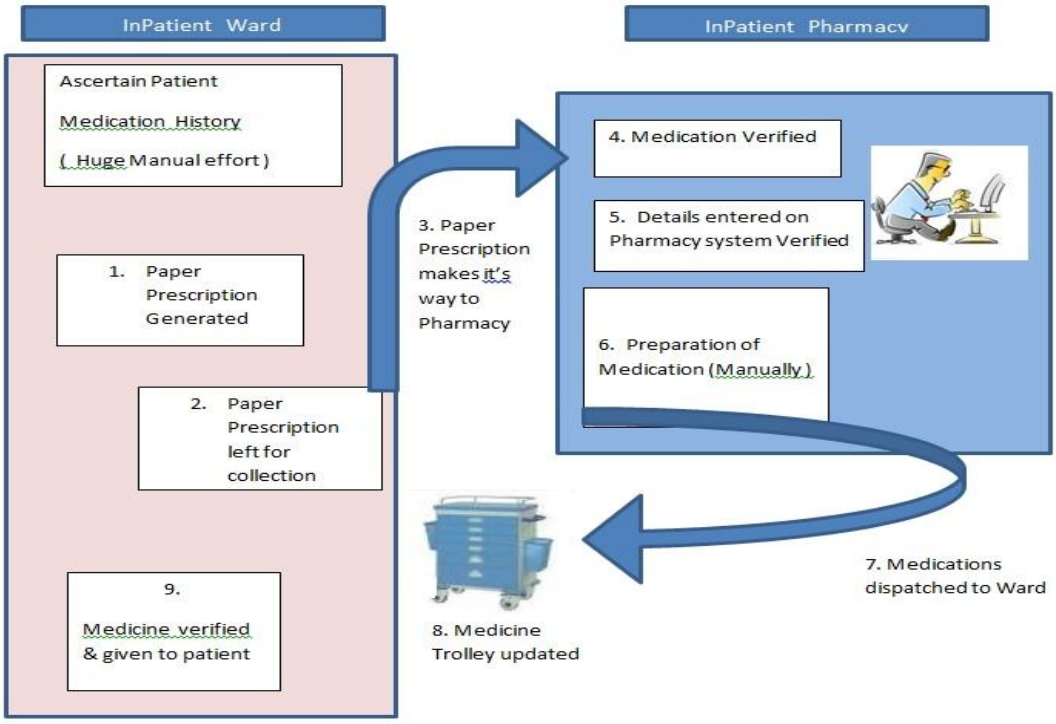

Figure 1.8: Manual medicines management system in hospitals in Ireland adopted from eHealth Ireland (92)

1.5 Irish national eHealth initiatives

1.5.1 Current eHealth infrastructure

Three types of hospital provisions exist in Ireland:

- The HSE provides and funds all public health services in hospitals and communities across the country. The Minister for Health has responsibility for its overall governance. New structures are currently in the process of formation with the establishment of six Hospital Groups as a transition to Independent Hospital Trusts and the government's overall commitment to reform the current highly criticised health service (93). Each with their own

governance, management, and primary academic partner, the establishment of Hospital Groups is potentially a key enabler for reorganisation of services across hospitals with associated benefits of high quality patient care in a cost efficient manner. These changes will bring many challenges to an already strained system and will require increased investment in eHealth systems, change management, and implementation support infrastructure.

- Voluntary public hospitals, most of whose income comes from state funds, are sometimes owned by private bodies such as religious orders. Other voluntary public hospitals are incorporated by charter or statute and are run by boards often appointed by the Minister for Health. Both HSE public hospitals and voluntary public hospitals operate in a similar way (94).
- Private hospitals receive no state funding and operate independently of the state with separate governance policies (94).

This thesis focuses on the 48 HSE/voluntary public hospitals in Ireland as they cover the majority of hospital types nationally and are guided by national eHealth programmes and availability of government funding which impacts on decisions to invest in eHealth systems.

The current eHealth infrastructure in Ireland's healthcare sector is fragmented which prevents the safe and effective transfer of information and results in service users being requested to provide the same information on multiple occasions. Healthcare delivery is continuously transforming due to various demographic, organisational, and resourcing dynamics as well as from the increasing proliferation of technology. Demographic changes are as a result of ageing populations, rising chronic diseases, and increased demand and complexity of healthcare services (91). With an estimated population of four and a half million, Table 1.5 illustrates the estimated national demographic trends for 2017 and its impact on hospital services adopted from Smyth et al (96).

Table 1.5: National demographic trends for 2017 adopted from Smyth et al (96)

- The population is projected to increase by four percent or 190,600 people between 2017 and 2022
- There will be 131,600 additional people aged 65 years and over by 2022
- There will be 16,100 additional people aged 85 years and over by 2022
- Life expectancy in Ireland has increased. At 79 years for males and 83.1 years for females, it is now above the average for the European Union (EU)
- Approximately 65% of people aged 65 years and over have two or more chronic conditions which equates to 404,470 people. Using population projections, in 2017 this will rise by 12,830 additional people and a further 72,080 by 2022
- 25% of children aged three, five, and nine years are overweight or obese
- In 2016 the healthcare budget had decreased by 15% from 2010 and demographic pressure had increased by 9%

Between two to three percent of government budgets are spent on implementation of Healthcare ICT globally (95), with Luxembourg, Norway, and the Netherlands allocating more than five percent of their hospital budget to eHealth systems (72). In Ireland, investment in Healthcare ICT is approximately 0.85% (95) which accounts for one of the lowest levels in Europe and 63% of hospitals dedicate less than one percent of their budget to IT (72).

1.5.2 National eHealth programmes

Hospital medication management processes are typically complex, making standardisation more complicated. Fundamental building blocks required to be in place prior to ePrescribing implementation include unique health identifiers for individuals, healthcare professionals, and organisations; an interoperability framework and messaging standards to facilitate the secure transfer of prescriptions between prescribers and dispensers; and a data model to support the implementation of a standardised national medicinal product catalogue (97). Other prerequisites include stakeholder engagement and privacy impact assessments.

In recent years, the National *eHealth Strategy* published by the HSE in 2013 identified ePrescribing as a key priority for Ireland (95). The *Knowledge and Information Strategy* by the HSE launched in 2015 outlines how integrated technology will support the delivery of innovative, safe, and high quality patient

care and identifies capability requirements and a vision for healthcare delivery in the future (98). HIQA is also addressing the current fragmented ICT infrastructure and working to ensure high quality health information is available to support the delivery, planning, and monitoring of services. This statutory government-funded agency has undertaken multiple projects in the area of ePrescribing and medication safety (70)(97)(99)(100)(101)(102)(103). On par, the Health Research Board is a statutory agency under the DoH and is the main national funding agency for health research. Its five-year strategy between 2016-2020 emphasises the importance of research in technology to improve patient care (104). eHealth Ireland was also established in 2015 to focus on the promotion and implementation of patient-centered technology through measurable cultural change (92).

Various national eHealth initiatives are either at the implementation stage or being planned as a part of the overall eHealth agenda in Ireland, as outlined in Figure 1.9 (92).

Figure 1.9: Key national eHealth strategic programmes adopted from eHealth Ireland (92)

ePharmacy focuses on the development of a national medicinal product catalogue and deployment of digital solutions across different care settings to allow the delivery of safer and more efficient pharmacy services. The availability of drug catalogues and pharmacy solutions are key enablers for developing the medication management and ePrescribing capabilities. Progress on other national eHealth initia2tives are summarised in Table 1.6 adopted from the Office of the Chief Information Officer (OCIO) *EHR Strategic Business Case* in 2016 (105) and the *National Service Plan 2017* (106).

Table 1.6: eHealth national initiatives adopted from the OCIO and HSE (105)(106)

Individual Health Identifier (IHI)	Uniquely identifies individuals, has the capability to share patient data across systems in a national portal, implementation in progress
EHR	Investment of €875 million over a ten-year period, plan includes a national summary EHR available by 2019, incorporates real-time patient-centered records across hospital and community care settings, maintains integrity and security of data, can lead to a 68% reduced likelihood of medication errors, 76% reduction in errors in discharge summaries, and 11% reduction in drug costs. EHR lighthouse projects covers three clinical areas: epilepsy, haemophilia, and bipolar disorder
Maternal and Newborn Clinical Management System	EHR which incorporates ePrescribing for all women and babies in maternity services in Ireland, allows all information to be shared with relevant providers, first introduced in Cork University Maternity Hospital in December 2016
Medical Oncology Clinical Information System	Patient-centric information system solution, tracks oncology drug usage, forms part of the longitudinal view of care delivered to patients, work to commence in 2017 and the overall project will take 4 years to deliver
National Medical Laboratory Information System	Replaces all laboratory systems with a single national solution, ensures 24-hour access to accurate laboratory data across all sites, phase one implementation will commence in 2018
eReferrals	Facilitates general practitioners to submit an electronic referral from their practice management system to hospitals using the HIQA approved referral form, all public hospitals now receiving eReferrals
Open Data	Identifies current datasets, establishes a plan to structure and publish further datasets over time, provides a valuable resource that can drive innovation
eHealth priorities for 2017	▪ Further develop ePharmacy ▪ Continue to build the foundations for the implementation and integration capability of an EHR for Ireland ▪ Deliver phase one of the patient portal for IHIs and connect 50% of health user systems to the IHI service ▪ Develop the framework for a single information services function for health including business intelligence tools ▪ Analyse and deploy the next phase of the data governance programme in conjunction with the DoH's requirements and needs and the HSE's own capability

1.5.3 Clinical engagement initiatives

Many studies have demonstrated that the implementation process for hospital eHealth systems is central to determine overall success (6)(107)(108)(109)(110). An important theme has been the problem of resistance or refractory behaviours of healthcare professionals and the assumption that their attitudes to eHealth are the root problem (4). The identification of pre-existing barriers and obstacles, and the investigation of the diverse concerns and perceptions of different groups are crucial steps in implementing change (91)(111). Healthcare professionals, educators, and researchers also increasingly recognise the value of human factors/ergonomics, a discipline which examines the design of a system and people's interactions with it, and treats the system as holistic rather than concentrating on individual components (112)(113). It explicitly recognises that systems change and modify in light of circumstances and events, thus showing emergent properties relevant to the dynamic field of eHealth. A systematic review by Yusof et al in 2010 on eHealth adoption identified 55 studies and concluded that technology, human, and organisational factors are equally important, in addition to the fit between them (114). This alignment appears to be achieved easier in small-scale, organic, incrementally developed systems in contrast to larger more ambitious eHealth projects that are now increasingly being parachuted into complex environments (115).

The concept of human factors has been recognised by the eHealth Ireland programme which has put significant focus on clinical engagement. The Council of the Chief Information Officer (CCIO) was established in 2015 to provide clinical governance in the delivery of eHealth solutions in Ireland. With over 300 voluntary members, including the primary researcher, its role is primarily advisory and includes participating in several meetings per year with clinical leaders and professionals who have successful programme delivery experience. In addition, the eHealth Ecosystem conferences were established in 2015 by the DoH and the HSE to connect communities involved in eHealth and address themes aligned to ePharmacy, clinical engagement, research, and the EHR programme. Technology has also been recognised as a key enabler of future pharmacy practice in the PSI's *Future Pharmacy Practice in Ireland – meeting*

patients' needs report to allow for operational efficiencies and greater focus on clinical and patient facing activities.

Successful implementation will largely depend on this ongoing support, a highly committed collaboration from all stakeholders, and the willingness of healthcare professionals to integrate new work practices. Other requirements include effective leadership and clinical champions, the availability of high quality eHealth systems, the development of appropriate skills and training for those impacted by the new system, and consideration to systems ergonomics in totality (116).

1.6 International eHealth initiatives

Global healthcare needs are changing. The increasing demands of managing an aging population, rising expectations, and advances in life and engineering sciences are complex and logistically challenging (116)(117). Healthcare strategists worldwide increasingly promote the adoption of eHealth to deliver a modern and effective healthcare system and are investing heavily in the area (118)(119)(120).

Implementation of eHealth is influenced at a micro-level by interpersonal factors such as individuals' attitudes and beliefs, at a meso-level by operational aspects such as readiness and resources, and at a macro-level by socio-political forces (121). At a macro-level, many countries including the USA, the UK, Canada, Australia, and Estonia have been at the forefront of attempts to embed eHealth into routine healthcare (70)(122)(123)(124), exemplified by hospitals in England who expect to be paperless by 2020 (125). Almost all European countries have detailed documents outlining concrete eHealth goals including ePrescribing adoption which is among the key activities identified in the ECs *eHealth Action Plan 2012-2020* (119), the *Digital Agenda for Europe* (126), and the World Health Organization-International Telecommunication Union *National eHealth Strategy Toolkit* (127). A recent UK report *Operational productivity and performance in English NHS acute hospitals: Unwarranted variations* published by the DoH in 2016 recommend the adoption of digital information systems including integrated ePrescribing systems within an EHR in all trusts by October 2018 (128).

Despite this political commitment and substantial investment, there has been significant variability in the success of different eHealth implementations internationally (4). For example, the NHS invested over €11 billion over 10 years in the national programme for Information Technology (NPfIT) for an EHR which failed to be delivered (91). This was mainly due to haste with unrealistic timelines, limited engagement with users, inadequate preliminary work, and failure to test systems and check progress against expectations (129). Other limitations included confidentiality issues, a failure to recognise the risks or limitations of big information technology (IT) projects, lack of clear leadership or understanding of the aim of the project, insufficient budget allocation with treasury emphasis on price over quality, and lack of training or contingency plans (129). Difficulties in eHealth implementation are an international phenomenon and have been widely reported, with the EU stating adoption of eHealth strategies "*has almost everywhere proven to be much more complex and time-consuming than initially anticipated*" (130).

1.7 Facilitators to system implementation

Enablers to successful system implementation include end-users' attitudes towards the innovation, end-users' capacity and competence, strategic project management, effective leadership and communication, continual quality improvement, and evaluation (14). Assessing and fostering readiness for system implementation appears to be particularly important.

Implementation and dependability of eHealth systems draw on a wide range of insights and disciplines (131)(132). Healthcare professionals are continually exposed to new research findings that could contribute to more effective patient care. However, with only 55% adherence to evidence-based medicine, this gap between what healthcare professionals know and what they do challenges effective and efficient healthcare delivery (133)(134)(135). To bridge this gap between 'the known and the done', a commonly suggested strategy is to identify facilitators and barriers for changing practice and then implement interventions to enhance enablers and reduce identified barriers (136). As these systems promise much in terms of reduction in clinical risk and process inefficiencies, it is

important that perceptions of healthcare professionals are reflected in system design, development, implementation, and sustainability.

1.7.1 Driving factors for successful system implementation

International practice and broader engagement with clinical, technical, and economic stakeholders have informed key aspects that underpin successful system implementation (98). These include good governance and integrity, the design and delivery of systems which supports the strategic vision for healthcare, clinical leadership for effective delivery, and readiness for change which requires significant commitment, motivation, and capability to change (95)(98)(137).

In a recent systematic review of 44 studies by Ross et al in 2016 on factors that influence the implementation of eHealth, key facilitators for effective implementation included the need for adequate infrastructure and resources, engagement of key personnel, and consideration to the fit of eHealth systems with current organisational workflow (138). The prevailing focus on organisational issues included the need for financial resources, policy support, standards and interoperability, management of expectations, and evaluating system use. Klynveld Peat Marwick Goerdeler (KPMG) has also proposed key facilitators to system implementation in their report *Accelerating innovation: the power of the crowd* published in 2012 on global lessons learnt in eHealth implementation as summarised in Table 1.7 (139).

Table 1.7: Summary of key facilitators for successful system implementation adopted from KPMG (139)

- Developing and communicating strong management support throughout the organisation and identifying champions, preferably senior prescribers
- Estimating necessary financial resources such as hardware, software, additional human resources (HR), training, and technical support with an emphasis on patient safety benefits and efficiencies to justify financing
- Fostering a culture of change by placing value on the system and promoting and supporting implementation
- Adequate, timely, and ongoing on-site training and technical support with protected time for training
- Reconfiguring roles, responsibilities, and work tasks
- Assessing and managing unrealistic expectations and concerns pre-implementation with clear goals and anticipated benefits
- Ensuring system backup as well as considering workflow design as part of the implementation process
- Developing formal goals, objectives, and key indicators of success
- Anticipating challenges in the implementation process

An interpretative review by Cresswell and Sheikh in 2013 specific to organisational issues in the implementation of eHealth innovations identified 13 systematic reviews (140). They concluded that consideration to the complex relationship between technical, social, and organisational dimensions is essential in ensuring systems are useful, usable, and support the organisation within which patients and healthcare professionals operate (Figure 1.10).

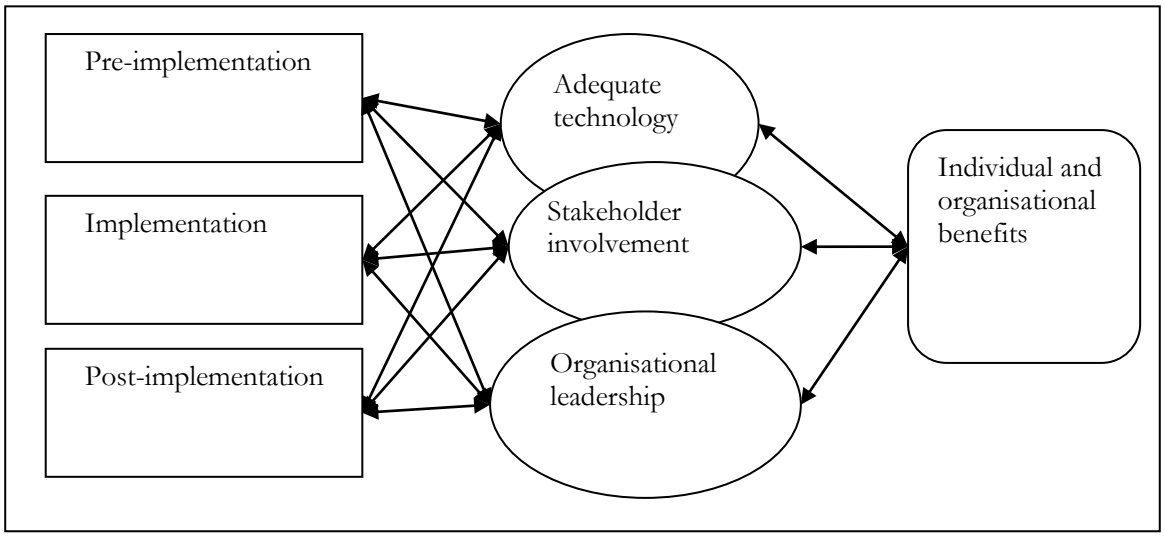

Figure 1.10: Interrelated technical, social, and organisational factors over time in eHealth innovations adopted from Cresswell and Sheikh (140)

A careful balance between organisational demands such as resources, social demands such as user requirements, and technical demands such as interoperability and performance will be required.

1.8 Evidence of the challenges to system implementation

Complexity often increases by the integration of technology into healthcare delivery due to significant process changes and required expertise in both technical considerations and clinical practice. There is a general consensus that organisational issues are central to problems with system implementation and adoption (138)(141). Such issues that pertain to eHealth innovations cover a multidisciplinary field inclusive of organisational psychology, change management, and human factors. Additional workload at the initial stages of implementation, critical workflow changes, negative emotions, and unexpected alterations in power structures can result in significant barriers to adoption (138)(141).

The impact on patient safety with system implementation has been the subject of many reviews (142)(143)(144)(145)(146)(147)(148)(149). Whilst system adoption should in theory enhance healthcare delivery, it may introduce new unanticipated negative consequences. These include unfavourable workflow, continuous system demands, issues with paper persistence, untoward changes in communication practices, negative emotions, unexpected changes in power structures, and overdependence on technology (150). Generation of new kinds of

errors may also be evident exemplified by incorrect decision support, inaccurate patient data input, and erroneous orders selected (151). Donyai et al found 10 new errors created by the use of ePrescribing in a UK hospital (60). These included selection of incorrect drugs, frequency, and formulation. Koppel et al also found 22 types of medication error risks with the use of a computerised physician order entry (CPOE) system in a tertiary teaching hospital in the USA (152). Fragmented displays preventing a coherent view of patients' medications, double dosing and incompatible orders, and inflexible ordering formats generating wrong orders were reported (152). However, whilst often cited, this study has been much criticised due to the high risk of bias with key findings.

A systematic review by Mair et al in 2007 included 19 reviews mostly conducted in the USA on understanding the implementation and integration of eHealth services (153). Key barriers identified related to inadequate information management, insufficient inter-agency cooperation, intrusive technology/rigidity of system, cost, and lack of testing systems (153). Another systematic review by Gagnon et al in 2009 on the effectiveness of interventions to promote the adoption of ICT by healthcare professionals included 10 studies mostly from the USA (154). Concerns specific to eHealth innovations related to application design and usability. They concluded poorly designed systems and a failure to recognise cultural aspects associated with adoption can inhibit successful implementation and introduce new risks to patient safety (154) .

Researchers have also found risks to patient safety can transpire from lack of system usage (155)(156)(157)(158). Wang et al assessed the capabilities of ePrescribing systems in 2005 and found a mere 50% of recommended capabilities were fully implemented (159). There were substantial discrepancies between capabilities that vendors claimed for their products and capabilities that were actually identified. Another study found systems permitted the entering of unsafe orders and some applications were not pre-programmed with a set of mandatory fields (160). A systematic review of randomised controlled trails (RCTs) by Mollon et al in 2009 on features predicting the success of CDS for prescribing identified 41 studies and found no consistent translation into improved patient outcomes (161). The included studies did not adequately report or give sufficient attention to features of system design or implementation (161).

Time issues have been identified as further barriers. An early USA study by Tierney et al in 1993 reported doctors spent 33 minutes longer during a 10-hour observation period writing orders into an ePrescribing system (162). Bates et al in 1999 also found junior doctors took twice as long to input medications electronically than the traditional paper-based method (163). However, almost half the time was recovered due to the facilitation of some administrative tasks. With regard to drug administration ward rounds, Almond et al in 2002 found the time to complete this task by nurses had doubled in a UK hospital (164).

Another well documented contribution to potential errors is overriding alerts due to alert fatigue (165)(166)(167). Studies addressing user response to alerts in ePrescribing applications identified most alerts were ignored with clinical 'irrelevance' being the main reported reason for overriding (143)(167).

Several additional factors that surfaced include concerns regarding the privacy and confidentiality of patient information, lack of standards for data coding and exchange, and challenges during the transition from paper to electronic systems (103)(168)(169)(170)(171)(172). Various barriers with eHealth adopted from KPMG are illustrated in Figure 1.11, the most prominent being finance and professional attitudes (139).

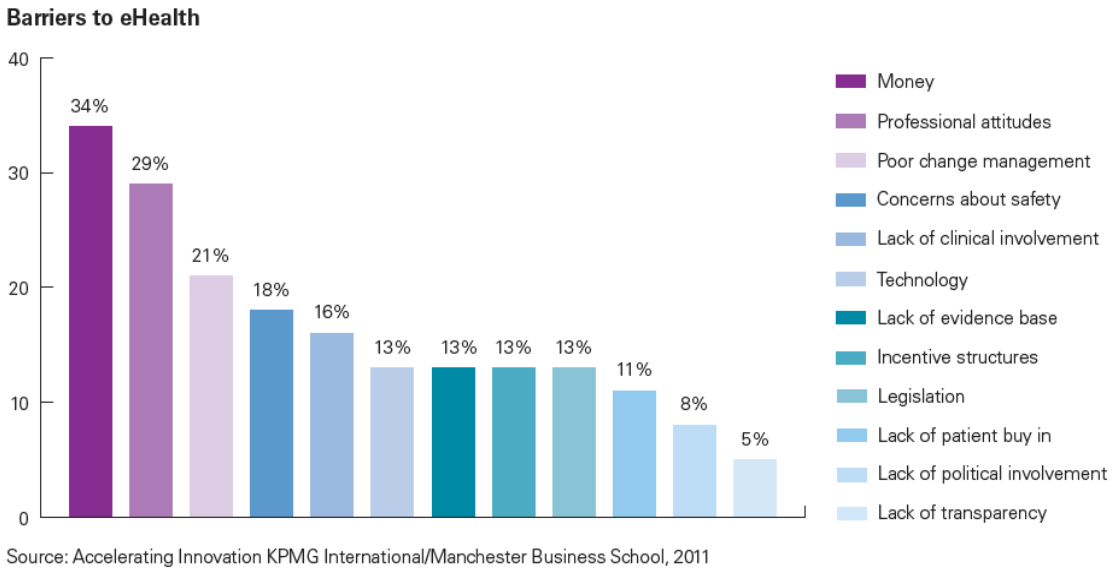

Figure 1.11: Barriers to eHealth adopted from KPMG (139)

From an Irish perspective, reluctance to invest in such systems with medium to longer term returns may be due to lack of prioritisation with ever increasing pressures in Emergency Departments (EDs), public waiting lists, and late hospital discharges, as well the recent economic difficulties within the Irish economy (90). System suitability where systems may have been designed for a different healthcare market may also be problematic and not fit for purpose. In addition, major lessons were learnt from the failure of the abandoned national personnel payroll and related system (PPARS), a HSE personnel and payroll electronic system estimated to cost approximately €150 million over a 10-year period up to 2005. This failure was similar to NPfIT and was mainly due to lack of a clear vision, substantial variation in pay and conditions between and within health agencies, a desire to implement the system quickly, and lack of readiness of health agencies to adapt to the changes required (173)(174). Taking account of the particular landscape in Ireland and from the experiences of other countries, the likely major challenges of system implementation are provided in Table 1.8.

Table 1.8: Challenges to system implementation in Ireland

▪ Maintaining alignment with the eHealth vision
▪ Addressing any public or healthcare provider concerns over data privacy and the sharing of information
▪ Maintaining stakeholder support
▪ Having the capacity to absorb change across the health service
▪ Providing required resources including clinical and management resources

1.9 Gaps in the literature

As previously described, ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems have the potential to ensure continuous improvements in patient safety and efficiency. Whilst there is a plethora of literature regarding evaluation of these systems and recommendations for adoption from national and international policy documents and government strategies, a limited number of studies have been published on system implementation processes in hospitals and none have been identified in Ireland. There is a clear need to explore facilitators and barriers to system implementation and provide original insight into this complex area in a hospital

setting to inform policymakers, implementers, and end-users of mechanisms for successful system adoption.

1.10 Overall research aim and objectives

1.10.1 Research aim

Gaps identified within the literature evolved into the overall novel aim of this thesis, namely:

- To explore the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

The focus is process driven rather than outcome-based and specifically explores technologies relating to ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems.

1.10.2 Research objectives

As anticipated, the original research objectives which emerged during work in the earlier stages of this research programme have subsequently evolved, transformed, and been refined. The original research aim formed in 2012 was to explore the current and future role of eHealth in prescribing, dispensing, and administering medicines in acute hospitals in Ireland incorporating three phases. The first phase was to conduct an outcome-based systematic review on the benefits and drawbacks of system implementation. Subsequently it became evident that several outcome-based reviews had been published and that it would be more timely and beneficial to review implementation processes as Ireland had limited experience of system adoption and momentum had started to emerge nationally for progress in this arena. Evolution into a process-based systematic review on healthcare professionals' perceptions of the facilitators and barriers to system implementation emerged as an area under-researched and highly significant.

The second phase of this research initially consisted of conducting postal questionnaires with chief pharmacists in public hospitals in Ireland to establish the adoption of eHealth initiatives. Shortly after considering this proposal a

baseline study of hospital pharmacy in Ireland was published by the PSI in December 2012 which provided similar information (8). This phase also included interviewing chief pharmacists, local eHealth leads, and national eHealth leads to explore their views and experiences of system implementation. This was modified and evolved into a more exploratory approach involving two cohorts namely local key stakeholders, and national key stakeholders and eHealth leads.

The original third phase involved exploring the structures, processes, and outcomes of currently established eHealth systems in hospitals in Ireland and selected international sites. At the time of the research, no public sector hospital in Ireland had a hospital-wide integrated ePrescribing system, one public sector hospital had a robotic pharmacy system, and four public sector hospitals had implemented automated medication storage and retrieval systems. The research team felt it was not feasible to conduct a case study as there were no suitable hospitals to choose from and in addition, several case studies had been previously conducted internationally, this it was not thought to significantly add to the novel focus of this research (139)(175)(176)(177)(178)(179)(180)(181).

Figure 1.12 illustrates the research approach which has developed with an emphasis on theory-based qualitative rich data generation and analysis.

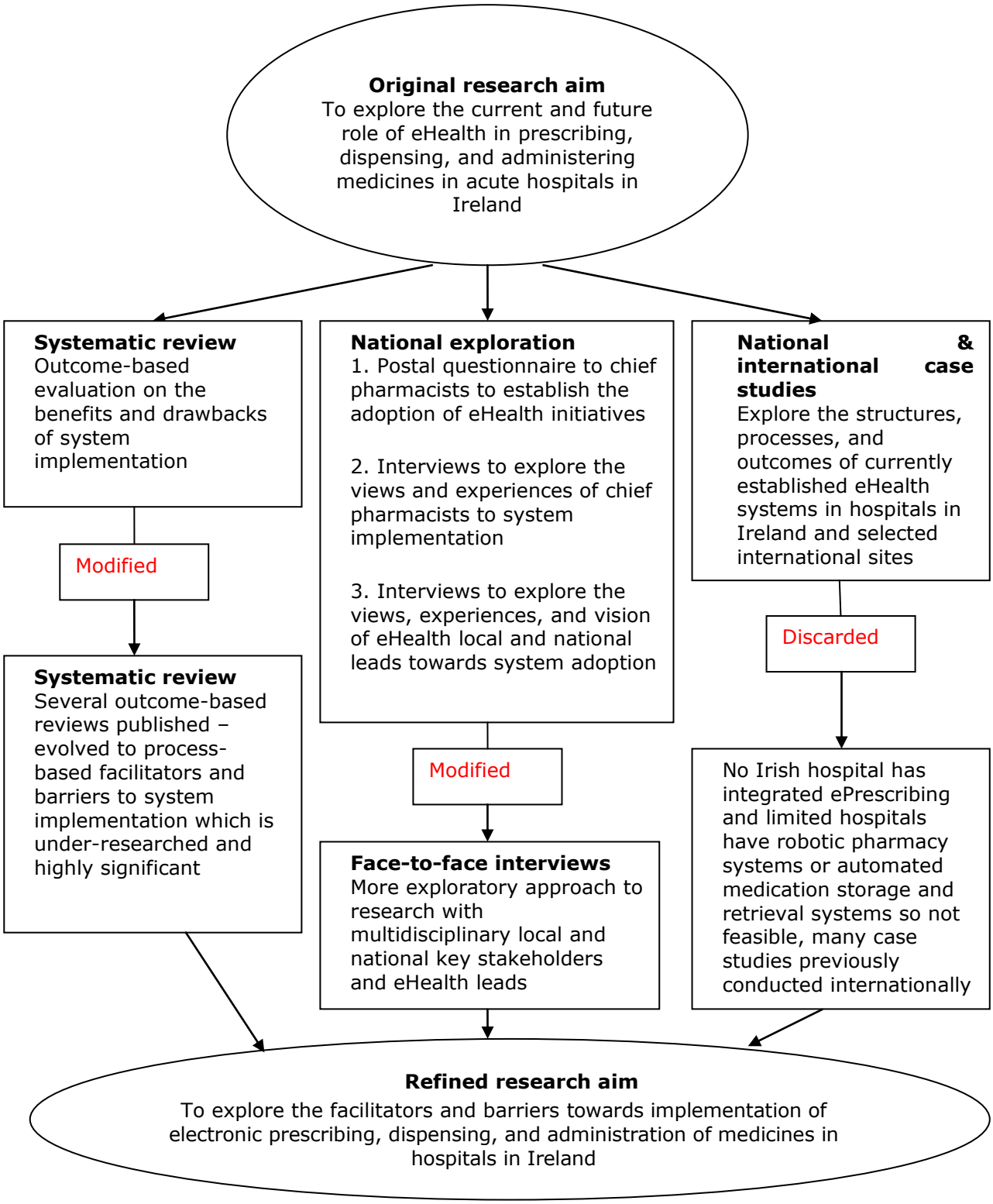

Figure 1.12: Schematic representation of evolution of research aim, objectives, and methods

Phase one objective: systematic review

- Identify and critically appraise the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.
- Synthesise and present the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.

Phase two objective: interviews with local key stakeholders

- To explore the perceptions of local key stakeholders towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using Normalization Process Theory (NPT) as a theoretical framework.

Phase three objective: interviews with national key stakeholders and eHealth leads

- To explore the perceptions of national key stakeholders and eHealth leads towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework.

Figure 1.13 depicts each incremental phase of the doctoral research.

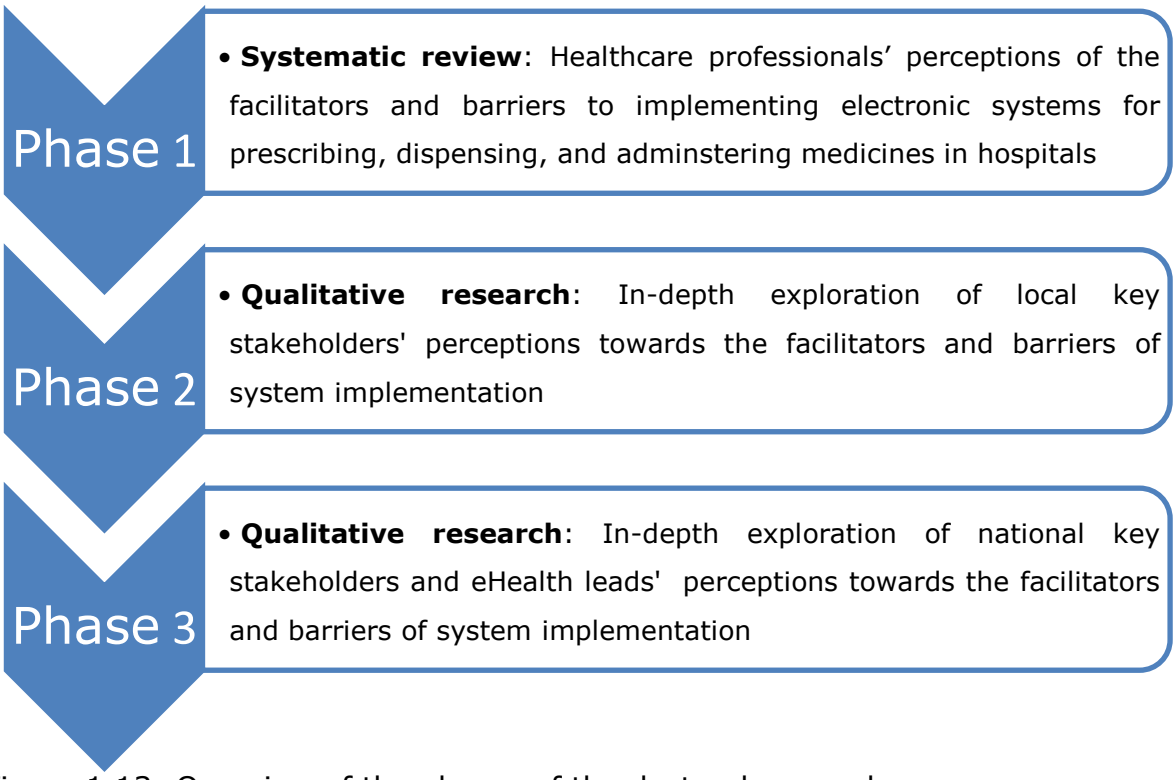

Figure 1.13: Overview of the phases of the doctoral research

It is evident from reviewing the literature that this area is under-researched. This exploration aims to provide a unique insight into facilitators and barriers towards system implementation in hospitals in Ireland and make a significant contribution to original knowledge and impact on the research subject. System-users, implementers, and evaluators will be able to use this research when planning, implementing, maintaining, and sustaining these systems. Findings can then be used to improve the current system in hospitals and maximise the implementation and potential use of these systems in the future. As this area is dynamic in nature, the evolving nature of technological, social, and organisational dimensions needs to be taken into account.

1.11 Chapter summary

A number of recommendations and issues to consider when embarking on system implementation have been provided in the literature. There is potential to significantly improve patient safety and efficiency through enhanced access and exchange of clinical data using interoperable ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems. Benefits are likely to be dependent on how systems are implemented, supported, and used in practice.

Chapter 2: Methodology

2.1 Introduction

Chapter 2 reviews and justifies the research philosophy, methodology, methods, and theory applied throughout this doctoral research. The processes for data sampling, generation, analysis, and quality assurance are described along with the reasoning for the choice of such approaches.

2.2 The selection of a research approach

Research approaches are types of inquiry that provide specific direction that range from broad assumptions to detailed methods of data generation, analysis, and interpretation. The researcher should provide detail on which philosophical assumptions, procedures of inquiry, and specific research methods are to be applied to the study. Three approaches include qualitative research which focuses on words and text, quantitative research which centres on numbers and statistics, and mixed methods research which resides in the middle of this continuum incorporating elements of both qualitative and quantitative approaches (182). A strong distinction is usually apparent between these methods due to their differences in characteristics and techniques for analysis. Natural science has typically focused on quantitative positivist analysis which was adopted from the human sciences until its limitations became apparent. As subjective human feelings are difficult to quantify, a more personal approach evolved into qualitative anti-positivist analytical methods. Its historic origin comes from anthropology, sociology, the humanities, and evaluation (183).

2.3 Philosophical paradigms

The nature of scientific inquiry is a large subject area in itself, and one that has been addressed and contested from many positions. Approaches to research involve the influence of distinct philosophical paradigms, a set of beliefs that guide action through four elements: ontology; epistemology; axiology; and methodology (184)(185)(186)(187).

Researchers from different disciplines have their own approach to viewing 'their world'. This is sometimes referred to as ontology, the 'reality' that researchers investigate and the nature of what exists (188). Epistemology considers what is

acceptable knowledge and the relationship between reality and the researcher and the possible ways of knowing social reality. Axiology is more concerned with the role of values and ethics in research and the researcher's stance. Methodology is the technique used by the researcher to investigate that reality (183)(189). Diverse techniques of viewing phenomena are frequently complementary and an array of researchers from different backgrounds may be involved in addressing many issues in pharmacy practice research.

Four common philosophical paradigms, each relating to different epistemological and ontological positions, include positivist, post-positivist, interpretivist, and pragmatic (183).

2.3.1 The positivist paradigm

Assumptions and beliefs of the positivist paradigm, otherwise known as naïve realism, revolve around an objective reality typically expressed by quantitative experimental methods (190)(191)(192). Rooted in the ontological principle, reality is free and independent of the researcher and knowledge is objective and quantifiable. Hypotheses are tested via inductive reasoning during the research process and presented by empirical means.

2.3.2 The post-positivist paradigm

The post-positivist paradigm, also referred to as critical realism, connects more with quantitative than qualitative research. The key assumptions of this position are that knowledge is conjectural and that the absolute truth can never been found. It is for this reason that a hypothesis is not proven. Instead, a failure to reject the hypothesis is indicated. Researchers objectively make claims, test theories, and seek to develop relevant true statements that describe the causal relationship of interest (183). Evidence and rational considerations shape knowledge to ensure validity and reliability of data. This is in contrast to positivist beliefs in quantitative research where the researcher is removed from the subject being investigated and becomes an objective observer (188).

2.3.3 The interpretivism paradigm

This worldview is often seen as an approach to qualitative research and is mostly related to phenomenology which assumes that people construct social reality as

they interpret the world around them, interact with each other, and assign meaning to their perceptions and experiences (193). An interpretivism perspective, also referred to as constructivism, is based on an epistemology which considers social realities to be constructed out of individual's experiences of phenomena and not from discrete tangible facts that can be measured (183). Individuals seek understanding of the world in which they live and construct meanings as they engage and make sense of it based on social perspectives and interactions. Interpretivism dictates research should be conducted in the natural environment to encourage active engagement between the researcher and research participants and requires the researcher to be central in the research process in order to understand the social world (183)(194). Engagement and personal experiences of the researcher are acknowledged as important in understanding the issues under study (195).

2.3.4 The pragmatic paradigm

As a philosophical underpinning for mixed methods studies which arises from different dimensions in the research process, the pragmatic paradigm is not committed explicitly to any one philosophy as one philosophy cannot fit all (196). The truth is what works at that time. Both quantitative and qualitative approaches to address research questions are valid which underscores the pragmatic philosophy of mixed methods research. It focuses on pluralistic approaches to derive knowledge about the problem where researchers use all available strategies to address the issues (183). The task of finding answers to research questions via induction, deduction, and abduction drives knowledge acquisition and takes precedence over philosophical arguments (197).

Table 2.1 summarises the various research paradigms and fundamental beliefs adopted from Wahyuni (198) and based on Saunders et al (199), Guba and Lincoln (200), and Hallebone and Priest (201).

Table 2.1: Fundamental beliefs in research paradigms adopted from Wahyuni (198)

Fundamental beliefs	**Positivism (Naïve realism)**	**Post-positivism (Critical realism)**	**Interpretivism (Constructivism)**	**Pragmatism**
Ontology position on the nature of reality	External, objective, independent	Objective, independent, interpreted through experiences	Socially constructed, subjective, may change, multiple options	External, multiple use in order to best answer the research question
Epistemology view on what constitutes acceptable knowledge	Observable, measurable, can provide credible data, cause and effect	Observable, can provide credible data in context	Subjective, focus on details and meaning behind details	Observable and/or subjective depending on research question, focus on integrating different perspectives to interpret data
Axiology role of values in research and the researcher's stance	Objective, value-free and etic	Value-laden and etic, researcher biased	Subjective, value-bond and emic	Objective and subjective, value-bond and etic-emic
Methodology model behind the research process	Quantitative	Quantitative or qualitative	Qualitative	Quantitative and qualitative (mixed or multimethod design)

2.3.5 Overall philosophical paradigm employed in current research

The research objective terms for all phases of this research inclusive of *explore, perceptions, facilitators, barriers,* reject the positivist and post-positivist paradigms which are typically quantitative in nature and reflects the interpretivist paradigm which is typically qualitative in nature.

Phase one: systematic review

The first objective of the systematic review was to broadly identify and critically appraise the available evidence on healthcare professionals' perceptions,

attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting. The second objective was to synthesise and present the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to system implementation. While a systematic review can relate to any or all of the above paradigms, the systematic review objectives in this research were exploratory in nature and therefore focused on qualitative research and aligned to the interpretivist paradigm.

Phase two: interviews with local key stakeholders

The objective of phase two was to explore the perceptions of local key stakeholders towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework. NPT is a sociological theory used to understand the implementation, embedding, and integration of new technologies and organisational innovations which is further detailed in this chapter along with the rationale for selection. An interpretivist paradigm was again appropriate for phase two which considered findings from phase one and sought to explore perceptions. Meaning was constructed by participants in the research. Other paradigms did not fit the research objective as hospitals in Ireland have had limited experience with implementing ePrescribing, robotic pharmacy systems, and medication storage and retrieval systems and a more explorative interprtivist approach was considered the most suitable paradigm in order to understand the perceived facilitators and barriers to implementation.

Phase three: interviews with national key stakeholders and eHealth leads

The objective of phase three was to explore the perceptions of national key stakeholders and eHealth leads towards the facilitators and barriers to system implementation in public hospitals in Ireland using NPT as a theoretical framework. This explorative research also maps to the interpretivist paradigm in order to answer the research question appropriately. Other paradigms did not match the research objective as Ireland was at the stage of building momentum towards implementation of electronic systems for medicines management and a more explorative interprtivist approach was considered the most suitable

paradigm in order to understand the perceived facilitators and barriers to implementation.

2.4 Methodology and method

Research methodology is a systematic way to answer a research question. It covers the logic surroundings of how new knowledge is generated, justified, and critically analysed (188). The scope of research methodology extends beyond research methods which are task oriented techniques for collecting and analysing data (202) and includes philosophical paradigms that govern these techniques as a basis for selecting appropriate methods in research.

Methodologies for undertaking research include quantitative, qualitative, and mixed methods research, all with certain strengths and weaknesses. Consideration to the different types of methodologies and associated methods will assist in ensuring the optimum approach is selected when constructing the research design to answer the required research question, as provided in Table 2.2 adopted from Creswell (183). Whilst mixed methods research designs have grown in popularity in recent years in health services, this methodological approach should only be applied if deemed the most relevant and appropriate to address the research aim and objectives (203). Combining methodologies has also been difficult because of the view that quantitative and qualitative methodologies belong to separate and incompatible paradigms. Researchers subscribing to this view argue it is not possible to combine both methodologies as they represent essentially different and conflicting ways of viewing the world and how data is generated (203). Other researchers take a more pragmatic view, believing that these concerns of incompatible worldviews can be lessened if the combination of quantitative and qualitative designs addresses the research question effectively.

The topic of this research merits a qualitative approach as the research aim is exploratory in nature. Little research has been previously carried out in this area necessitating further understanding and in-depth rich descriptions characteristic of qualitative research. Aspects relevant to this thesis will now focus on the rational for selecting the methodology and methods employed in order to justify, guide, and achieve the objectives set out at the onset.

Table 2.2: Research methodologies adopted from Creswell

Quantitative	Qualitative	Mixed Methods
Experimental designs Non experimental designs e.g. surveys	Narrative research Phenomenology Grounded theory Ethnographic Case study	Convergent Explanatory sequential Exploratory sequential Transformative, embedded, or multiphase

2.4.1 Overall research methodologies employed in current research

Phase one

Content of the systematic review was qualitative in nature and employed a narrative design.

Phase two

Qualitative interviews with local key stakeholders utilised a phenomenological design with the phenomenon being perceptions of implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland.

Phase three

Phase three consisted of interviews with national key stakeholders and eHealth leads and was also qualitative in nature, utilising a similar phenomenological design.

These qualitative methodologies and methods are now described and justified in greater detail.

2.5 Systematic reviews

Systematic reviews occupy the highest hierarchy in terms of quality of evidence and are a cornerstone of the evidence-based practice and policy movement. Cochrane describes systematic reviews as:

> "*a high-level overview of primary research on a particular research question that tries to identify, select, synthesize, and appraise all*

high quality research evidence relevant to that question in order to answer it" (204).

Narrative reviews provide an overview of research methodologies, methods, findings, and interpretation within a research field by experts using their knowledge and experience which can introduce a high degree of bias (205). In contrast, a systematic review attempts to cover all known literature on the specific topic and details its design and methods explicitly for future quality assessment. Several organisations have been established to support systematic reviews in healthcare inclusive of the Cochrane Database of Systematic Reviews (CDSR), the University of York's Centre for Reviews and Dissemination (CRD), and the Joanna Briggs Institute (JBI).

The CDSR is a database of primary research systematic reviews in healthcare and health policy provided by the Cochrane Collaboration which has been established for over 20 years (206). Cochrane Ireland supports activities of the Cochrane Collaboration in Ireland by providing training and support to ensure systematic reviews underpin policy, practice, and decision-making. The primary researcher undertook a two-day Cochrane Systematic Review course in Ireland prior to commencing phase one (Appendix 2.1).

The CRD was also established over 20 years ago and aims to provide evidence-based systematic reviews and meta-analysis of healthcare interventions via three databases: Database of Abstracts of Reviews of Effects (DARE); NHS Economic Evaluation Database (NHS EED); and Health Technology Assessment (HTA) Database. The systematic review protocol in phase one of this research was registered with the CRD (Appendix 3.1) and is available online (207).

The JBI collaborates with over 80 entities globally to promote and support the synthesis, transfer, and use of evidence through identifying effective healthcare practices to assist in the improvement of healthcare outcomes internationally (208). This includes translational science, synthesis science, implementation science, software for healthcare professionals, and promoting evidence-based practice. The JBI is affiliated with the Scottish Centre for Evidence-based Multi-professional Practice in Robert Gordon University (RGU) which includes training in conducting systematic reviews and promotion of implementation of findings

into practice (209). The primary researcher undertook training with JBI in RGU prior to commencing phase one (Appendix 2.1).

2.5.1 Scoping reviews

A fundamental step in the systematic review process is to comprehensively define the scope of the research aim. This requires consideration of existing literature, including gaps in the literature, clarification of definitions related to the research aim, and an understanding of how these are conceptualised within existing literature (210). An increasingly popular way to retrieve background information and obtain existing evidence is to conduct a scoping review, defined as a process of mapping the existing literature or evidence base (211). Scoping reviews are commonly used to clarify working definitions and conceptual boundaries of a field and are particularly useful for determining the value and probable scope of a full systematic review (212).

2.5.2 Overcoming challenges of systematic reviews in qualitative research

Qualitative research has been increasingly recognised as having a distinctive and important contribution in healthcare research as a means to explain processes and outcomes, and enhance the link between evidence and practice (213)(214). Qualitative research can contribute to systematic reviews by (214)(215):

- informing reviews and ensuring reviews include appropriate studies to maximise relevance
- enhancing reviews by synthesising evidence
- extending reviews by undertaking a search to address research questions
- supplementing reviews by synthesising evidence within a stand-alone, but complementary, qualitative review to address research questions

Nonetheless, evidence-based practice, defined as *"the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients....from systematic research"* (216), strongly asserts that primary research based on RCTs is the most appropriate method to determine the effectiveness of interventions (217). Qualitative research has traditionally been excluded from systematic reviews and concerns have been documented

about the scope of this evidence base, including the need to incorporate more qualitative research in clinical practice (218)(219). For example, only five qualitative studies out of 76 studies investigating potential barriers to guideline adherence were included in a systematic review by Cabana et al in 1999 (220) and no Cochrane review template is currently in place for qualitative evidence exclusively (214).

Much effort is now being invested into resolving the methodological and epistemological challenges associated with more inclusive forms of review, such as methodological prejudice, problems with searching for qualitative evidence, and issues with synthesising qualitative data (213)(221).

2.5.3 Narrative approaches to synthesis of qualitative evidence

The synthesis of qualitative research is an area of debate and evolution (214).

In this research, a narrative synthesis of the systematic review was carried out to provide an analysis of included studies, and an overall assessment of the rigour of the evidence. Narrative synthesis relies primarily on the use of words and text to summarise and explain, or to 'tell the story', of findings of multiple studies (222).

Weaknesses of this type of synthesis include potential lack of transparency and clarity of methods employed (221) and formal guidance used on how to conduct such synthesis (223). Guidance from Popay et al (222) was applied to this systematic review which provides details on how narrative synthesis can be conducted in a more systematic and transparent way, focusing on implementation of interventions (Table 2.3).

Table 2.3: Tools and techniques for narrative synthesis adopted from Popay et al (222)

Element of synthesis	Suggested tools and techniques
Developing a preliminary synthesis of findings	Textual description of studies, tabulation, transforming data into a common rubric, thematic and content analysis for translating data
Exploring relationships in the data	Subgroup analyses, idea webbing and conceptual mapping, qualitative case descriptions, investigator triangulation
Assessing robustness of synthesis	Weight of evidence, best evidence synthesis, validity assessment, reflecting critically on the synthesis process, checking the synthesis with authors of primary studies

2.6 Qualitative methodology

2.6.1 Main features of qualitative research

Qualitative research is interested in idealism and inductive reasoning and is an approach for exploring and understanding the meaning individuals ascribe to a social or human dilemma. This type of research has been defined as inductive, subjective, and contextual (183). The process of research is flexible in structure and involves emerging questions to data analysis where the researcher interprets meaning of the data. Hence, the researcher is characteristically involved in a continued and intensive experience with participants and acts as the instrument of data generation.

Table 2.4 provides an overview of qualitative research methodologies adopted from Creswell (183). Included are narrative, phenomenology, grounded theory, ethnography, and case study designs. Starks et al propose phenomenology and grounded theory are most suitable for qualitative research in healthcare (224).

Table 2.4: Qualitative research methodologies adopted from Creswell (183)

Design	**Narrative**	**Phenomenology**	**Grounded theory**	**Ethnography**	**Case study**
Aim	Exploring the life of participants	Understanding experiences about a phenomenon usually obtained by interviews	Developing a theory grounded from data in the field via multiple data generation periods	Study of a culture or social group in the natural environment of participants	In-depth long-term study of a single case or multiple cases
Main methods of data generation	Story collection via interviews and document analysis	Interviews and focus groups	Interviews and focus groups	Observations and interviews	Document analysis, archival records, interviews, and observations
Approaches to data analysis	Stories and historical content	Statements, meaning, essence description, themes and coding	Open coding, axial coding, selective coding, and conditional matrix	Detailed description of setting/group, analysis, and interpretation	Detailed description of setting/ individual, themes, and assertions
Approaches to data interpretation	Conceptual to form a detailed picture of a participants life	Themes categorised and described	Probability of concepts or a theoretical model	Themes categorised and described	Themes categorised and described

In comparison to quantitative studies which generate findings from statistical analysis, qualitative research investigates the *why* and *how* of decision-making. Smaller more focused samples are typically used covering a range of philosophies, research designs, and specific techniques where data are either naturally occurring, such as observation and document analysis, or generated, such as in-depth interviews intended to elicit views and opinions from participants (136)(214)(222). Little emphasis is put on predefined concepts of a research project. Instead, hypotheses are developed and refined as the research progresses (195).

Like all research approaches, advantages and limitations arise depending on the type of research methods selected. The main drawbacks in qualitative research relate to data generation and analysis being relatively time consuming and dependent on the skills of the researcher to extract valuable information (197). It does however provide depth and detail on little known topics or complex issues and stimulates participants' individual experiences in a natural environment creating an openness to related issues (194)(200). As a result, qualitative research has gained in popularity for studying complex human interactions in health services (225).

Grounded theory was rejected in this doctoral research as there was no attempt to generate theory. Instead, a qualitative phenomenological approach was employed in phase two and phase three to facilitate generation of in-depth rich data to understand and describe participants' perceptions towards the facilitators and barriers to system implementation in hospitals in Ireland. Moustakas describes this approach as returning to the participants' experience in order to obtain comprehensive descriptions which then provide the basis for a reflective structural analysis to portray the essences of the experience (226).

2.6.2 Qualitative methods

2.6.2.1 Data generation

Healthcare professionals seek evidence to substantiate the worth of interventions, thus the type of evidence needed depends on the purpose and nature of the activity under enquiry. The most common approaches to interpretive phenomenology

include focus groups and in-depth interviews to elicit perceptions and views from participants.

Focus group discussions have gained in popularity for the initial exploratory phase of research to develop topics for inclusion in surveys (227). This approach explicitly uses group interactions as part of the method, usually with six to eight participants (183). Individual participants are encouraged to ask questions, exchange anecdotes, and comment on each others' experiences and points of view (228). Focus groups have been reported to require greater skills on the part of the researcher to control group discussions, manage any effect of dominant group members, and encourage reserved participants to express their opinions (229)(230). In addition, micro-analysis of the differences in individual views is difficult to undertake (231).

Individual face-to-face interviews have been the dominant mode of data generation and many authors hold this method of interviewing in qualitative research as the gold standard to elicit comprehensive exchanges between the researcher and participants (232)(233). Researchers can take added advantage of non-verbal cues from participants to gain in-depth insight into the data. Limitations include both time and expense (234). The use of online interviews via video conferencing is another adaptation to qualitative data generation brought about by technological advances in the research world which overcomes time, financial, and geographical constraints. However, the relative anonymity of online interactions may increase presentation of self and authenticity compared with face-to-face interviews (235). Telephone interviews are an equally efficient and cost-effective method but are largely neglected in qualitative research literature as an alternative to face-to-face interviewing due to the absence of visual cues and loss of contextual and nonverbal data potentially compromising rapport, probing, and interpretation of responses (236). A study by Irvine in 2011 reviewing the duration, dominance, and depth of talk between researcher and participant when comparing telephone and face-to-face interviews found telephone interviews were typically shorter as a result of participants speaking for less time and providing relatively less detail or elaboration (237).

Table 2.5 illustrates the strengths and weaknesses of focus groups and in-depth interviews adopted from Creswell (183), Bowling (194), and Irvine (238).

Table 2.5: Strengths and weaknesses of focus groups and in-depth interviews adopted from Creswell (183), Bowling (194), and Irvine (238)

Type	**Appropriate for**	**Strengths**	**Weaknesses**
Focus groups	Identifying group norms	Elicits information on norms and opinions in a short time	Requires a good interviewer to guide group and extract maximum relevant information
	Eliciting opinions on group norms Discovering variety within a population	Group dynamic stimulates conversation, reactions	Trustworthiness can be reduced as participants may only offer desirable answers in a group setting
In-depth interviews	Eliciting individual experiences, opinions, feelings	Eliciting in-depth responses	Can be costly and labour intensive
	Addressing sensitive topics	Explores interpretive perspectives, e.g. the connections and relationships individuals see between particular events, phenomena, and beliefs	In jeopardy of personal biases and poor interview skills Participants may have poor recall of important information

The format is typically structured, semi-structured, or unstructured where interviews are recorded and transcribed, as summarised in Table 2.6 adopted from Bowling (194).

Table 2.6: Comparisons of different interview types adopted from Bowling (194)

Type	Structured	Semi-structured	Unstructured
Description	A set of predetermined questions on a specific topic asked in a standard way	A set of predetermined questions with the ability for more in-depth questioning as topics arise	Open questions for in-depth responses from participants usually about a relatively unknown topic
Data generation tool	Questionnaire	Interview schedule	Interview guide
Advantages	Interviewer predetermines fixed questions with fixed order, control lies with interviewer	More open questioning, order can vary, control lies with interviewer and participant	Non leading in-depth interviews, control lies with participant
Disadvantages	Data likely to be coded in advance, lacks flexibility limiting depth	May be time consuming, reliant on skill of interviewer for trustworthy responses	Lack of consistency in approach and fixed order of questioning

As focus groups are more suitable for studying how views are created and modified and may potentially inhibit participants when openly sharing information with others (233)(238)(239), individual face-to-face semi-structured interviews were considered the most appropriate method for phase two and phase three to achieve the overall research aim. This in-depth approach allows participants time to express their own views on the subject and facilitates the generation of high quality, comparable data which is useful for understanding the viewpoint and experiences of individuals.

2.6.2.2 Sampling in qualitative research

Most research methods require sampling due to large population sizes and inability to research select groups in its entirety. Qualitative research seeks to understand complex human issues through a detailed study of several participants rather than capturing a representation of the general population. Non-probability sampling is commonly employed in qualitative research using non-random techniques to select participants, such as purposive sampling, snowball sampling, and convenience sampling as illustrated in Table 2.7 adopted from Morgan (240).

Purposive sampling entails selecting participants intentionally based on their experiences and interest in the subject, often chosen to reflect varied perspectives in order to achieve maximum variability and enhance data quality (241)(242). Starks et al suggest purposive sampling should be used in qualitative research in healthcare settings to capture participants who have knowledge of the investigated experience (224). Snowball sampling, also referred to as chain referral sampling, is a type of purposive sampling that relies on recruiting well-informed participants who then suggest other people of interest to be recruited. Participants are usually difficult to find or not easily accessible through other sampling strategies (183)(194)(243). Both sampling types are vulnerable to selection bias and confounding variables. Convenience sampling, the selection of the most accessible subjects, is resource efficient in terms of time and economics but is the least rigorous technique as participants are not necessarily representative of the population which may result in poor data quality (241).

Table 2.7: Non-probability sampling adopted from Morgan (240)

	Description	**Common Usage**	**Strengths**	**Weaknesses**
Purposive	Participants selected based on a particular goal and their perceived relevance to the study	Small, specific populations with a certain goal, more accurate findings	Often cheap and efficient, more accurate results with select group	Vulnerable to research bias, high risk of sampling error
Snowball	Subsequent participants identified from response of initial participants	Small, difficult to access populations	Low cost, access to difficult to reach participants	High risk of sampling error, subject to participant bias, limits transferability
Convenience	Participants selected based on ease of accessibility	Pilot studies	Easy to recruit, efficient, cheap	Least dependable, high risk of sampling error

Purposive sampling was employed in phase two and phase three of this research in order to explore a range of key stakeholders' perceptions towards system implementation and generate rich data.

2.6.2.3 Sample size in qualitative research

Debates continue about what constitutes an adequate sample size in qualitative research which is predominantly dependant on judgement, experience, research design, methods, and philosophical beliefs (244)(245). The intent of data generation is to gather extensive information from a sample size appropriate to answer the research question. Issues such as ethics, time, and cost may arise if the sample is larger than required. Creswell states that sample size depends on the qualitative design employed and that narrative research generally includes one or two individuals, phenomenology typically ranges from three to 10 participants, grounded theory varies from 20 to 30, ethnography examines one single group, and case studies includes approximately four to five cases (183). Another approach to sample size is data saturation derived from grounded theory where data generation ceases when themes are saturated with no new insights (183)(246)(247). Francis et al propose specifying a minimum sample size for initial analysis for theory-based studies and then specifying how many more interviews will be conducted without new ideas emerging, referred to as the stopping criterion. They found data saturation was achieved after 17 interviews and suggest using an initial analysis sample of 10 and a stopping criterion of three (246).

2.6.2.4 Approaches to data analysis in qualitative research

With the exception of grounded theory, data analysis in qualitative research involves reducing large data generations and coding data into a small number of themes via relevant theoretical frameworks. Creswell suggests an average of five to seven themes as an appropriate number (183). Qualitative software programmes, such as QSR NVivo, are a popular method to organise, sort, and search for data in text databases.

Methods of data analysis include content analysis, grounded theory, thematic analysis, and framework analysis (194). Content analysis is a method used to

identify patterns across qualitative data by coding data to themes and analysing accordingly (230). This type of analysis tends to focus at a micro-level, often providing counts (248), and allows for quantitative analysis of initially qualitative data (249). Grounded theory analysis commences as soon as data generation begins and involves searching for codes, concepts, and categories within the data with no preconceived hypothesis (250). The coding approach is a form of content analysis.

Thematic analysis is the most traditional method of analysis for qualitative studies which consists of arranging data content into themes (251). The six phases in thematic analysis adopted from Braun and Clarke are illustrated in Table 2.8 (251).

Table 2.8: Phases of thematic analysis adopted from Braun and Clarke (251)

	Phase	**Description**
	Familiarisation of data	Transcribing data, reading and rereading the data, noting down initial ideas
	Generating initial codes	Coding interesting features of the data in a systematic way across the entire data set, collating data relevant to each code
	Searching for themes	Collating codes into potential themes, generating all data relevant to each potential theme
	Reviewing themes	Checking the themes work in relation to the coded extracts and the entire data set, generating a thematic 'map' of the analysis
	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, generating clear definitions and names for each theme
	Producing report	Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back analysis to the research question and literature, producing a scholarly report of the analysis

The framework approach is another method of data analysis similar to thematic analysis, the terms often used interchangeably. Ritchie and Lewis define the framework approach as:

"*a matrix based analytic method which facilitates rigorous and transparent data management such that all the stages involved in the 'analytic hierarchy' can be systematically conducted*" (252).

This approach is increasingly used in health research where data is sifted, charted, and sorted in accordance with key themes using five steps as illustrated in Table 2.9 (252). Generation of descriptions, categories, explanations, and typologies are important features of the framework approach (253). The analytical process begins during transcribing by listening to recordings and reading transcriptions continuously to immerse the researcher in the data. This involves coding of data, a common inductive technique, by reducing data into smaller numbers of themes guided by the research objectives and interview schedule (202). Key themes are listed in columns with each participant assigned to rows usually facilitated through computer assisted qualitative data analysis software such as QSR NVivo®. The framework approach is better adapted to research with defined objectives, a limited time frame, a pre-designed sample, and *a priori* issues (254).

Table 2.9: Phases of the framework approach to data analysis adopted from Ritchie and Lewis (252)

Phase	**Description**
Familiarisation	Transcribing and reading data
Thematic framework	Initial coding framework via *a priori* and familiarisation phase
Indexing	Thematic framework applied to data via codes corresponding to differing themes
Charting	Creating thematic charts for each theme across all respondents or case charts for each respondent across all themes
Mapping and interpretation	Searching for patterns, associations, concepts, and explanations in data via visual aids

The framework approach to data analysis was considered the most appropriate method in phase two and phase three of this research to complement the research phenomenological methodology. It facilitates rigorous and transparent data management ensuring all steps of analysis are systematically conducted

(252)(254). This approach was also considered most suitable since the research was led by predefined objectives and semi-structured interview schedules, thus giving the research more structure.

2.7 Trustworthiness and rigour in qualitative research

Evaluating the quality of research is necessary if findings are to be utilised in practice and incorporated into healthcare delivery. Reliability, validity, and objectivity are common concepts employed by both positivist and post-positivist investigators in order to define the integrity of the research process (255). Many naturalistic researchers have, however, preferred to use alternative terminology to distance themselves from the positivist paradigm and differing ontological and epistemological beliefs. Frameworks for ensuring rigour in qualitative research include Guba's four constructs which correspond to the criteria employed in quantitative research, as illustrated in Table 2.10 and described by Shenton (255). Unlike quantitative researchers who apply statistical methods for establishing validity and reliability of research findings, qualitative researchers aim to apply methodological strategies to ensure 'trustworthiness' of findings (256).

Table 2.10: Constructs to ensure quality in research adopted from Shenton (255)

Qualitative research	**Quantitative research**
Credibility	Internal validity
Transferability	External validity/generalisability
Dependability	Reliability
Confirmability	Objectivity

Qualitative research is often criticised for lacking scientific rigour with poor justification of methods applied, lack of transparency in the analytical process, and findings subject to researcher bias (257)(258). However, qualitative researchers have made provisions to promote credibility and ensure the phenomena under scrutiny has been accurately described, recorded, and analysed. The design, method, and interpretation of data should be systematic and avoid as much researcher bias as possible (194).

Participants should be encouraged to be frank from the outset to ensure honesty of data through direct instructions, developing rapport, and opportunities to withdraw from the study (255). Applying a reflective commentary where the researcher seeks to evaluate the project as it develops with emerging inferences as well as scrutiny of the research by the research team, colleagues, peers, and academics should further enhance credibility. Researchers can also request participants to comment on data transcription and interpretation (255).

Triangulation is a powerful strategy for enhancing credibility, based on the idea of convergence of multiple perspectives for mutual confirmation of data to ensure all aspects of a phenomenon have been investigated (259). Denzin (260) and Patton (261) categorised four different triangulation techniques: triangulation of data methods; triangulation of data sources; theoretical triangulation; and triangulation of investigators. The former is the most commonly employed, where data generated by various means such as interviews and observations are compared in order to contribute to in-depth understanding of the topic under investigation. Triangulation of data sources capitalises on the range of data that may contribute to complete understanding of the concept and is reliant on variety in time, space, and person. Examples of triangulated sources include sampling of a range of heterogeneous participants in different organisations to form a rich picture of the perceptions and needs of those being interviewed. This may reduce local factors specific to an establishment and provide a variety of perspectives to achieve a more comprehensive view of 'reality'. Theoretical triangulation allows ideas from diverse or competing theories be tested. Triangulation of investigators occurs in a study in which data are analysed by a research team, often with a diversity of approaches, rather than by a single individual (259)(260)(261).

Bias arises when systematic error is introduced by selecting or encouraging one outcome or answer over another and is a threat to credibility (262). This can transpire at any phase of research, including study design, data generation, data analysis, interpretation, and publication, as illustrated in Table 2.11 adopted from Bowling (194). In all steps, the qualitative researcher remains aware and sensitive to any personal presumptions, biases, and potential influences on response of

participants and considers the degree to which bias was prevented or minimised by appropriate study design and implementation, and how bias might influence a study's conclusion (263).

Table 2.11: Types of bias in qualitative research adopted from Bowling (194)

Type of bias	**Description**
Acquiescence response set	Tendency of a participant to agree with a statement when in doubt, *'yes-saying'*
Design bias	Use of inappropriate methods, sampling, or analysis
Evaluation apprehension	Anxiety may result in participants providing responses which they feel are expected rather than their actual opinion on the topic in question
Interviewer bias	A partiality towards a preconceived response based on the structure, phrasing, or tenor of questions asked by the interviewer e.g. leading questions
Non-response bias	Effective sample size reduced due to invitees not responding
Publication bias	Published literature likely to contain only positive results and not negative studies
Recall (memory) bias	Selective memories in recalling previous occurrences, experiences, and conduct
Reporting bias	Failure of the participant to reveal full information or disclose requested information
Sampling bias	Non-representative selection of participants. Unequal opportunity for all of the population of interest to be included in the sample

Transferability describes the extent to which findings can be applied to other contexts and settings. Silverman considers the ability of the researcher to relate findings to an existing body of knowledge as a key criterion for evaluating qualitative inquiry (264). As the tendency to use small sample sizes in qualitative research can make transferability difficult, the provision of background data to establish the context of the research and a detailed description of the phenomenon in question should assist in transferability and allow comparisons be made with other research (255). This detail should include the number and location of

organisations participating, participant inclusion and exclusion criteria, sample size, and data generation such as the number and length of interviews and the time period over which the data will be collected to convey the boundaries of the study (255). Awareness of potential ethical issues with identification of data sources such as participants or settings should be considered when detailing the phenomenon.

Dependability can be increased by providing in-depth methodological descriptions of the research inclusive of design, details of data generation, and reflective appraisal of the research. This in-depth methodological description and self-reflection of the effectiveness of the data generation process will facilitate repeatability (255). It can also enhance confirmability by allowing integrity of the findings to be scrutinised from data generated rather than the biases and preconceived notions of the researcher. Techniques for promoting confirmability include triangulation, self reflection and awareness of ethical issues, and details of all research processes (255).

The principles provided in Table 2.12 adopted from Creswell (183) and Guba (255) have been applied in phase two and phase three of this research as detailed in Chapter 4 and Chapter 5. The consolidated criteria for reporting qualitative research (COREQ) was also applied which comprises a 32-item checklist for in-depth interviews. The checklist relates to important aspects of sampling method, setting for data generation, method of data generation, respondent validation of findings, method of recording data, description of the derivation of themes, and inclusion of supporting quotations (265).

Table 2.12: Quality framework in qualitative research adopted from Creswell (183) and Guba (255)

Quality Framework	Researchers' responsibility
Credibility	▪ Adoption of appropriate research methods ▪ Familiarity with the culture of participating organisations ▪ Appropriate sampling e.g. purposive ▪ Triangulation of data sources via different participants and settings ▪ Strategies to assist in the honesty of participants e.g. use of probing questions to elicit information from interviewees ▪ Use of reflective commentary and scrutiny of project ▪ Background, qualifications, and experience of researcher ▪ Checks of data generated and interpretations formed ▪ Examination of previous research to frame findings
Transferability	▪ Background data and thick description of phenomenon under scrutiny and study design
Dependability	▪ Employment of overlapping methods ▪ In-depth methodological description to allow the study be repeated ▪ Content credibility and regular reflection of interview schedules by research team
Confirmability	▪ Triangulation of data sources to reduce effect of researcher bias ▪ Admission of researchers' beliefs and assumptions ▪ Recognition of limitations in methods ▪ In-depth methodological description to allow integrity of research results be scrutinised ▪ Transcriptions and interview recordings reviewed for dependability by research team

2.8 Theory in qualitative research

There are numerous definitions of theory. Meleis defines theory as:

> "*An organized, coherent, and systematic articulation of a set of statements related to significant questions in a discipline that are communicated in a meaningful whole. It is a symbolic depiction of aspects of reality that are discovered or invented for describing, explaining, predicting, or prescribing responses, events, situations, conditions, or relationships. Theories have concepts that are related to the discipline's phenomena*" (266). Creswell states theory is "*a scientific prediction or explanation for what the researcher expects to find*" (183).

Theories can provide useful 'lenses' to assist researchers in focusing on particular aspects of complex systems and enhance rigour and impact of findings. Adopting this theoretical perspective can be applied at various stages of the research process and can offer a rationale for conducting the study, determining the research aim and questions, defining the methodology, developing data generation instruments, and providing a framework for data analysis and interpretation (267)(268)(269). The criteria for 'good theory' has been expressed as being explanatory by providing reasoning around variables and effects; plausible by providing meaningful explanations which are consistent with existing evidence; explicit by summarising, explaining, and organising facts; and parsimonious by using variables which are arranged simply to explain effects (270)(271).

In qualitative research, theory is influenced considerably by ontological and epistemological positioning and its associated methodologies (272)(273)(274). Sandelowski states theory provides justification for the methodological approach and is derived from the researcher itself or enters from the outside (275). Theory may also be central or only peripheral to the phenomena under study, thus, it is not always clear when theory entered or left a study (275).

Despite significant promises for improved healthcare quality and efficiency with eHealth technologies, concerns about the large numbers of pilot studies that fail to lead to sustainable services are repeatedly expressed (276). The bridge between research evidence and practice remains wide (111). In attempting to address such problems, the field of 'implementation science' is now fast growing as researchers investigate issues relating to the implementation of healthcare interventions and the science behind implementation processes via the application of theory. Nilsen describes five categories of theoretical approaches that can be used in implementation science: process models; determinant frameworks; classic theories; implementation theories; and evaluation frameworks, as illustrated in Table 2.13 (277). Other theoretical diversity include approaches relating to technology design and its relationship with human actors (278)(279), and psychological theory on individuals attitudes and behaviours (280)(281), particularly with regard to healthcare professionals' perceptions towards evidence-based practice (282)(283).

These theoretical approaches conceptualising the interaction between technology, human factors/ergonomics, and organisations include diffusion of innovations; sensemaking; social shaping of technology; sociotechnical changing; technology acceptance model; and the notion of 'fit' (140).

Table 2.13: Five categories of theories, models, and frameworks used in implementation science adopted from Nelsen (277)

Category	Description	Examples
Process models	Specific steps in the process of translating and implementing research into practice	The Canadian Institutes of Health Research Model of Knowledge Translation; the Knowledge to Action Framework; the Stetler Model; the Academic Center for Evidence-Based Practice (ACE) Star Model of Knowledge Transformation; the Iowa Model; the Ottawa Model; the Quality Implementation Framework
Determinant frameworks	Understand and explain influences on implementation outcomes, e.g. predicting or interpreting outcomes retrospectively by specifying enablers and barriers (independent variables) that influence implementation outcomes (dependent variables)	Consolidated Framework for Implementation Research; Theoretical Domains Framework (TDF); Promoting Action on Research Implementation in Health Services; Active Implementation Frameworks; Understanding-User-Context Framework; Conceptual Model; Cochrane Framework; Ecological Framework
Classic theories	Theories that originate from fields external to implementation science, e.g. psychology, sociology, and organisational theory, to provide understanding and explanation of aspects of implementation	Theory of Diffusion; social cognitive theories; theories concerning cognitive processes and decision-making; social networks theories; social capital theories; communities of practice; professional theories; organisational theories
Implementation theories	Theories developed by implementation researchers to provide understanding /explanations of adoption	NPT; Implementation Climate; Absorptive Capacity; Organizational Readiness; Capability, Opportunity, Motivation, Behaviour (COM-B)
Evaluation frameworks	Specify aspects of implementation to evaluate implementation success	Reach Effectiveness Adoption Implementation Maintenance (RE-AIM); Predisposing Reinforcing and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation-Policy Regulatory and Organizational Constructs in Educational and Environmental Development (PRECEDE-PROCEED)

Overall, there is no overarching conceptual framework in relation to eHealth implementation. The main tensions of various theoretical considerations include: a focus on relatively linear stages and integration of technology over time, with some theories focusing on exploring one feature of the lifecycle in detail; a focus on individual adopters in isolation; a focus on complexity and unpredictability of the change process; and frameworks seeking to be as inclusive as possible resulting in less specificity (140).

With consideration to the above and additional theories researched, three of the most suitable theoretical frameworks were contemplated to best match the overall research aim and the objectives for phase two and phase three: TDF; NPT; and a general theory of implementation.

2.8.1 Theoretical domains framework

TDF was developed in 2005 by a group of psychological theorists, health service researchers, and health psychologists as a framework rather than a theory to "*…simplify and integrate a plethora of behaviour change theories and make theory more accessible to, and usable by, other disciplines*" (284). TDF is derived from 33 theories of behaviour change used extensively within healthcare intervention implementation (285)(286). However, many healthcare interventions are more complex than just the behaviour of individuals, such as systems ergonomics and socio-organisational factors.

2.8.2 Normalization process theory

Interventions aimed at changing the behaviour of healthcare professionals have had limited success (135)(287)(288). A lack of robust research-based theoretical frameworks to explain change beyond the narrow focus of individual behaviour is of particular significance given the current need for systematic, theoretically informed studies on the applicability of research-based knowledge to routine clinical practice (289)(290). NPT, a middle-range theory of socio-technical change, provides one such framework for understanding why healthcare interventions are accepted and embedded routinely in organisations and others rejected (291). It focuses on work that individuals and organisations must perform for a new technology or practice to

become embedded and sustained in routine practice and is used as a conceptual framework to explore the gap between health research evidence, policy, and practice (292). It targets implementation of an intervention into routine practice through four generative constructs: coherence (sense-making, shared beliefs of process aims); cognitive participation (relational work, who does what); collective action (operational work, what they do); and reflexive monitoring (appraisal work, how outcomes are assessed). The principal constructs and components of NPT are summarised in Table 2.14 adopted from Mair et al (141). Interventions are more likely to be sustained with consideration to these aspects.

NPT concentrates on what people actually do rather than what they think. It helps to explain which factors promote and prevent the adoption of innovations with an emphasis on early and subsequent phases of implementation that lead to new ways of working and long-term sustainability. It can be used to develop interview schedules, coding and analytical frameworks, and considers the interpretation and impact of research findings. A NPT user manual is available online with further explanations of its use (293).

Table 2.14: NPT constructs and components applied to this doctoral research adopted from Mair et al (141)

Coherence (Sense-making work)	**Cognitive participation (Relationship work)**	**Collective action (Enacting work)**	**Reflexive monitoring (Appraisal work)**
Differentiation Is there a clear understanding of how the new eHealth system differs from existing practice?	**Enrolment** Do individuals buy-in to the idea of the eHealth system?	**Skill set workability** How does the eHealth system affect roles and responsibilities or training needs?	**Reconfiguration** Do individuals try to alter the new service?
Communal specification Do individuals have a shared understanding of the aims, objectives, and expected benefits of the eHealth system?	**Activation** Can individuals sustain involvement?	**Contextual Integration** Is there organisational support?	**Communal appraisal** How do groups judge the value of the eHealth system?
Individual specification Do individuals have a clear understanding of their specific tasks and responsibilities in system implementation?	**Initiation** Are key individuals willing to drive implementation?	**Interactional workability** Does the eHealth system make people's work easier?	**Individual appraisal** How do individuals appraise the effects of the eHealth system on them and their work environment?
Internalization Do individuals understand the value, benefits, and importance of the eHealth system?	**Legitimation** Do individuals believe it is right for them to be involved?	**Relational integration** Do individuals have confidence in the new system?	**Systematization** How are benefits or problems identified or measured?

NPT is being used in a wide variety of studies inclusive of the implementation of eHealth in secondary care (141). Given its sociological origins, this theory does not focus on the relationship between individual attitudes, intentions, and behavioural outcomes but pays attention to how knowledge is held, transferred, and created within and across professional groups. It also seeks to understand the work that prescribers, implementers, and patients alike have to engage in to implement new knowledge in practice. NPT was applied in phase two and phase three of this doctoral research to compliment and best fit the objectives.

2.8.3 A general theory of implementation

NPT has been further extended to include a general theory of implementation developed by May comprising four constructs: *capacity* which is dependent on individuals working together collectively to make implementation successful; *potential* which is dependent on individual's ability to implement or use the complex innovation; *capability* which concerns whether the innovation is workable in practice and if it can be subsumed into the local context; and *contribution* which is dependent on individuals continuing to engage and develop the complex intervention (294). A literature search identified this theory has had limited use in eHealth implementation.

2.9 Chapter summary

The alignment of philosophical belief with the research aim and objectives puts forward qualitative methodology as the most suitable approach. Phase one, the systematic review, was exploratory in nature and aligns to the interpretivist paradigm employing a narrative design. Interpretive phenomenology of individual face-to-face semi-structured interviews was selected for phase two and phase three so that the perceptions of key stakeholders involved in system implementation could be fully understood and described. NPT was selected as the theoretical framework of choice for designing the interview schedules and analysing findings. This explanatory framework was applied in order to assist in understanding perceived facilitators and barriers described within this research and inform future implementation. The framework approach to data analysis was considered the most

appropriate method to complement the research phenomenological methodology and semi-structured interview schedules, thus giving the research more structure.

Trustworthiness and rigour were addressed in the form of Guba's four constructs: credibility; transferability; dependability; and confirmability (255). These constructs were enhanced by triangulation of data methods involving the use of findings from the systematic review and individual face-to-face semi-structured interviews; triangulation of data sources comprising heterogeneous participants in diverse settings; and triangulation of investigators with multiple research team analysts. This assisted in understanding the perceptions of healthcare professionals responsible for system delivery as well as end-users, and in enhancing the contextual data relating to individual organisations.

Peer and academic scrutiny of the research project continued to be welcome in order to refine the methods employed, develop a greater explanation of the research design, and strengthen arguments as necessary. A reflective commentary inclusive of progressive subjectivity and monitoring of the primary researchers developments via research experience and expanding research skills further assisted in ensuring trustworthiness and credibility. Examination of previous research findings allowed comparisons and contrasts to be made to current findings with reasons provided.

Figure 2.1 summarises the paradigms, methodologies, and methods applied to phase one, phase two, and phase three of this research.

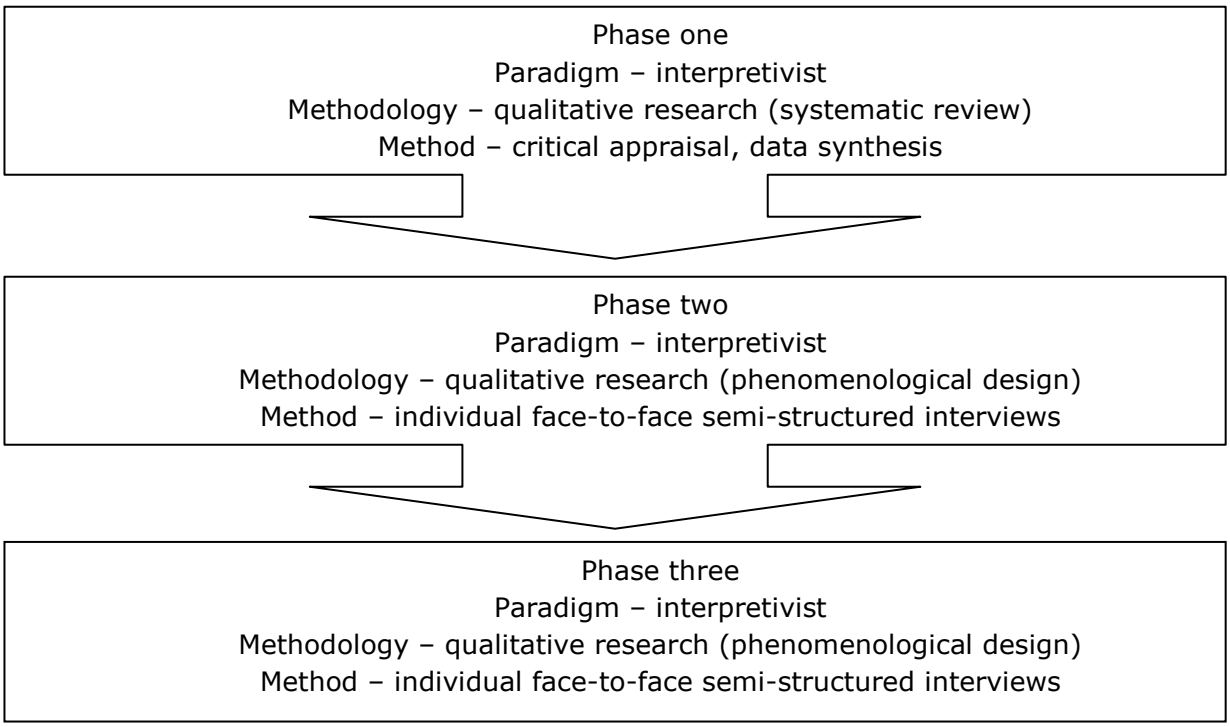

Figure 2.1: Paradigms, methodology, and methods in research phases

Chapter 3: Systematic review

3.1 Introduction

There are increasing opportunities in the hospital setting to improve medicines management due to advances in eHealth such as the use of ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems. Whilst numerous studies advocate the use of these systems in enhanced efficiency and effectiveness of medicines management and decision-making, their rate of adoption in practice to date has been slow (54)(295). An important theme has been the problem of resistance or refractory behaviours of healthcare professionals and the assumption that their attitudes to eHealth are the root problem (296). Several studies have demonstrated that the implementation process for hospital eHealth systems is important to determine overall success (6)(107)(108)(109)(110).

While several systematic reviews have been published on outcomes such as the effects of ePrescribing, electronic dispensing, or electronic administration of medicines on medication errors and cost, no systematic review and few primary studies have been conducted on healthcare professionals' perceptions of system implementation in a hospital setting (146)(297)(298)(299). Studies that only focused on system implementation were therefore included. Understanding healthcare professionals perceived benefits and concerns could assist in informing and strengthening implementation strategies. It is hoped that findings will be used to improve the current system in hospitals and maximise the adoption and potential use of these eHealth systems in the future.

3.2 Phase one objectives

- Identify and critically appraise the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.
- Synthesise and present the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to

implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.

3.3 Method

3.3.1 Research team

The research team consisted of the primary researcher, three research team members [SC, AT, and AS], and two experts as required [DS and VP].

3.3.2 Database search for pre-existing systematic reviews

In addition to a comprehensive literature search, Medical Literature Analysis and Retrieval System Online (MEDLINE), CDSR, Cumulative Index to Nursing and Allied Health (CINAHL), the International Prospective Register of Systematic Reviews (PROSPERO), and the CRD inclusive of the DARE and HTA were searched for pre-existing systematic reviews on the research subject prior to commencing the review. The initial scoping exercise revealed an under-researched area with the potential for original findings to inform system implementers and end-users of the various facilitators and barriers to adoption.

3.3.3 Review protocol

A systematic review protocol was developed and agreed by all members of the research team. The format of the protocol was based on the CRD's guidance for undertaking reviews in healthcare and principals from the Cochrane Handbook for Systematic Reviews of Interventions (214)(300). The protocol was then registered with PROSPERO (301). This international database aims to provide a comprehensive list of registered healthcare-related systematic reviews in order to avoid duplication and compare submitted review methods with the planned protocol (302). Minor formatting amendments to the review were reported to PROSPERO during the review process (Appendix 3.1).

3.3.4 Inclusion and exclusion criteria

3.3.4.1 Types of participants

All doctors, nurses, pharmacists, and other allied healthcare professionals inclusive of dieticians, podiatrists, physiotherapists, and pharmacy technicians involved in

prescribing, dispensing, and/or administering medicines were included in the review. Non-healthcare professionals were excluded.

3.3.4.2 Phenomena of interest

An exploration of healthcare professionals' perceptions of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting was the main focus of this review. Perceptions included healthcare professionals' attitudes, beliefs, and views. This phenomenon of interest excluded other eHealth systems such as EHRs, CDS, and electronic discharge prescriptions. Studies that did not focus on implementation, for example, clinical and fiscal outcomes and effects on patients and resources, were also excluded.

3.3.4.3 Types of studies

Any study which focused on the phenomena of interest was reviewed. Whilst the area of interest is likely to identify qualitative studies, a broad range of study types included any:

- evaluative study design e.g. RCTs and derivatives
- quasi-experimental studies e.g. non-RCTs, before and after studies
- observational studies e.g. cohort, case-control, case series, and cross-sectional studies
- qualitative studies
- qualitative/narrative reviews
- systematic reviews

Only full text papers were included in the review. Summaries of the literature for the purpose of information or commentary, editorial discussions, and papers whose abstract identified them as reviews but lacked supporting evidence in the main text were excluded. Relevant studies not meeting the inclusion criteria were supplemented where appropriate in the doctoral research.

3.3.4.4 Language

Only studies published in the English language were considered.

3.3.4.5 Context

All types of hospital settings were included. Nursing homes, ambulatory care settings, rehabilitation, and step-down units were excluded.

3.3.5 Search strategy

The following healthcare sources were considered to be the most relevant to identify literature pertaining to the inclusion criteria.

3.3.5.1 Databases

- MEDLINE [via EBSCOhost]

MEDLINE is produced by the United States National Library of Medicine and contains over 14 million references to journal articles in life sciences with citations from over 5,600 worldwide journals (303).

- CINAHL [via EBSCOhost]

CINAHL is produced by EBSCO Publishing Inc. and has more than three million records and indexing for more than 3000 journals relating to allied health-related topics with a focus on nursing literature. It also indexes book chapters, dissertations, evidence-based care sheets, audio-visuals, and journals from 17 allied health disciplines (304).

- International Pharmaceutical Abstracts (IPA) [via EBSCOhost]

IPA is produced in conjunction with the American Society of Health-System Pharmacists and contains 500,000 abstracted and indexed records from over 800 journals in the areas of pharmaceutical, medical, and health disciplines (304).

- PsycArticles [via EBSCOhost]

PsycARTICLES is a database produced by the American Psychological Association, the Canadian Psychological Association, and the Hogrefe Publishing Group with

access to the full text of nearly 200,000 articles from more than 100 journals in behavioural science and related fields including nursing and pharmacy (305).

- PsycINFO

PsycINFO is produced by the American Psychological Association and has more than three million records of peer reviewed literature in behavioural science and mental health (306).

- CDSR

CDSR is part of the Cochrane Library produced by John Wiley & Sons and publishes systematic reviews of primary research in human healthcare and health policy. They are internationally recognised as the highest standard in evidence-based healthcare (204).

- CRD

The CRD database is produced by the University of York and provides access to over 30,000 quality assessed healthcare-related systematic reviews, over 13,000 summaries of completed and ongoing health technology assessments, and the summaries of all Cochrane reviews and protocols (307).

A wide variety of search terms were combined within each of the three main concepts: healthcare professionals; ePrescribing, electronic dispensing of medicines, or electronic administration of medicines; and hospital setting. A MEDLINE search is provided in Appendix 3.2 and summarised in Table 3.1. In order to capture all relevant data, the primary researcher completed a comprehensive tutorial using EBSCOhost. This online information resource is widely used by institutions worldwide allowing for full text journal and electronic book searches (308). No date limitation was applied to the search which was conducted in 2013.

Table 3.1: Search terms using MEDLINE via EBSCOhost

MEDLINE	Search terms (limit English language)
1	(MH healthcare professionals+ OR MH health care professionals+ OR MH healthcare providers+ OR MH health care providers+ OR Healthcare N8 profession* OR Health care N8 profession* OR Health profession* OR Healthcare N8 provider* OR Health care N8 provider* OR Health provider* OR MH doctors+ OR doctor* OR MH clinicians+ OR Clinician* OR MH prescribers+ OR prescriber* OR MH physicians+ OR Physician* OR MH pharmacists+ OR Pharmacist* OR Chemist OR Druggist* AND Apothecary* OR hospital N8 pharmacist* OR Dietician* OR Nutritionist* OR Pharm* N8 technician* OR Chiropodist* OR Podiatrist* OR Physiotherapist* OR MH nurse+ OR (Nurse OR nurses) OR (Dentist OR dentists) OR Radiographer* OR Optometrist*)
2	(MH electronic prescribing+ OR e-prescri* AND eprescri* OR OR robot* AND pharmacy OR medic* OR electronic transfer of prescription* OR ETP OR Electron* N8 prescri* OR E N8 prescri* OR MH electronic administration+ OR electronic administ* OR automated dispens* OR automated dispens* system* OR ((electronic administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR ((bar N5 code N5 administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR electron* N8 prescrib* OR e N8 prescrib* OR ((e N8 admin*) AND (medic* OR drug* or tablet OR remed* OR treat* OR dos*)) OR Ehealth* OR E health* OR Health information technolog* OR HIT OR Mobile technolog* OR Mobile health*)
3	(MH hospital+ OR hospital* OR secondary N3 care OR tertiary N3 care OR ward*)
4	1 + 2 + 3

3.3.5.2 Manual searching of journals

Core journals relating to eHealth were searched electronically and by hand for relevant articles inclusive of:

- International Journal of Medical Informatics
- American Journal of Health-System Pharmacy
- International Journal of Health Care Quality Assurance
- International Journal of Pharmacy Practice

3.3.5.3 Conference abstracts

The following conferences were searched for relevant abstracts both by attendance and electronically.

- International Pharmaceutical Federation Congress
- Health Services Research and Pharmacy Practice Conference
- Healthcare Informatics Society of Ireland Annual Conference, Scientific Symposium & Exhibition
- All Ireland Pharmacy Conference
- Electronic Prescribing in Hospitals: Moving Forward, Healthcare Conferences UK, London
- Hospital Pharmacy Association of Ireland Conference

3.3.5.4 Other sources

Online theses from RGU OpenAir, Electronic Theses Online Service, the Directory of Open Access Repositories, Networked Digital Library of Theses and Dissertations, OAIster, Intute, TROVE, and WorldCat were searched for relevant titles.

The bibliographies of relevant full text literature were also screened. Alternative spellings including US and British English variants, abbreviations, synonyms, geographical variation, and changes in terminology over time were accounted for when selecting free text terms.

3.3.6 Study selection

- Stage 1: All identified articles for potential inclusion in the systematic review were imported into 'Refworks' and thereafter exported to Microsoft Excel for title/abstract screening by the primary researcher. Ten percent of the studies were independently screened by SC for relevance in order to enhance trustworthiness of included studies.
- Stage 2: Full texts/abstracts were sought for all studies appearing to meet the inclusion criteria and a final selection for data extraction and quality assessment was independently made by the primary researcher and both SC

and AT by equally dividing the papers between the two research team members to enhance rigour of included studies.

3.3.7 Data extraction

As all eligible studies identified were qualitative in nature, a data extraction form for qualitative studies was developed by the primary researcher and agreed by SC, AT, and AS. The form was designed from a combination of extracts from the CRD's guidance for undertaking reviews in healthcare (300), the JBI Reviewers' Manual (309), and the Cochrane Collaboration Qualitative Methods Group Supplementary Guidance for Inclusion of Qualitative Research in Cochrane Systematic Reviews of Interventions (214). The final studies deemed relevant were extracted independently by the primary researcher and two members of the research team [SC and AT] using the data extraction form and scored for inclusion as either yes, no, or unclear depending on the quality of the study: 0-4 poor quality; 5-6 average quality; 7-10 good quality. Appendices 3.3-3.4 provide a blank data extraction form and a data extraction form for an included paper (310) in the systematic review as examples of this rigorous process.

3.3.8 Quality assessment of identified studies

In order to promote best practice at all stages of the systematic review and consider the trustworthiness of the findings from each of the studies, papers were quality assessed as per the Critical Appraisal Skills Programme (CASP) checklist for qualitative research (311) and scored for inclusion as either yes (2 points), somewhat (1 point) or unclear (0 points). A blank quality assessment form and a completed form for an included paper in the systematic review (310) are provided in Appendices 3.5-3.6 as examples of this rigorous approach.

3.3.9 Data synthesis

Narrative synthesis of the results was conducted involving the collation, combination, and summary of the findings using text and tables. This type of synthesis combines the results of multiple studies and relies primarily on the use of words and texts to summarise and explain findings of the review (222)(312). As all included studies were qualitative in nature, which are commonly text-based and

adopt a narrative approach, this type of synthesis was believed to be the most appropriate. The Guidance on the Conduct of Narrative Synthesis in Systematic Reviews was used as a framework which provides guidance on how narrative synthesis can be conducted in a systematic and transparent way that reduces the potential for bias (222).

3.4 Results

3.4.1 Study origin

A total of 2566 study titles were identified as potentially relevant from seven different databases. Twenty-nine papers were thereafter identified as potentially relevant on the basis of full text. Independent screening resulted in 21 studies being discarded due to inappropriate setting, inappropriate systems, lack of focus on healthcare professionals' perceptions, or mainly due to the retrieval of studies not centred on implementation but focused on outcomes. Eight papers were included for data extraction and quality assessment. Three studies were excluded thereafter due to poor methodological approaches and a lack of integrity of the results post independent analysis by the primary researcher and two membettrs of the research team [SC and AT] (313)(314)(315). Reasoning for exclusion is summarised in Appendix 3.7. Disagreement on inclusion for one paper was independently screened by AT and agreement was reached.

Figure 3.1 illustrates a preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram which represents the flow of information through the different phases of a systematic review and maps the number of records identified, included, and excluded (316). Five studies were included in the final systematic review of which three studies were based in the USA, one in Sweden, and one in Australia. Grey literature and manual searching of key journals did not provide additional literature.

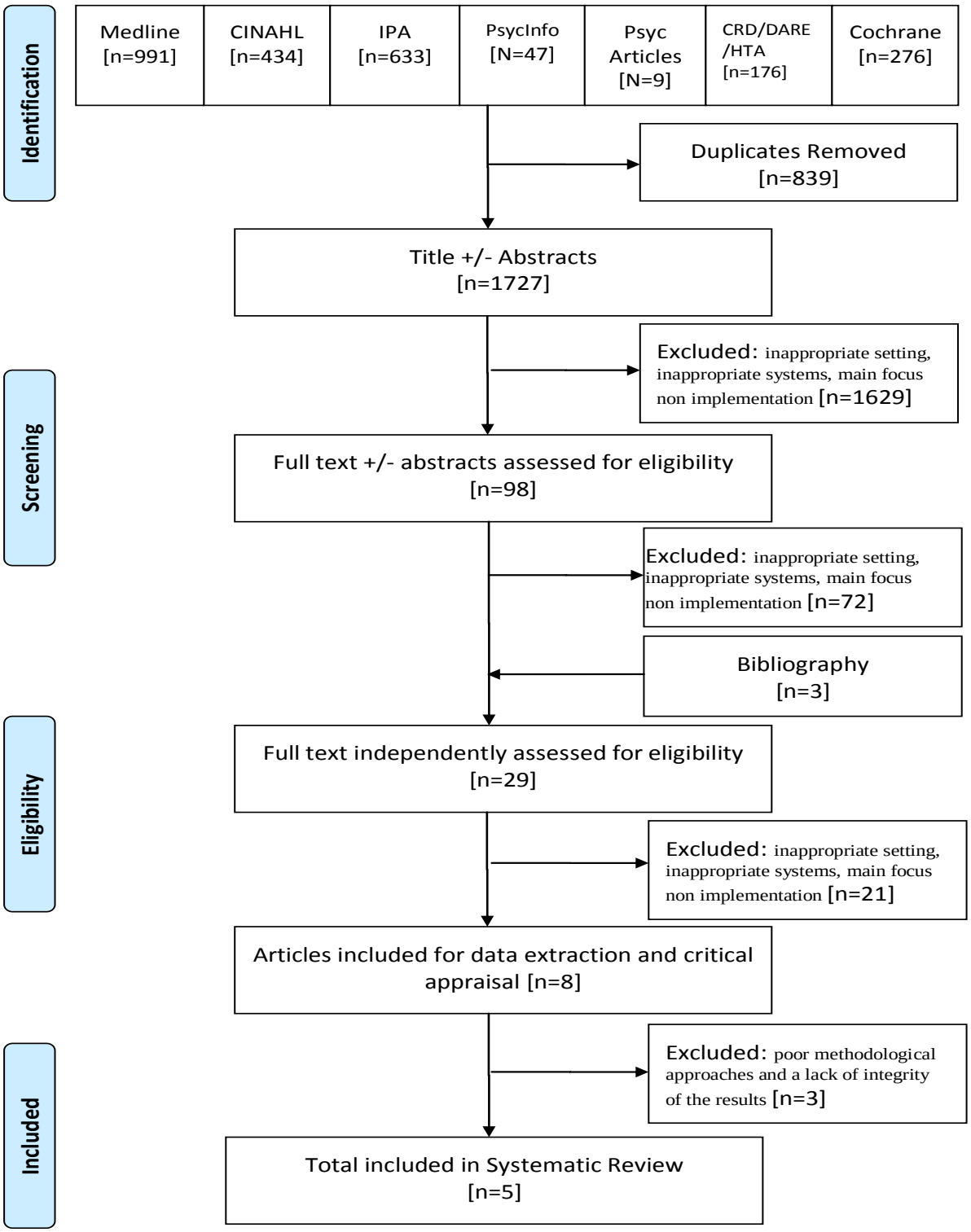

Figure 3.1: PRISMA flow diagram of literature search

3.4.2 Design

Qualitative approaches were employed in all five studies included in the systematic review: semi-structured individual interviews (n=3); semi-structured individual interviews and focus groups (n=1); and open-ended individual interviews and observations (n=1). Table 3.2 provides a summary of the study authors, year, and country of origin, the types of participants, the types of systems, the context, the aim of the studies, the research methods used, and the main findings from each of the included studies.

3.4.3 Study population

Studies focused primarily on nurses, doctors, and pharmacy staff: nurses (n=2), doctors (n=1), and a mix of nurses, pharmacy staff, doctors, managers, and IT staff (n=2). Snowball technique was employed to identify participants in a nursing specific study (317) and chain referral sampling and purposive sampling techniques were used in a study which focused on a mix of healthcare professionals (318). Interview subjects were selected using purposive sampling in a study with a mix of healthcare professionals (319) and by convenience sampling in a study targeting nurses (320). All doctors agreed to participate in a medical specific study which was based in an ED (310).

3.4.4 Types of system implementation

An ePrescribing system with CDS and electronic transfer of prescriptions to pharmacy (310), an ePrescribing system with CDS (318), an automated medication storage and retrieval system (317), an eMAR system with CDS (320), and a barcode medication administration (BCMA) system (319) were included.

3.4.5 Implementation phase

Two studies focused on the pre-implementation phase (310)(318), one study centred on the initial week of implementation with a follow up after three months (317), and the remaining two studies focused on the post-implementation phase at six months and 18 months (320), and more than six years after implementation (319).

Table 3.2: Description of studies included in systematic review

Authors, year, country	Participants	Type of system	Context	Aim	Research methods used	Main findings
Rahmner et al, 2004, Sweden (310)	21 ED physicians	ePrescribing system with CDS and electronic transfer of prescriptions to pharmacies	This pre-implementation study was conducted in the largest ED in the Nordic countries with approximately 90,000 visitors per year. Physicians hand write prescriptions and use a dictaphone for medical record documentation	To identify physicians' perceptions of the various facilitators and barriers prior to system implementation	Semi-structured individual interviews	Facilitators identified included: easy access to a patients' drug history; enhanced pharmacological knowledge from medication alerts; readily accessible information; and time efficiencies Barriers identified included: technical problems; alerts signalled too frequently; shortage of computers in the ED; an alteration to routine and habits resulting in diminished patient contact Technical prerequisites formed the base for successful implementation where time was perceived as a necessary requirement to adapt to new ways of working

Authors, year, country	Participants	Type of system	Context	Aim	Research methods used	Main findings
Malato and Kim, 2004, USA (317)	12 nurses	Automated medication storage and retrieval system	This initial and post-implementation study was conducted in two acute care units in a large 600-bed public acute hospital. Nursing staff administer approximately 300 medications per hour. A paper-based medication system had been replaced by implementation of this system	To examine nurses' perceptions of system implementation	Open-ended individual interviews Observation	Barriers identified included: end-user perceptions of inadequate training; negative experiences of implementation; perceived deficiencies in quality of technology; perceptions of lack of participatory design; and an ensuing circumvention of the new system Facilitators were not included in the scope of this study

Authors, year, country	Participants	Type of system	Context	Aim	Research methods used	Main findings
Georgiou et al, 2009, Australia (318)	50 managerial, medical, nursing, and pharmacy staff	ePerscribing system with CDS	This pre-implementation study was conducted in a large teaching hospital. Initial planning for the new system had been underway for over two years and training had not yet begun for a large majority of staff. The hospital already had a CPOE system in place involving ordering pathology and radiology tests, and diet and allied health requests. Existing medication management was performed using paper charts	To identify the main barriers of a broad range of hospital staff prior to system implementation	20 semi-structured individual interviews 6 focus groups, with a total of 30 participants	Barriers identified included: alteration to work practices; software/hardware concerns; alteration to relationships/communication; requirements for education and training; inexperienced staff ability; and deskilling Four interrelated constructs highlighted what participants were concerned about: if it would help; if it would work; if they could cope; and if it would impair existing interactions Facilitators were not included in the scope of this study

Authors, year, country	Participants	Type of system	Context	Aim	Research methods used	Main findings
Culler et al, 2011, USA (320)	14 nurses	eMAR system with CDS	This post-implementation study was conducted in two large paediatric hospitals which provides for 470,000 patient visits, 23,000 hospital admissions, and >128,000 inpatient days Interviews were conducted at six and 18 months after system implementation	To describe the various facilitators and barriers by nurses to system implementation in two paediatric hospitals	Semi-structured individual interviews	Facilitators included identified: systems ability to improve patient safety; accessibility of patient information The most significant barrier to adoption was excessive time for logging into the system

Authors, year, country	Participants	Type of system	Context	Aim	Research methods used	Main findings
Spetz et al, 2012, USA (319)	118 nursing, pharmacy, medical, IT, and managerial staff	BCMA system	This post-implementation study was conducted in seven of the 162 Veteran Affairs hospitals. Site selection was based on staff satisfaction, survey data, staff turnover, geography, and the level of care provided. A computerised patient record system was implemented over a decade from the early 1990s. The BCMA system was implemented over a one year period	To identify factors and strategies associated with successful system implementation in Veteran Affairs hospitals and how these might apply to other hospitals	Semi-structured individual interviews	Five broad themes arose as factors that affected the process and success of implementation: organisational stability and implementation team leadership; implementation timelines; hardware/software availability and reliability; staff training; and changes in workflow

3.4.6 Data analysis

Thematic analysis (310)(319), content and descriptive analyses (320), concurrent and content analyses (318), and domain analysis (317) were conducted in the included studies.

3.4.7 Quality assessment

The quality of included studies is provided in Table 3.3 and Figure 3.2 and detailed in the quality assessment form of an included paper (Appendix 3.6).

Table 3.3: Quality assessment of qualitative studies as per CASP checklist (311)

Quality assessment criteria	Rahmner et al 2004	Malato and Kim 2004	Spetz et al 2012	Culler et al 2011	Georgiou et al 2009
Was there a clear statement of the aim of the research?	Y	Y	Y	Y	Y
Was a qualitative methodology appropriate?	Y	Y	Y	Y	Y
Was the research design appropriate to address the aim of the research?	S	Y	S	Y	Y
Was the recruitment strategy appropriate to the aim of the research?	S	Y	S	Y	Y
Were data generated in a way that addressed the research issues?	S	S	Y	Y	Y
Was the relationship between researcher and participants adequately considered?	S	S	U	S	S
Were ethical issues taken into consideration?	S	U	S	S	S
Was the data analysis sufficiently rigorous?	Y	U	Y	S	S
Was there a clear statement of findings?	S	S	Y	S	Y
Total score	12	11	13	14	15

Y: Yes (2 points); S: Somewhat (1 point); U: Unclear (0 point)

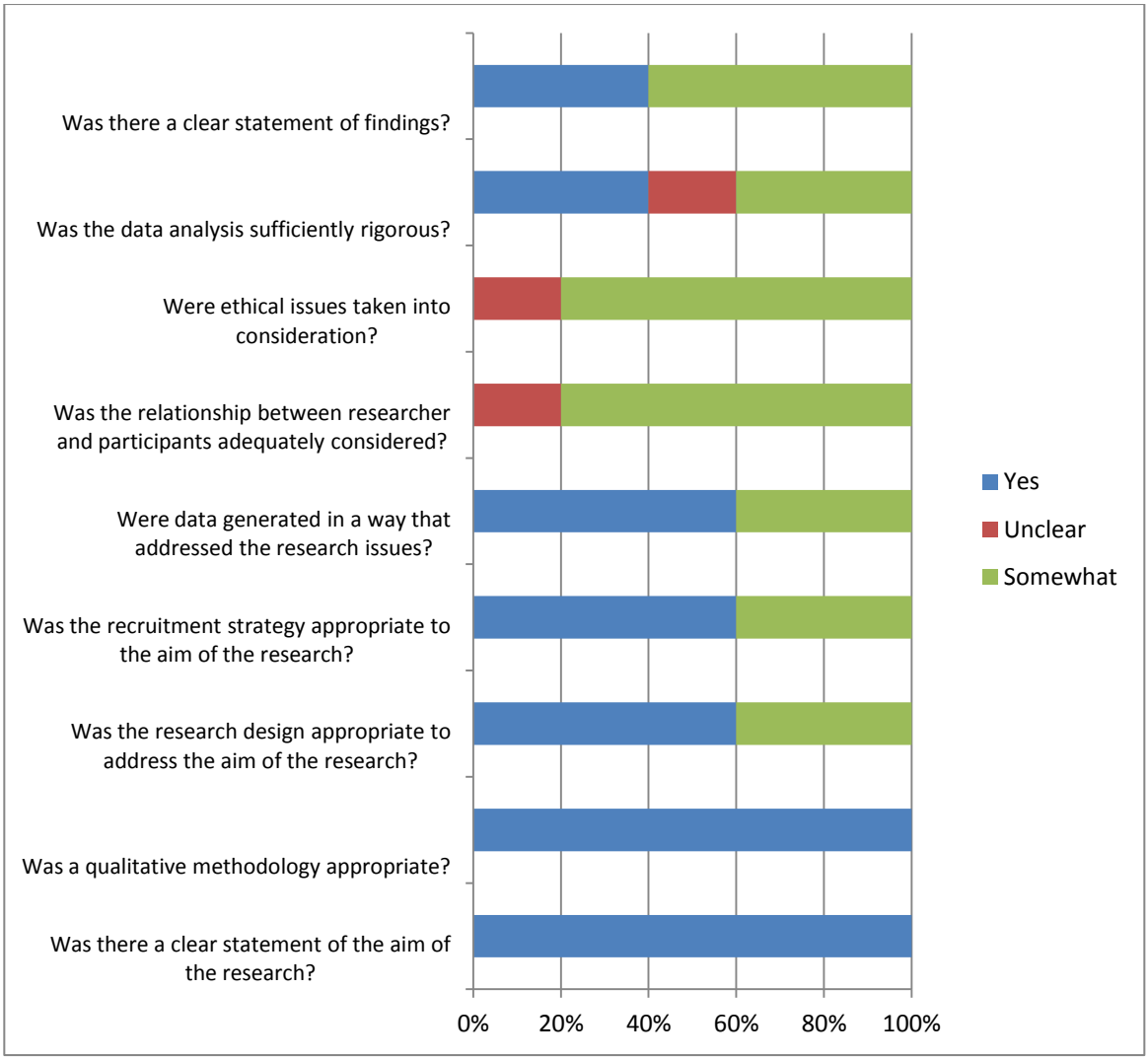

Figure 3.2: Stacked bar chart representing quality of qualitative studies as per CASP checklist (311)

One paper was assessed as poor quality, one as average quality, and three as good quality. All of the studies were explicit in their aims/objectives and rationale for study method. Limitations of the design were stated in four of the five studies. Whilst the study by Rahmner et al did not document limitations or potential for bias when exploring physicians' perceptions of the possibilities and obstacles prior to implementing an ePrescribing system with CDS, the study methods and analysis were well documented and identified that themes were comparable with other research (310).

The research design was appropriate to address the aims of the research in three of the studies and partially in two studies. Rahmner et al justified the research design and methods employed but as previously stated, no limitations of research design were outlined (310). The use of quality criteria inclusive of credibility, dependability, confirmability, and transferability was clearly documented. In the study by Spetz et al, 118 participants were interviewed in order to establish factors associated with successful implementation of a BCMA system (319). Whilst participants were heterogeneous in nature which possibly requires more interviews to be conducted, and whilst there is no set number of participants required to conduct individual semi-structured interviews, this number appears to be large for both recruiting and analysing results. Also, the study was retrospective which is limiting in that memories of implementation may have been inaccurate or biased by the passage of time and some staff may not have been available to be interviewed. However, this concern was addressed in the limitations section. Although one of the objectives was to determine how successful system implementation might be applied to other hospitals, the researchers stated their hospital structure provided valuable information regarding implementation for hospitals in the private sector. This was not comparable with the initial objective and the researchers did not directly discuss whether or how findings could be transferred to other hospital settings.

Rationale for selecting the study population was provided in three studies whilst one study did not offer this information and it was not clear in another. Spetz et al explained how participants were selected but the number of participants from each discipline was not documented (319). Rationale for the setting and selection of nurses in the target sample was provided but no reasons for including other disciplines were offered. There was no discussion around recruitment and if/why some people chose not to take part. Vague and general descriptions of the study locations were provided in order to represent a range of implementation timelines, geography, and staff characteristics. Details of the seven selected hospitals were not specified, for example, the numbers that were teaching hospitals, rural hospitals, or urban hospitals, the size of hospitals, or their location. The basis for inclusions and exclusions were not outlined.

Researchers in the study by Rahmner et al explained how ED physicians were selected which was post system training (310). They did not explicitly detail why physicians were the most appropriate participants to provide the type of knowledge sought by the study, presumably because they prescribe. The researchers discussed recruitment and that all physicians agreed to participate. A comprehensive description of the study location characteristics was provided but no detail was offered of exactly how and why this hospital and ED were chosen. In the study by Georgiou et al which explored the main barriers prior to implementation of an ePrescribing system with CDS by a broad range of hospital staff, it was not clear which participants were categorised in the 'senior staff predominantly in management', 'senior clinical management staff' and 'predominantly clinical staff' (318). For example, it was unclear if senior pharmacists were categorised in the 'senior clinical management staff' or the 'predominantly clinical staff' category.

Three studies provided justification around appropriateness of sample size and data saturation and all studies stated the recruitment strategy. The relationship between the researcher and participants in terms of data generation was not adequately portrayed in any of the studies. Four studies partially described ethical considerations whilst it remained unclear in one study. Measures to enhance rigour of the data collection tool were outlined in four studies whilst it remained unclear in one paper. Data analysis was performed independently with several analysts in three studies, with one analyst in one study, and it was not stated in another paper. Only one study was explicit in explaining bias arising from the analyst position. Limitations of the findings were discussed in three papers and conclusions were made relevant to the research question in four studies. All studies discussed theoretical transferability of the findings as either a possibility or limitation.

A clear statement of findings was evident in two studies and partially in three studies. In the study by Malato and Kim which explored nurses' perceptions of an automated medication storage and retrieval system post-implementation, the findings were explicit and well formatted and there was discussion of the evidence both for and against the researchers arguments (317). However, the authors did not discuss the credibility of their findings, for example, triangulation, respondent

credibility, or if there was more than one analyst. There was no description of any formalised appraisal criteria used, when generated, how, and by whom.

Whilst the findings by Spetz et al provide details of five themes that emerged which were supported by various quotes, it was not hugely explicit and remained unclear as to who said what (319). The researchers discussed the credibility of their findings via triangulation and multiple analysts. There was no evidence of respondent trustworthiness. Findings were discussed in relation to the original research topic and the literature review summarised knowledge to date and key issues raised by previous research. Thematic analysis was based on notes taken by the investigators rather than full transcriptions.

Findings by Culler et al which explored nurses' perceptions and experiences with the implementation of an eMAR system with CDS were explicit and provided a clearly constructed thematic account with key messages highlighted and summarised (320). The researchers described how the data was analysed via content analysis using a grounded theory approach. They also discussed the credibility of their findings via triangulation and by using more than one analyst as well as member checks during the interviews. However, there was little discussion of the evidence both for and against the researcher's findings and of key issues raised by previous research. The researchers also stated one limitation of the study which was the relatively small sample size. This appears to be a quantitative limitation as 14 interviewees is a comprehensive number in qualitative research (183)(190)(241)(321)(322)(323). No bias or conflict of interest was likely in any study included in the systematic review.

3.4.8 Facilitators and barriers to implementation

A total of 21 facilitators and barriers were identified from the included studies by nursing, medical, and pharmacy staff regarding the implementation of ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting. Using a narrative approach, all studies were combined for synthesis. Whilst more barriers than facilitators were identified, two studies focused solely on barriers

with the remainder focusing on both barriers and facilitators. These studies are listed in Table 3.4 and further described in the sections that follow.

Table 3.4: Facilitators and barriers to system implementation

Facilitators to implementation	Barriers to implementation
Increased patient safety: decreasing medication errors by reducing transcription errors (320)	**Technical problems:** logged out and information not saved; malfunctions and cumbersome access procedures; poorly functioning proximity badges; fear of a slow system with poor functionality and integration with pharmacy systems; cumbersome process for co-signing medications; miscoded medications, items not scanned, empty unit-dose packages delivered to wards, batteries not holding charges or recharged regularly; mobile carts large and difficult to move; network trouble and problems with patient wristbands (310)(317)(318)(319)(320)
Better access to patient's drug records: comprehensive patient overview and easier to alter patients drug list (310)(320)	**Altered work practices:** effect on ward rounds and remote ordering potential for errors; total patient care at risk, task allocation practice; computer illiteracy making training difficult; time pressure on using system and less time on wards; time pressure with no allocation of extra staff (318)(319)(320)
Organisational stability and implementation team leadership: teamwork and involvement of end-users (319)	**Weakened interpersonal communication:** less face-to-face interaction between healthcare professionals and patients; loss of an unofficial means of communication; potential for exposing knowledge deficits and increasing conflicts (310)(318)
Hardware/software availability and reliability: adequate access to and reliability of hardware and computer network; need to be intuitive and user-friendly (310)(319)	**Practice-related medication errors:** administer medications at the incorrect time, rely on technology (320)(310)
Adequate staff training: classroom training; one-on-one training; 24-hour support; availability of superusers (319)(320)	**Poor access to systems:** long wait times; priority issues (318)(320)

Facilitators to implementation	Barriers to implementation
Flexible implementation timelines: time to gain experience; adapt to new ways of working (310)(319)	**Logistics of education and training:** training staff prior to and during system implementation problematic due to shift work; resistance or busy schedules; healthcare professionals spending time to train others (318)(319)
Improved pharmacological knowledge: via automatically generated interaction alerts and producer-independent drug information (310)	**Unsupportive management teams**: more challenging both during and after implementation (319)
Time efficiency: reduce duplication of administrative work; ease of locating chart information (310)(320)	**Implementation roll out:** time for potential stress and errors; short implementation timelines increased pressure (318)(319)
Improved interdepartmental communication: information exchange between departments coupled with the ability to quickly and easily communicate with pharmacy (320)	**Cost:** cost of the system; cutting cost resulting in an inferior system (318)
	Circumvention of the system: misuse or non-use of key elements due to poor implementation management; lack of training; lack of input into the design and deficiencies in quality of technology (317)
	Security: online patient medication details more accessible and visible than paper charts (318)
	Deskilling: becoming dependent on the system (318)

3.4.8.1 Facilitators to implementation

Nine main themes emerged from three studies that focused on facilitators to system implementation: increased patient safety; better access to patient's drug records; organisational stability and implementation team leadership; hardware/software availability and reliability; adequate staff training; flexible implementation timelines; improved pharmacological knowledge; time efficiency; and improved interdepartmental communication (Table 3.4). Two studies focused on nursing (320) and nursing, medical, and pharmacy staff (319) post system implementation whilst the third study centred on physicians' perceptions prior to system implementation (310). Themes overlapped between the different implementation phases and healthcare professionals.

Two studies that explored participants perceived benefits to system implementation found increased patient safety, improved pharmacological knowledge by physicians, enhanced interdepartmental communication between physicians and nurses, and time efficiencies (310)(320). Successful system implementation depended on many facets including staff training, appropriate workflow adaption, reliability of medication safety alerts, and team leadership. Spetz et al detailed the perceived structures needed to be in place to determine successful system implementation such as organisational stability and implementation team leadership (319). They found successful system adoption depended on: support for change from both leaders and end-users; development of a gradual and flexible implementation approach; allocation of adequate resources for hardware/software, infrastructure, hands-on support, and deployment of additional staff; and implementation team planning for setbacks and thereafter for achieving success. A description of each of the facilitators perceived by healthcare professionals is now detailed.

Increased patient safety

Nurses perceived decreasing medication errors by reducing transcription errors as the most significant facilitator of the eMAR system with CDS six months post-implementation (320). This facilitator translated into immediate benefits by increasing patient safety.

Better access to patient's drug records

Rahmner et al identified the greatest facilitator perceived by physicians prior to implementing the ePrescribing system with CDS was gaining better access to patient's drug records (310). Physicians anticipated attaining this data would provide an enhanced overview of the patient's health status and assist in altering medications easily for optimum treatment.

> *"It is difficult and it takes time to check the patient's drug list…often we find patients don't need that many drugs". (Physician, pre-implementation)* (310)

However, the proposed ePrescribing support system in this study was not developed for accessing drug histories and could not fulfil this requirement. Similarly, improved accessibility to patient's drug information was perceived as a key facilitator by nurses with the implementation of the eMAR system with CDS (320).

Organisational stability and implementation team leadership

Implementation teams which led in the adoption of a BCMA system were central to its success (319). Participants recognised that pharmacy and IT staff had to be partners in the process and that nursing involvement was fundamental: "*success is all about teamwork*". Physicians and nurses in visible roles during implementation achieved buy-in from other healthcare professionals more easily.

Hardware/software availability and reliability

Adequate access to and reliability of hardware and software inclusive of computer networks were essential during system implementation (319). This was echoed in the study by Rahmner et al where a prerequisite for physicians to accept system adoption was that it functioned technically (310).

Adequate staff training

A combination of classroom training and one-on-one training during medication delivery was perceived by nurses, doctors, and pharmacy staff as a criterion for successful implementation of the BCMA system (319). Training teams also assisted nurses for a fixed number of medication administration cycles, or until each nurse was comfortable with the system. The 24-hour support available

post-implementation was universally noted as "*essential*" and that "*everyone is less stressed when 24-hour help is provided*". Nurses in another study by Culler et al specifically indicated that the availability of superusers in the clinical setting during the transition period assisted in ensuring quick resolution of implementation issues (320).

Flexible implementation timelines

Regardless of how the implementation was specifically planned, flexibility in implementation helped healthcare professionals adapt to the system (319). Time to gain system experience using a gradual ward-by-ward rollout worked effectively as well as introducing the system in wards with relatively stable populations. Rahmner et al also highlighted time needed to be allocated to users to adapt to new ways of working and that shortcuts resulted in system failure (310).

Improved pharmacological knowledge

Another possibility of the ePrescribing support system perceived by physicians pre-implementation included enhancing their pharmacological knowledge via access to automatically generated interaction alerts and producer-independent drug information (310).

Time efficiency

All physicians indicated the duplication of administrative work associated with manual drug prescribing was both time-consuming and laborious.

> *"To prescribe drugs doesn't take so much time. What takes time is finding out the patient's drug list…the best thing would be to have these lists in the computer so that you could print them". (Physician, pre-implementation)* (310)

Nurses also believed time efficiency was facilitated post system implementation by ease of locating chart information and the systems "*user-friendly design*" and overall "*ease of navigation*" (320).

Improved interdepartmental communication

Improved information exchange between departments coupled with the ability to quickly and easily communicate with pharmacy was identified as a benefit to adoption.

> *"Communication is great; all you have to do is write a message and hit send". (Nurse, post-implementation)* (320)

3.4.8.2 Barriers to implementation

Difficulties in implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in hospitals consisted of obstacles at both an individual and organisational level. Healthcare professionals faced numerous challenges with various system implementations. As illustrated in Table 3.4, 12 main themes emerged when synthesising findings from a combination of all studies: technical problems; altered work practices; weakened interpersonal communication; practice-related medication errors; poor access to systems; logistics of education and training; unsupportive management teams; implementation roll out; cost; circumvention of the system; security; and deskilling. Several themes that were viewed as facilitators by healthcare professionals were also perceived as barriers to system implementation inclusive of interpersonal communication, patient safety, time availability, information access, and staff training. A description of each of the barriers perceived by healthcare professionals is now detailed.

Technical problems

The greatest obstacle physicians perceived prior to system implementation was technical malfunctions (310). Physicians expressed concern with the integration of the new and current system in relation to being logged out and information not saved. Nurses complained about the associated complication of workflow due to malfunctions and cumbersome access procedures post-implementation of the automated medication storage and retrieval system.

> *"There is great potential for abuse. Narcotics are exposed because of drawer malfunctions, and wastes are not being witnessed until later, because it takes too long to find a finger that works". (Nurse, post-implementation)* (317)

Nursing staff also identified problems with poorly functioning proximity badges which resulted in an inability to log into the eMAR system with CDS (320).

Doctors and nurses protested that they would not tolerate a slow system prior to implementation of the ePrescribing system with CDS (318). Other concerns centred on functionality such as how the system would cope with access to a patient's chart by different users at the one time, and whether the entire medication record would be visible on one screen. Pharmacists voiced the added problem of current pharmacy information systems not being able to integrate with the proposed new system resulting in pharmacists having to work in different system environments. Network and hardware problems were also identified by healthcare professionals post-implementation of the BCMA system (319). Difficulties with miscoded medications, items not scanned, and empty unit-dose packages delivered to wards were identified. Batteries that did not hold charges or were recharged regularly, mobile carts that were large and difficult to move, and network problems were additionally voiced as problems by healthcare professionals. Nurses stated that they had "*a computer that is buggy*", that the "*computer would just kick you out*", and that "*the machine will crash in the middle of a medication pass*". Problems with scanning patient wristbands were also reported.

Altered work practices

A concern expressed by doctors, nurses, and pharmacists was the effect of system implementation on ward rounds (318). Traditionally, written changes to patient's medications are documented during a ward round contemporaneously with medical decisions. There was apprehension that the new system would not facilitate this process, with participants doubting the system would have enough mobility or flexibility. Concern was verbalised that "*remote ordering*", when changes are made to a patient's medication chart away from the patient or ward, could introduce new errors as doctor-patient contact declines. Some nurses perceived the current model of total patient care in which a number of patients are allocated to one nurse could be at risk and expressed unease regarding the possibility of the re-emergence of task allocation practice. Included in this area of discussion was the anxiety that some staff were "*computerphobic*" and would not use the system resulting in a model of care delivery that moved away from a

patient-centered approach. There was also apprehension that agency staff would be unable to use the system and that permanent staff members would be relegated to performing their medication administration work. Some staff had little prior contact with computers resulting in concern that there was a level of computer illiteracy that would make training difficult. Participants expressed apprehension towards the limited access to computers and the time taken to log on or off resulting in fewer opportunities to scan through a patient's record online. Pharmacists also expressed disquiet regarding changes that may ensue, mainly centred around time available on the wards.

Use of the BCMA system interrupted the flow of care for many physicians and nurses (319). Nearly all staff found the system placed substantial demands on their time during implementation, but most sites could not allocate additional nursing or pharmacy staff during this time. A number of nurses used terms such as "*frightened*", "*nervous*", and "*scary*" to describe how they felt about the system at first. The most resistant nurses and physicians reportedly left the organisation through retirement or turnover. Managers reported older nurses were less likely to be comfortable with technology.

Excessive time for logging into an eMAR system with CDS was also identified by nurses as a significant barrier to implementation and a deterrent to documenting patient medications at the point of care (320).

> *''Log-in times slow you down…it's too slow…you tend to wait until you can chart more than one patient…''. (Nurse, post-implementation)* (320)

The cumbersome process of co-signing orders was also considered time consuming and an additional barrier.

Weakened interpersonal communication

Healthcare professionals perceived more time would be spent on technology and less time on face-to-face interaction with system implementation (318). Pharmacists were particularly concerned that their visibility on the wards would decrease resulting in less personal communication with other professionals and patients, and less opportunities for informal discussions around medication issues.

> *"Face-to-face is less confronting than on the phone…lots of doctors say that whenever the pharmacist's number comes up on their pager, they think oh, what have I done now?". (Pharmacist, pre-implementation)* (318)

This feeling of preference for face-to-face communication was reinforced by doctors. Loss of an unofficial means of communication using paper medication was also expressed as a barrier by healthcare professionals as well as reduced contact with patients as routinely paper charts are located at the patient's bedside which directs doctors, nurses, pharmacists, and other allied healthcare professionals towards the patient. For similar reasons, diminishing patient contact was identified as challenging by physicians in the study by Rahmner et al (310). A lack of physicians' knowledge when communicating with staff was also perceived to be more exposed with system implementation causing potential conflict.

Practice-related medication errors

Nurses identified an increased potential to administer medications at the incorrect time as a barrier to adoption as drug times appeared in the system without a record of when the last dose was administered (320). This was especially problematic with new admissions and in departments not linked to the eMAR system with CDS.

In contrast to relying on technology, physicians perceived important factors when choosing medications depended on personal experience, knowledge, patients desires, and consulting colleagues and guidelines (310).

Poor access to systems

Another perceived barrier by nursing staff was long wait times in the medication room for electronic access.

> *"I think it has slowed down our work processes…for example, in our unit medications are centrally located, and if four nurses are in the medication room waiting to get on the system at 10am, they may get impatient...". (Nurse, post-implementation)* (320)

These problems were frustrating to participants during the implementation period when more time was needed to become familiar with the technology (320).

Medical, nursing, and pharmacy staff also expressed concerns about access to computers and who would get priority if multidisciplinary professionals requested use at the same time (318).

Logistics of education and training

Healthcare professionals envisaged training staff prior to and during system implementation would be problematic (318). It was also acknowledged that training within a hospital might be difficult due to shift work. Some participants reported difficulty in getting staff to attend training due to resistance or busy schedules (319). Many healthcare professionals believed support staff would need to be available after training and system implementation (318). Concern was expressed regarding ward staff having to spend time training others at the expense of their own work (318).

Unsupportive management teams

More challenges were evident both during and after implementation of the BCMA system with unsupportive management teams or where staff did not respect the ability of management.

> *"If nurse managers were in support you could get a lot further". (Leader, post-implementation)* (319)

Implementation roll out

The implementation period prior to the introduction of an ePrescribing system with CDS was perceived to be a time for potential stress and errors, in particular with a phased roll out with areas both on-line and off-line (318). Healthcare professionals with system implementation experience believed short timelines increased pressure.

> *"The software wasn't ready, and the hardware had not been researched". (Staff member, post-implementation)* (319)

Cost

Healthcare professionals raised concern about the cost of the ePrescribing system with CDS and feared cutting cost may result in the implementation of an inferior system (318).

Circumvention of the system

Circumvention of the automated medication storage and retrieval system was verbalised by nurses three months post-implementation (317). Even though the system was designed to track and supply medications through a biometric scanner where nurses specify medications to be removed at that time and return for additional medications as required, they accessed medications on override or retrieved more medications than entered. Interview findings and observations demonstrated misuse or non-use of key elements of the system by nurses such as retrieving all medications required for an entire shift.

> *"We find ourselves breaking a lot of rules just to help our patients get meds on time". (Nurse, post-implementation)* (317)

Nurses shared perceptions of "*learning to live with the system*" and this "*black hole*" in the process was viewed as a failure of management, lack of training, lack of design input, and a deficiency in the quality of the technology itself.

Security

Participants perceived online patient medication details may be more visible to others than paper charts and that networked information could be accessible either legitimately or illegitimately (318).

Deskilling

Doctors felt they may become dependent on the ePrescribing system with CDS and would be unable to function confidently in another hospital without the same level of decision support (318).

3.5 Discussion of the findings

This is the first published systematic review conducted on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing electronic systems for prescribing, dispensing, and/or administering medicines in the hospital setting. Available evidence was synthesised in order to describe and understand these perceptions for future exploratory work.

A very limited number of studies were identified, few of which have been carried out in Europe. Whilst a comprehensive search strategy with effective search terms was adopted, a limited number of studies met the inclusion criteria despite a large volume of papers initially screened for possible inclusion. This was due to inappropriate setting, inappropriate systems, lack of focus on healthcare professionals' perceptions, and/or the retrieval of studies not centred on implementation. No systematic reviews were identified for inclusion. Similar to statements from Creswell, research in exploratory qualitative studies most likely offers limited literature at the outset given the lack of research in the subject area (183).

A narrow range of methods were adopted from the identified literature, namely qualitative face-to-face interviews, focus groups, and observational studies. This may be due to the exploratory nature of the topic researched. Differences in study settings and countries, sampling, and bias around participant selection may explain variations in facilitators and barriers. Further qualitative studies may best identify the nature of these changes.

No study was identified for inclusion that explored the perceptions of pharmacy staff on the facilitators and barriers towards the implementation of electronic systems for dispensing medicines in the pharmacy department. More barriers were identified than facilitators possibly due to all five studies focusing on barriers and three studies focusing on facilitators and barriers to system implementation. Studies reflect healthcare professionals perceived systems improved patient safety and enhanced access to patient's drug records and that team leadership and hardware/software availability and reliability were essential for successful adoption. Effectiveness, ability to work with existing practices, and appropriate management of systems were major constructs identified in this review. Applying a participatory approach in system design and providing user support through training were key lessons learnt. Key barriers included hardware and network problems, changes to routine work practices, weakened interpersonal communication between healthcare professionals and with patients, and resistance to technology and training. Technology anxiety was expressed by a variety of healthcare professional groups and was not specific to any one profession.

Building eHealth systems for prescribing, dispensing, and administering medication requires designs that provide significant advantages in comparison to traditional methods in order to prevent medication errors, increase efficiency, produce cost savings, and ultimately improve patient care delivery. Comparable with study findings from Rahmner et al (310), Schiff and Rucke found sufficient electronic access to patient's drug records had the potential to significantly improve patient safety and the working environment for prescribers (324).

It is important to use pre-implementation findings to assess whether new technology fits the existing model of healthcare provision. A consistent feature in study findings that focused on system pre-implementation was the unease on whether implementation would deliver the necessary hardware requirements and the potential changes in multidisciplinary group interactions (318)(310). Doubts about the ability to cope with new technology were also voiced as concerns which related to the availability of sufficient training, support, and recognition of major work changes. Adequate preparatory training was recognised as a chief concern among doctors, nurses, and pharmacists, and the implementation period as a time for potential stress and medication errors.

Similar to findings from this systematic review, Pare et al identified lack of project champions was perceived to be an important cause of problems with implementation, followed by lack of dedication from top-level management (110). Previous research has further documented issues with degraded communication between nurses and doctors, nurses failing to complete care duties due to excessive workload created by new systems, and an increased focus on managing systems rather than patient needs (325).

Perceptions of inadequate training, deficiencies in quality of technology, and lack of participation were evident by a variety of healthcare professionals. A study by Johnson found the most significant barrier to adoption was doctors lack of knowledge or training on how to use the systems effectively as well as financial challenges and difficulties with access to technology (326).

In a descriptive questionnaire-based study by Cresswell et al in 2013 that primarily investigated the current implementation status of ePrescribing systems

in NHS hospitals, lessons learnt from early implementation included the need for increased guidance in relation to implementation strategies, adequate system choice, and top-level management support to sufficiently resource adoption (327). Parallel to findings in this systematic review, desired functionalities included integration with existing local systems and a more sophisticated decision support. The researchers also found that unrealistic expectations surrounding the capabilities of systems may inadvertently result in disappointment and disillusioned stakeholders (327).

The elucidation and understanding of healthcare professionals' perceptions of the positivity and concerns can assist in informing, strengthening, and sustaining implementation strategies. A key finding from human factors literature is the risk of failure of eHealth systems if managers, designers, and implementers fail to pay adequate attention to the aspirations, beliefs, perceptions, and experiences of end-users (131). As these systems become more embedded within work processes, understanding the organisational context assumes greater importance for successful adoption (14)(131). It is important that implementers systematically plan for all aspects of the implementation process inclusive of staff training, support, workflow changes, and communication. Success requires a high-level of collaboration and negotiation across departments and between IT, end-users, and management, as well as a requirement to provide reassurance that staff will be supported.

3.5.1 Consideration of strengths and limitations

Conducting systematic literature reviews are a fundamental scientific activity (328). All types of research methods were searched, though due to time constraints, papers that were not in English were not considered.

A wide range of databases were used to search the literature. Manual searching of core journals for relevant titles and searching of conference proceedings and online theses led to no studies considered for potential inclusion which raises issues around adoption of such methods in the future. However, literature searching is a highly developed skill and even trained experts may only identify 50% of relevant literature (329). Three researchers working independently added to the rigour of the literature inclusion and exclusion decisions. In

addition, this strengthened the review process in terms of data extraction and quality rating. Structured data extraction forms ensured no relevant data were missed. Development of a quality assessment form as per standard guidelines helped to ensure important elements around study quality were properly scrutinised (214)(300)(309). A narrative synthesis of findings allowed results to be tabulated and categorised in a comprehensive manner. Meta-analysis of the results was not necessary due to the nature of the research methods included.

An unambiguous, externally validated protocol documenting the process in every aspect of the systematic review allowed any deviations from the set procedures to be recorded which increased transparency (301).

Limitations of the included studies related to a general lack of rigour with one paper assessed as poor quality, one as average quality, and three as good quality. As discussed in Chapter 2, another possible limitation may be the inclusion of all qualitative studies in the systematic review. Nonetheless, it is increasingly recognised that evidence from qualitative studies that explore implementation of interventions and experiences of those involved in providing and using interventions have a significant role in ensuring data are of maximum value to policy, practice, and decision-making (223)(330)(331). The methodology and method selection in this phase of the research resulted in the generation of original, novel data which contributes significantly to the published literature.

3.6 Further work

A reflective approach has been employed throughout this doctoral research with consideration to the research aim, objectives, systematic review findings, and implications for the next phase of this study. From the results of this review and due to the limited number of studies included, it was clear that further qualitative work in the form of individual face-to-face semi-structured interviews with key stakeholders would provide much needed novel in-depth knowledge on facilitators and barriers to system implementation in an Irish setting. This will provide important information on successful system implementation for policymakers and healthcare organisations in order to improve patient safety and healthcare delivery.

3.7 Chapter summary

A very limited number of studies were identified on healthcare professionals' perceptions of the facilitators and barriers to system implementation in hospitals. It is evident from findings of this review that successful system implementation will largely depend on effective leadership, the availability of high quality systems, and the development of appropriate skills and training for end-users. Another important determinant of successful adoption is to ensure end-users are well informed of the potential benefits of the system for their own work practice.

Chapter 4: Interviews with local key stakeholders

4.1 Introduction

Chapter 4 includes phase two of this research, namely in-depth qualitative interviews. A summary of the rationale for conducting this research, which is underpinned by NPT, along with the objective is provided. A description of the method, results, and interpretation of findings is subsequently detailed.

Implementation of eHealth solutions has the potential to ensure continuous improvements in the quality of healthcare delivery (332)(333)(334). Whilst the use of medicines is currently increasing in number and complexity (335) which potentially amplifies medication error risks, systems for prescribing, dispensing, and administering medicines in Ireland and the UK have remained largely unchanged over the last few decades (8)(73)(336). As identified in the systematic review in phase one of this research, lack of system implementation may be due to a range of inter-related technical, social, and organisational factors with the multi-level complexity of integrating new technology into existing work practices (337). Implementation of electronic systems for medicines in hospitals in Ireland is further complicated by the immaturity of the IT systems market, the variable levels of commercial and organisational expertise, and the overall limited investment in healthcare ICT which accounts for one of the lowest levels in Europe (72)(116). However, support for eHealth adoption in recent years through publication of a national *eHealth Strategy* and the establishment of eHealth Ireland has been a positive progression and considerable interest has been expressed in the acquisition of these systems nationally (98)(116). This next phase of the programme of research complements the systematic review by providing depth and further novel insights into issues involved in implementation of electronic systems for medicines management.

4.1.1 Phase two objective

- To explore the perceptions of local key stakeholders towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework.

This work is timely as it has the potential to inform future implementers on factors that influence facilitators and barriers to adoption in a country with limited experience of such systems and in a field under-researched.

4.2 Method

4.2.1 Research design

The rationale for advancing with interpretative phenomenological methodology using individual face-to-face interviews has been previously described in Chapter 2. In summary, aligned to the constructivist approach, interpretative phenomenology seeks to generate rich descriptions and understanding of the phenomenon in question. Conducting individual face-to-face semi-structured interviews with local key stakeholders in three hospital sites using NPT as a theoretical framework was considered the most appropriate method to support the research aim, primarily to facilitate in-depth rich data capture and analysis. This method was believed to be more fitting than employing other methods such as individual phone interviews, focus groups, or naturally occurring data such as observational studies, as it facilitates more detailed data sharing and data retrieval by participants. It allows participants to converse in their own words without the risk of potential inhibition when openly discussing and sharing information with others in a focus group. For example, nurses may not discuss important concerns with automated medication storage and retrieval systems in the presence of a chief pharmacist or senior manager responsible for system implementation reducing rigour and trustworthiness. In addition, all five papers included in the systematic review in phase one used individual interviews as a research method, indicating this would be a suitable method for this phase of the research.

4.2.2 Setting

Three general hospitals which provide acute services in the public sector in Ireland were the focus for interviews with local key stakeholders due to the nature of the eHealth technology employed. Private hospitals were excluded from this phase of the research as they operate independently of state health services with different financial structures and governance policies and are therefore not comparable to public hospitals.

Of the 48 hospitals in the public sector in Ireland (338), no hospital has implemented an integrated hospital-wide ePrescribing system linking prescriptions electronically between prescribers and dispensers. Stand-alone ePrescribing systems are in place in a limited number of large public hospitals in specialist areas such as Intensive Care Units (ICUs). It was therefore not possible to select a public hospital with an integrated ePrescribing system. At the time of this study, one hospital in the public sector had implemented a robotic pharmacy system and three public hospitals had introduced automated medication storage and retrieval systems, two hospitals within the previous eight months. Opting for a hospital with a robotic pharmacy system would limit participants to pharmacy staff and prohibit site triangulation. Therefore, to capture a broad range of perspectives from participants with and without system experience and facilitate site triangulation and diversity in terms of maturity of system implementation, two hospitals that had introduced automated medication storage and retrieval systems at different implementation stages (over 10 years and seven months), and one hospital which was considering implementation were selected.

Hospital A is a 340-bedded acute general hospital in the HSE public sector with a catchment area of approximately 150,000 people situated in the North West of Ireland. Part of the Saolta Hospital Group, this institution has over 10 years' experience in implementing automated medication storage and retrieval systems in several wards and was the first hospital in the public sector in Ireland to implement such systems in 2006. With their extensive experience and vision, the research team felt including this hospital in the study would enhance, enrich, and contribute to data analysis.

Hospital B is a 260-bedded acute general hospital in the HSE public sector with a catchment area of approximately 150,000 people situated in the North East of Ireland. Part of the Royal College of Surgeons Hospital Group, a manual medicines management system is predominantly utilised for prescribing, dispensing, and administrating medicines. One automated medication storage and retrieval system was implemented in June 2015 in a 31-bedded ward with a mixture of medical, surgical, and gynaecological inpatients. The plan is to introduce more systems in the near future. With experience at the early stages

of system adoption, the research team believed including Hospital B in this study would further enhance data analysis.

Hospital C is a 340-bedded acute general hospital in the HSE public sector with a catchment area of approximately 150,000 people situated in the North West of Ireland. Part of the Saolta Hospital Group, it relies solely on a manual medicines management system but is planning to introduce automated medication storage and retrieval systems and a stand-alone ePrescribing system in ICU. In order to select similar type hospitals that have experience and have no experience but plan implementation, this final hospital was believed to be of equal benefit in understanding perceptions pre-implementation. Figure 4.1 maps the location of selected hospitals.

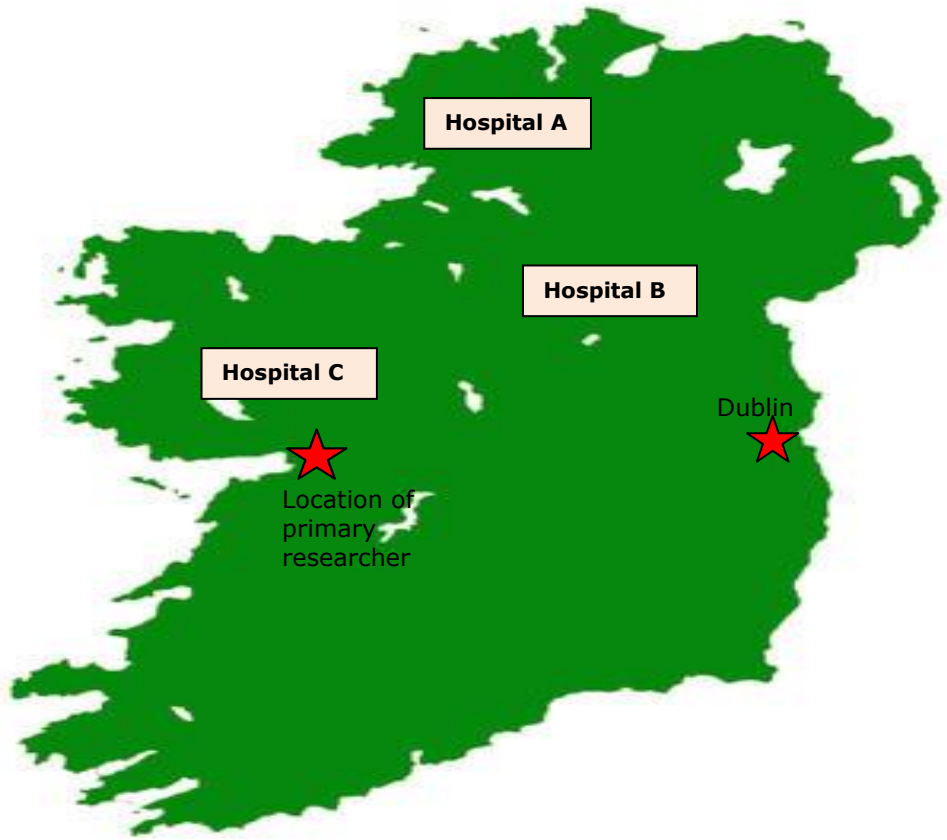

Figure 4.1: Map of location of selected hospitals

Site triangulation was achieved by the participation of a range of professionals within these hospitals so as to reduce the effect of local factors particular to one institution. Findings can then be understood within the context of the particular characteristics of the organisation. Table 4.1 provides a summary of the hospital characteristics.

Table 4.1: Summary of hospital characteristics

Characteristics	Hospital A	Hospital B	Hospital C
Type	Acute general hospital in the public sector	Acute general hospital in the public sector	Acute general hospital in the public sector
Size	340 beds	260 beds	340 beds
eHealth system	Automated medication storage and retrieval system (Omnicell©)	Automated medication storage and retrieval system (Omnicell©)	Relies solely on a manual medicines management system
Implementation phase	Late: >10 years post-implementation	Early: 7 months post-implementation	Pre-implementation planning stage
Number of systems	7	1	0
Location of systems	ED, acute medical assessment unit, haematology and oncology ward, and four medical 24-bedded inpatient wards	31-bedded mixed ward with medical, surgical, and gynaecological inpatients	

4.2.3 Research governance

This research was conducted in accordance with the ethics and research governance policies of RGU (339) and the HSE (340). A research degree registration form was submitted to the Research Degrees Office in RGU within three months of commencing the research to ensure ethical principals were adhered to. A research ethics: students and supervisor appraisal (RESSA) form was also submitted which aims to promote good ethical practice in the conduct of academic research and enable researchers to undertake an initial self-assessment of ethical issues in their research.

Ethical approval was a lengthy process, with applications taking 10 months to obtain all the necessary approvals. The project was approved initially by the ethical review panel of the School of Pharmacy and Life Sciences, RGU. A detailed research project proforma for ethical approval was completed by the primary researcher, reviewed by all research team members, and submitted to the ethical review panel (Appendix 4.1), along with an updated RESSA form (Appendix 4.2). A letter of invitation; participant information sheet; interview consent and copyright clearance form for participant and researcher; reply slip; letter of invitation reminder; and interview confirmation letter were also submitted (Appendices 4.3-4.9).

Minor amendments were required and completed as detailed in Appendix 4.10. The application was re-submitted and approval was received four weeks later, the process taking a total of 12 weeks (Appendix 4.11).

Each of the three hospitals required individual ethical review applications and had independent ethics review committees. Approval was sought and obtained from each hospital which included submission of:

- Ethical approval letter from the School of Pharmacy and Life Sciences at RGU (Appendix 4.11)
- A 84-page standard application form for ethical review of health-related research studies
- Research project proforma for ethical approval (Appendix 4.1)

- Letter of invitation; participant information sheet; interview consent and copyright clearance form for participant and researcher; reply slip; letter of invitation reminder; and interview confirmation letter (Appendices 4.3-4.9)
- Letter to the general manager on research for information (Appendix 4.12)
- Curriculum Vitae

Ethical approval from Hospital A, Hospital B, and Hospital C is provided in Appendices 4.13-4.15, respectively. All approvals were granted prior to recruiting any participants.

Throughout this study, the research ethics and governance policies at RGU and the HSE were adhered to by prioritising the dignity, rights, safety, and well being of the participants at all times and by using and protecting the research data appropriately (339)(340). The Irish Data Protection (Amendment) Act 2003 was also adhered to (341). This primarily states data may only be used for the specific purposes for which it is collected, data must not be disclosed to other parties without the consent of the individual to whom it concerns, individuals have a right of access to the information held about them, and adequate security measures are in place for holding personal information. Furthermore, in accordance with this Act, data will not be retained for longer than necessary in order to fulfil the purpose for which data were originally collected. The equivalent Health Research Authority approval for NHS in England or the NHS management permission in Scotland, Wales, or Northern Ireland does not exist in the Republic of Ireland.

4.2.4 Participant inclusion and exclusion criteria

Individuals directly or indirectly involved in medicines management working in the chosen hospital sites were included in the sample. Those not involved in medicines management working within or outside of these hospital sites were excluded.

4.2.5 Participant sample

Purposive sampling was employed in order to identify a range of relevant heterogeneous local key stakeholders for participation. As described in Chapter 2, this is a non-probability sampling technique typically used in qualitative

studies with the expectation that each participant will provide unique and rich information (3)(243)(342). Sample size is determined by data saturation and not by statistical power analysis. This approach was selected in place of other sampling techniques as it was most suitable to meet requirements of the research objective, qualitative design, and in generating rich data from a variety of participants' perceptions towards system implementation.

Purposive sampling conducted using pre-specified 'stratification' factors can lead to heterogeneity in the sample (246). The main stratification factors employed were: potential key implementers and operational end-users working in a hospital before system adoption; key implementers and operational end-users working in a hospital after system implementation; profession; and grade. This included both senior and junior employees from nursing, pharmacy, medicine, and IT. 'Implementers' were viewed as individuals in a role with responsibility for implementation, such as nurse and pharmacy managers. End-users were considered the main operational users of the system, for example, staff nurses and pharmacy technicians. The research team felt including participants without experience was equally as important as including participants with experience in order to identify perceived facilitators and barriers prior to implementation and understand its likely impact, success, and sustainability. Most invitees were known by the primary researcher. The remaining eight professionals from multidisciplinary backgrounds were identified through recommendations from senior pharmacists via verbal contact once they had agreed to participate. It is recognised that this recruitment method is dependent on the opinions of senior pharmacists on whom they consider to be appropriate participants.

The risk of sampling bias was minimised by the type of participants invited for interview as it was anticipated they would express many positive and negative perceptions and experiences of adoption as implementers, end-users, and potential adopters.

4.2.6 Sample size

In terms of sample size, Marshall states that data quality is more important than either the number of participants or volume of data in qualitative research, and that a sufficient sample size is reached when the research question is answered

adequately (241). Pharmacy researchers have routinely interviewed between 15 and 50 participants (343), whilst suggested numbers in phenomenology have been five to 25 (190) and at least six (321). Guest found in one study of 60 subjects, data saturation occurred after approximately 12 interviews which elicited 97% of the codes (322). The number usually becomes obvious as new categories, themes, or explanations stop emerging from the data (323)(241). Francis et al emphasise the importance of reaching data saturation to ensure content credibility has been achieved, and propose agreeing the minimum number of interviews to be analysed and then stating the number of further interviews to be completed without any new ideas being voiced. This method may not be suitable for interviews with subgroups but a modified version may be applicable (246).

The research team agreed that a modified approach was to interview an initial sample of 24 senior and junior participants comprising nine nurses, six pharmacists/pharmacy technicians, six doctors, and three hospital IT managers, equally divided per site. This number was expected to capture a broad variety of perceptions towards system implementation from the heterogeneous participants and assist the research team in identifying common and diverse themes and reaching data saturation. More nurses were included than other healthcare professionals as nurses are predominantly ward-based end-users and may provide further insight of system implementation and facilitate rich data analysis.

4.2.7 Invitation

Project information was posted to local key stakeholders' work addresses. This method of delivery was felt to be more personal than emailing potential interviewees. Included were a letter of invitation with a background to the project, objective of the study, and criteria for selecting them as interviewees; participant information sheet; consent/copyright clearance forms; reply slip; and a prepaid envelope (Appendix 4.3-4.7). Prospective participants were informed of the potential benefits of the project and the mechanism of disseminating results.

Individuals were requested to mail the reply slip either accepting or rejecting participation, with the most convenient date, time, and location for taking part in the interviews along with the consent/copyright clearance form if they were

willing to participate. Reminders were sent to non-respondents two weeks after mailing the first invitation followed by telephone contact to confirm they had received correspondence (Appendix 4.8). A confirmation letter was then sent to participants who agreed to take part with details of the interview appointment followed by an email 24 hours before the interview to confirm participation (Appendix 4.9).

4.2.8 Development of interview schedules

A qualitative systematic review by McEvoy et al in 2014 using NPT to research implementation processes identified 29 papers and found coherence and cognitive participation relate more to the 'planning' stages of implementation, and collective action and reflexive monitoring relate more to 'experiences' post-implementation (344). Two interview schedules were therefore developed by the research team for participants working in hospitals with and without system implementation.

Content of the interview schedules was underpinned by NPT and informed by the research objective and existing literature inclusive of the systematic review findings from phase one to ensure a consistent and systematic approach. As described in Chapter 2, the application of a theoretical framework provides a useful structure for complex studies (141)(267)(268)(269)(291). A considerable body of research now supports NPT as valuable for explaining processes of normalising practices associated with complex eHealth interventions and understanding the dynamics of: implementation and bringing new practices into action; embedding practices into routine everyday work of individuals and groups; and integration and sustainability of practices (293)(345). It goes beyond the narrow focus of individual behaviour and proposes implementation should be understood by the work that people do (293). Mapping of NPT constructs to the interview schedules is provided in Table 4.2. These four generative constructs comprise: coherence, the 'sense-making' work such as shared understanding; cognitive participation, the 'relational work' such as enrolment; collective action, the 'operational work' such as training and competency; and reflexive monitoring, the 'appraisal work' such as evaluating effectiveness. New systems are more likely to be normalised with consideration to these constructs.

Table 4.2: Mapping of concepts in the interview schedules to NPT

NPT constructs	Interview schedule concepts
Coherence Sense-making work that people do individually and collectively at the planning stages of implementation	Perceptions of the overall goals of implementation e.g. patient safety, increased efficiency
Cognitive participation Relational work that people do to enrol and engage with the planning of implementation	Responsibility for implementation e.g. implementers driving it forward, end-users buy-in to implementation
Collective action Operational work that people do to enact the new system	Tasks carried out in delivering the implementation process e.g. training, policies
Reflexive monitoring Assess and understand the outcomes of implementation	Monitoring the effectiveness of implementation e.g. individual and collective feedback

Particular attention was paid to Creswell's key recommendations in developing the interview schedule, as provided in Table 4.3 (346).

Table 4.3: Key recommendations for developing interview questions in qualitative research adopted from Creswell (346)

- Ask no more than five to seven sub-questions in addition to central questions
- Relate the central questions to the specific qualitative strategy of inquiry
- Begin the research questions with the words 'what' or 'how' to convey an open and emerging design
- Focus on a single phenomenon or concept
- Use exploratory verbs that convey the language of emerging design, use non-directional rather than directional words
- Expect the research questions to evolve and change during the study in a manner consistent with the assumptions of an emerging design
- Use open-ended questions without reference to the literature or theory unless otherwise indicated by a qualitative strategy of inquiry
- Specify the participants and research site for the study if not already provided

The initial interview schedules were developed by the primary researcher and reviewed several times for rigour and trustworthiness of content by all four other members of the research team who are experienced in research using qualitative methods [SC, AT, DS, and AS] (Appendix 4.16). An introductory general question around the participants' role was sought followed by more focused semi-structured questions specific to constructs of NPT. The interview schedules were then reviewed and refined further by all members of the research team followed by five expert reviewers both internal and external to academic staff at RGU. These experts were identified by members of the research team [SC and DS] as having vast experience in the topic under investigation:

- Professor Charles Swainson, eHealth clinical lead, General Council of the University of Edinburgh, Faculty of Medical Leadership and Management, University of Edinburgh
- Dr Lisa Kidd, reader, School of Nursing and Midwifery, Faculty of Health & Social Care, RGU
- Ian Rudd, director of pharmacy/CD accountable officer and HIV pharmacist, NHS Highland
- Dr Katrina Forbes-McKay, lecturer, RGU
- Pamela Mills, PhD student, RGU

In addition to two interview schedules, the expert reviewers were provided with background information on the subject via email communication from SC. They were requested to comment on the content of the questions in relation to the research objective and NPT. The interview schedules were modified with minor changes thereafter as per feedback offered. The schedule for participants with system experience is provided in Appendix 4.17 and post feedback in Appendix 4.18 as examples of questioning material.

4.2.9 Pilot interviews

Content and delivery of core and associated questions in interview schedules can improve through pilot testing (346). Individual face-to-face semi-structured interviews of approximately 35 minutes were piloted in Hospital B with a pharmacy technician who routinely utilised an automated medication storage and retrieval system, a ward nurse with no system experience, and a non-consultant

hospital doctor with previous experience of ePrescribing. Individuals were identified and recruited by the primary researcher who was familiar with participants. Interviews were audio recorded and reviewed by SC and AT specific to the primary researcher's interviewing skills and engagement with participants, as well as the quality of data generated via the structure, flow, and clarity of the interview schedules. It also provided an opportunity to review the length of time to conduct interviews. Minor amendments were made to the interview schedules and the pilot interviews were excluded from data analysis as a select number of interviewees with experience had already been chosen.

4.2.10 Data generation

Interviews were arranged and conducted sequentially per hospital by the primary researcher commencing in Hospital B followed by Hospital A and Hospital C between January and February 2016. The interviews were held within the specific hospital premises since this location was suitable for participants. Prior to commencement, signed informed consent and copyright clearance were obtained from all participants (Appendix 4.5). Interviewees were again provided with background information on the qualitative research and why they had been selected for interview. Participants were informed that they could withdraw from the study at any time without giving a reason and that the audio recorder could be turned off at any time at their request. They were then requested to complete a short background questionnaire which contained questions on profession, grade, years of experience, countries of practice, and any experience with using/implementing ePrescribing, robotic pharmacy systems, and/or automated medication storage and retrieval systems in a hospital setting (Appendix 4.19). The research team felt capturing this data may be of benefit during analysis to establish any trends with the above characteristics and emerging themes.

Interviews were guided by interview schedules which developed iteratively as they progressed to ensure true understanding of the data in order to direct the next stage of data generation (347). Associated probing and flexibility in interviewee responses were encouraged to ensure all relevant areas were discussed and to facilitate participants' personal perceptions and experiences of system implementation. At the end of the interview, participants were provided

with the opportunity to contribute any additional information deemed relevant not previously discussed and to review their own transcript for credibility.
All generated data were coded, anonymised, and securely stored. The signed consent forms were stored in a locked drawer in a hospital pharmacy office and the digital recordings, transcriptions, and all other electronic data were stored on an encrypted password protected computer. Access to data was restricted to the research team via a secure university network. Any records relating to the research will be destroyed after full dissemination of the research findings.

4.2.11 Data management and analysis

The two most commonly used transcribing techniques include naturalised, or verbatim, in which every utterance is captured in as much detail as possible, and denaturalised, in which grammar is corrected and interview noises such as pauses and stutters removed (348). In order to become immersed in the data, digital audio recordings of each interview were listened to several times and transcribed verbatim shortly after each interview by the primary researcher to allow further refining of the interview schedules as required. Audio recordings and transcribed data were coded for anonymity and verified for accuracy by SC and AT via allocating each research team member three transcripts for review against the recordings. This resulted in review of the first six transcripts.

Given the focus of this research was to identify *a priori* themes underpinned by NPT constructs, a framework analysis approach was adopted to facilitate a neat set of *a priori* codes. Other healthcare studies have employed a similar method of analysis with NPT (349)(350)(351)(352). This approach was first developed in the 1980s by social policy researchers and has grown in popularity as a means of analysing qualitative data derived from healthcare research (353). Framework analysis is most commonly used for thematic analysis of semi-structured interview transcriptions and is especially suited for qualitative research with predefined objectives, consistent with this project design. It is used to organise and categorise interview transcriptions into emerging themes and involves five inter-related stages as previously described in Chapter 2: familiarisation; identifying a thematic framework; indexing; charting; and mapping and interpretation (353)(354). Data tend to be a true reflection of the interviewee statement usually presented as anecdotes or direct quotes. This reflects an

inductive approach where the process is iterative and develops in response to data analysis through open coding followed by refinement of themes.

A summary of this approach is illustrated in Figure 4.2. Familiarisation involved the primary researcher transcribing the interviews verbatim and reading the transcriptions repeatedly whilst listening to the digital audio recordings. A thematic framework was identified by developing themes from re-reading the interview transcripts and highlighting significant quotes. Key words from the research objective identified some thematic codes as well as the recurrent themes from the transcripts. QSR NVivo11® qualitative data management software facilitated the sorting of codes during the indexing stage of data analysis. Charting was created by connecting the thematic codes according to how they related to each other by either merging or reducing themes. Mapping and interpretation involved searching for patterns, associations, concepts, and explanations of the data using verbatim quotes to illustrate themes.

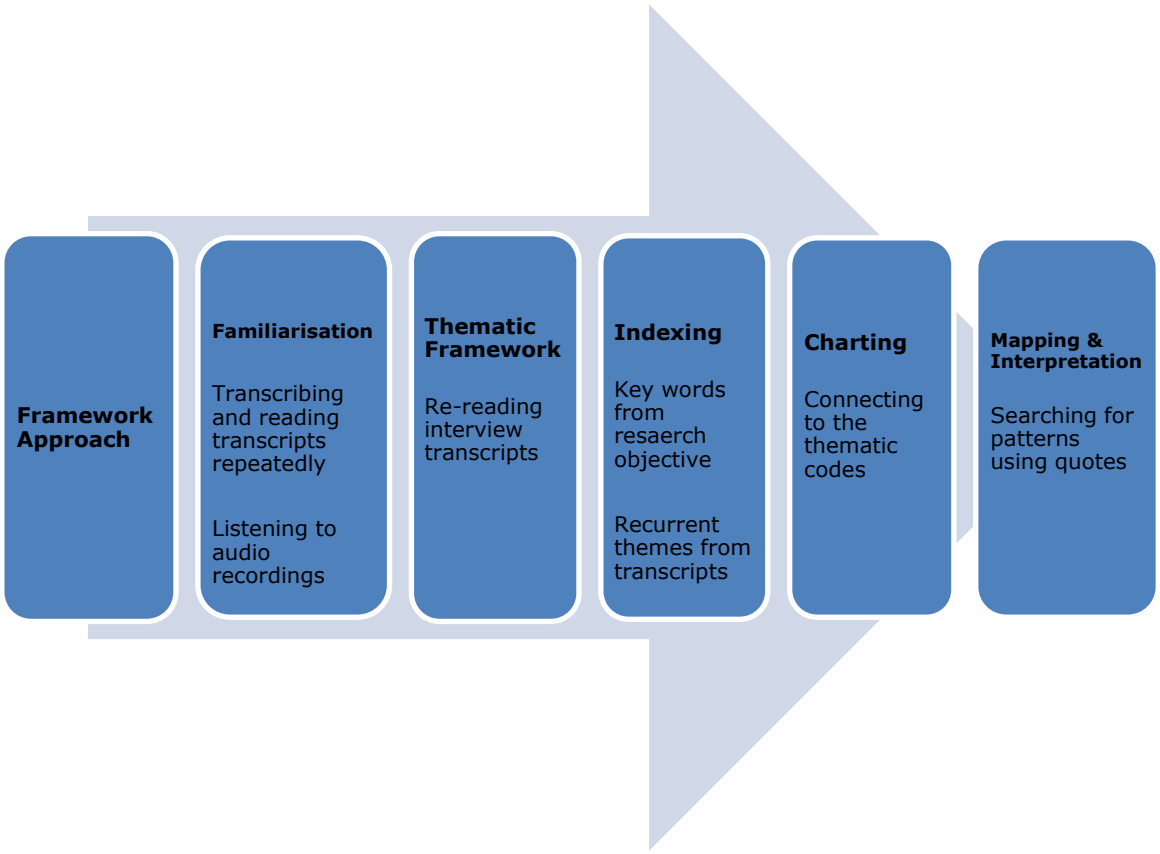

Figure 4.2: Summary of the framework approach to data analysis in this research

Independent analysis was conducted by the primary researcher and two other members of the research team [SC and AT] to confirm the trustworthiness of

emerging themes. This process involved dividing all transcripts equally among SC and AT, independently categorising potentially relevant quotes per NPT key constructs and components as either facilitators or barriers, and then comparing analysis with the primary researcher who analysed all transcriptions in a similar manner. Whilst very time consuming, this systematic approach enhanced rigour of data. No significant discrepancies were identified. Agreed thematic codes were then created by the primary researcher for each NPT component. Figure 4.3 illustrates a summary of the method of data generation and analysis employed.

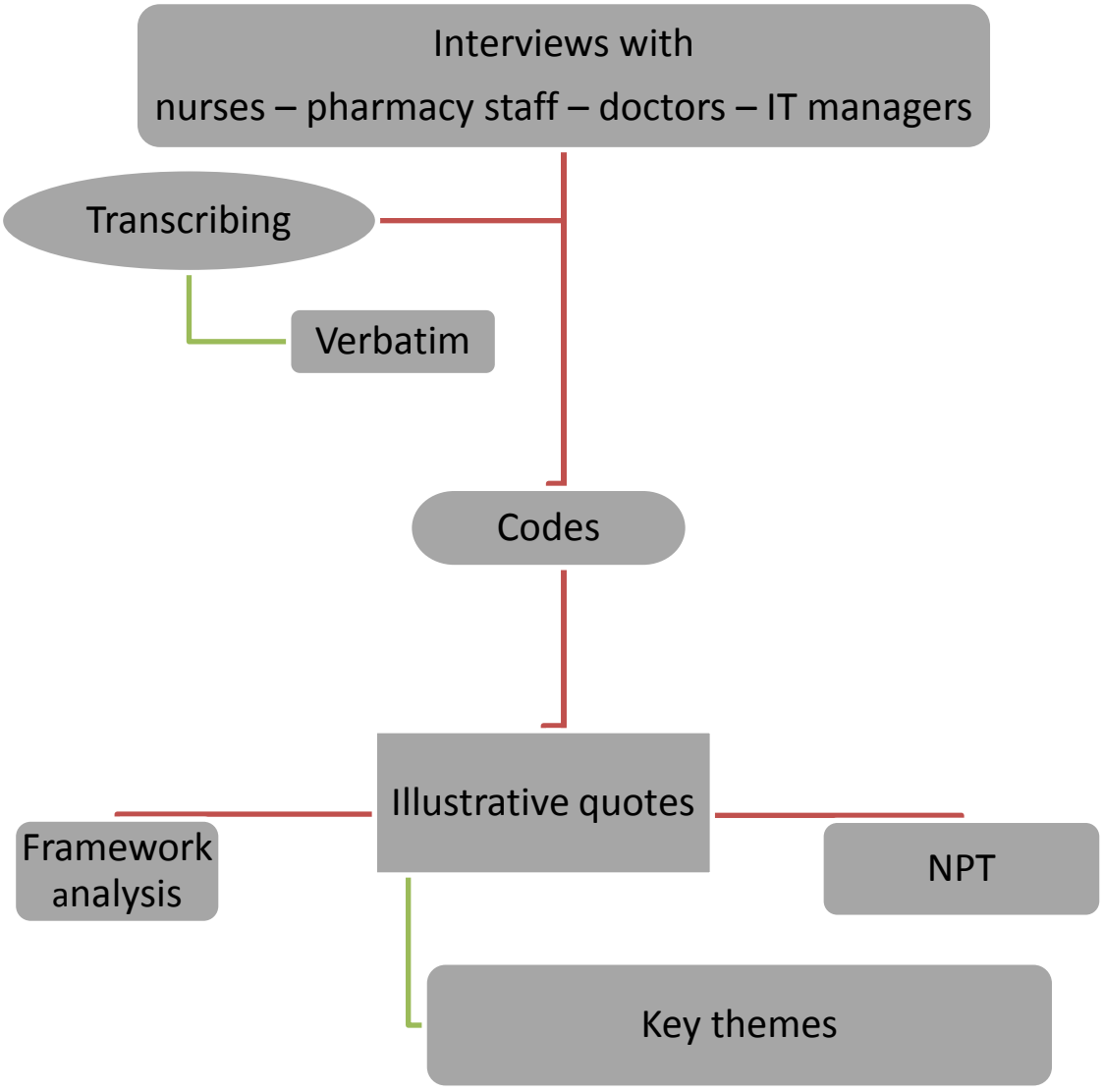

Figure 4.3: Qualitative process: method of data generation and analysis

4.2.12 Promoting research quality

Guba describes credibility, transferability, dependability, and confirmability as criteria used to enhance trustworthiness and rigour in qualitative research as previously detailed in Chapter 2 (355). Table 4.4 provides a framework of the quality employed throughout this research based on frameworks from Creswell (183), Stenton (255), and Guba (355).

Table 4.4: Quality framework in qualitative research adopted from frameworks from Creswell (183), Stenton (255), and Guba (355)

Quality framework	Method of application in this research
Credibility Confidence in the 'truth' of the findings	▪ In order to reduce bias of design and data generation, prior to commencing this phase of the research, the primary researcher attended relevant training ▪ In order to reduce interviewer bias, the primary researcher has no vested interest in findings which impact on either positive or negative perceptions towards system implementation ▪ In order to reduce sampling bias, triangulation of data sources from an array of different professions, grades, and hospitals were invited for interview widening the spectrum of interviewees from those with no experience (pre-implementation) to those recently exposed (seven months post-implementation) to those with extensive experience (>10 years post-implementation) ▪ Participants were informed of the possibility of withdrawal from the study at any stage of the research ▪ All aspects of the research were reviewed by the research team who have vast experience in qualitative research ▪ The personal experience and training of the primary researcher continued to broaden during this research to consider a more naturalistic human approach to system implementation and to understand the complexities involved through utilising NPT
Transferability Demonstrating findings have applicability in other contexts	▪ A description of contextual factors such as participants working environment is important to assist in transferability. Information such as the number of participants involved and where they were based, any restrictions in the type of participants who participated, the number and length of data collection interviews, and the time period over which data was generated was provided in order to convey the boundaries of the study ▪ Analytical claims were made transparent by ensuring all emerging themes were rooted in raw data ▪ Provision of quotes throughout the results section enables readers to contextualise and assess the relevance in their own context. The criteria for selection of quotes were representative of the most recurrent and poignant research findings

Quality framework	Method of application in this research
Dependability Showing findings are consistent and could be repeated	▪ Dependability has been offered through the use of a qualitative method and detailing the processes within the study. Included were details of the research design, data generation, data analysis, and reflective appraisal of the research. This in-depth methodological description will allow the study be repeated ▪ The interview schedule was embedded with theory and was tested and checked by the research team and five expert reviewers ▪ The COREQ checklist for reporting in-depth interviews was applied
Confirmability The extent to which findings are shaped by respondents and not researcher bias, motivation, or interest	▪ Participants were provided the opportunity to review and comment on their transcripts ▪ All transcripts were independently reviewed and analysed by members of the research team ▪ Data analysis was considered from within and across different professional groups and hospitals facilitated by the framework approach and NVivo11© software for data management ▪ Limitations of the method were made clear ▪ Use of figures and tables assisted in demonstrating clear methods and interpretation of data

4.3 Findings from the qualitative interviews: general analysis

4.3.1 Participant demographics

Twenty-four nurses, pharmacists, pharmacy technicians, doctors, and hospital IT managers were invited to participate in individual face-to-face semi-structured interviews. As illustrated in Figure 4.4, one hospital IT manager declined to participate without providing a reason.

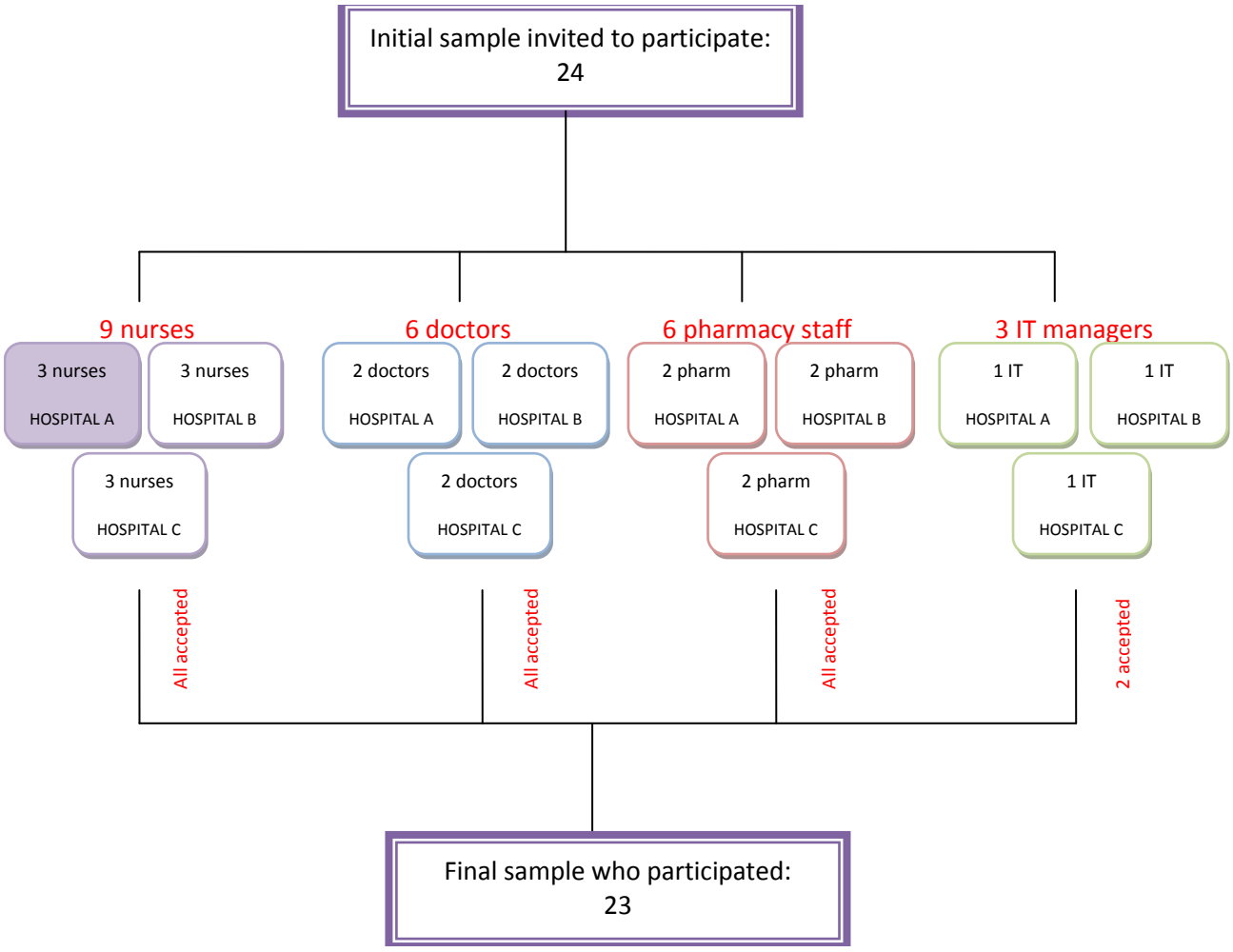

Figure 4.4: Participant sample

Data saturation was deemed to have occurred by the primary researcher and two other members of the research team [SC and AT] in terms of thematic ranges and hence further recruitment was not undertaken. All participants who accepted the invite to be interviewed completed a background questionnaire with results summarised in Table 4.5. The range of included participants provided diversity of professional and personal characteristics.

Table 4.5: Participant characteristics (n=23)

Characteristics	n
Sex	
Female	16
Male	7
Healthcare professionals	
Doctors	6
Nurses	9
Pharmacists	4
Pharmacy technicians	2
Hospital IT managers	2
Grade	
Senior	15
Junior	8
Years of experience in profession	
< 1 year	1
1-5 years	2
6-10 years	2
11-15 years	3
16-20 years	5
21-25 years	4
26-30 years	2
31-35 years	1
>35 years	3
Practised in countries outside Ireland	13
Countries	United Kingdom Jersey Island Pakistan New Zealand Australia
Experience of using/implementing ePrescribing	4
Experience of using/implementing robotic pharmacy systems	1
Experience of using/implementing automated medication storage and retrieval systems	13

The median years of professional work experience was 16-20 years and the majority of participants had practiced outside of Ireland and had system experience. Table 4.6 provides more detailed demographic data and codes for the 23 participants who agreed to be interviewed.

Table 4.6: Demographic data and codes for interviewees

Profession (grade)	Sex	Years experience	Experience abroad	Experience with system implementation
N1 – Nurse (junior)	F	26-30 years	No	Automated storage & retrieval systems
N2 – Nurse (manager)	F	>35 years	No	No
N3 – Nurse (senior)	F	31-35 years	No	No
N4 – Nurse (manager)	F	21-25 years	No	Automated storage & retrieval systems
N5 – Nurse (senior)	F	16-20 years	Yes	No
N6 – Nurse (manager)	F	26-30 years	Yes	Automated storage & retrieval systems
N7 – Nurse (junior)	F	16-20 years	Yes	No
N8 – Nurse (junior)	F	21-25 years	Yes	Automated storage & retrieval systems
N9 – Nurse (manager)	F	>35 years	Yes	Automated storage & retrieval systems
P1 – Pharmacist (senior)	F	11-15 years	Yes	ePrescribing, robotics, and automated storage & retrieval systems
P2 – Pharm tech (junior)	F	6-10 years	No	Automated storage & retrieval systems
P3 – Pharmacist (junior)	F	<1 year	No	No
P4 – Pharmacist (senior)	F	16-20 years	Yes	Automated storage & retrieval systems
P5 – Pharmacist (senior)	M	16-20 years	No	Automated storage & retrieval systems
P6 – Pharm tech (senior)	F	11-15 years	No	Automated storage & retrieval systems
D1 – Doctor NCHD	M	1-5 years	Yes	ePrescribing
D2 – Doctor (consultant)	M	21-25 years	Yes	ePrescribing and automated storage & retrieval systems
D3 – Doctor (NCHD)	M	1-5 years	Yes	No
D4 – Doctor (NCHD)	M	11-15 years	Yes	No
D5 – Doctor (consultant)	F	21-25 years	Yes	No
D6 – Doctor (consultant)	M	16-20 years	Yes	ePrescribing
IT1 - IT manager	M	>35 years	No	Automated storage & retrieval systems
IT2 - IT manager	F	6-10 years	No	Automated storage & retrieval systems

4.3.2 Interview and transcription length

Interviews varied in length of time from 19 minutes to 78 minutes and the median time was 38 minutes. Transcriptions differed in length from 3275-14071 words and the approximate time to complete was four months.

4.3.3 Type of systems participants discussed

Doctors mostly discussed ePrescribing systems, nurses and hospital IT managers mostly discussed automated medication storage and retrieval systems, and pharmacy participants mostly discussed automated medication storage and retrieval systems and robotic pharmacy systems, as illustrated in Table 4.7.

Table 4.7: Type of systems participants discussed

Profession	ePrescribing	Robotic pharmacy systems	Automated medication storage and retrieval systems
Nurse (n=9)			
Experience	-	-	5
No experience	1	-	3
Pharmacy (n=6)			
Experience	-	1	4
No experience	1	1	2
Doctor (n=6)			
Experience	1	-	1
No experience	3	-	2
IT (n=2)			
Experience	-	-	2
No experience	-	-	-

4.4 Findings from the qualitative interviews: thematic analysis

Eight key themes emerged from data analysis using NPT as a theoretical framework, as summarised in Table 4.8.

Table 4.8: Summary of key facilitator and barrier themes related to NPT constructs and components

Key themes	NPT constructs and components	Facilitators	Barriers
Theme 1: Understanding of how electronic systems differ from manual practices and the value of system implementation	**Coherence:** Differentiation Internalisation	Patient safety Efficiency: - Stock control - Traceability - Accountability - Cost reduction - Integration	Time inefficiencies Security issues Logistics of changing system
Theme 2: A need to work together to build a shared sense of purpose for system implementation and have a clear understanding of individual roles and responsibilities	**Coherence:** Communal specification Individual specification	Work together to understand reasons for implementation Participants with experience had a clear understanding of their roles	Limited communication on implementation Participants without experience had a limited understanding of requirements
Theme 3: A need for clinical leadership, champions at ward level, and a multidisciplinary implementation team to promote buy-in	**Cognitive participation:** Enrolment Activation Initiation Legitimation	Clinical champions to promote benefits and engagement via effective communication Early adaptors Multidisciplinary team approach	Older generation may not realise benefits as easily as younger generation Resist work changes: - Lack of prioritisation - Force of change - Limited involvement - Bureaucracy - Lack of recognition of professional roles
Theme 4: A need for adequate training and organisational support	**Collective action:** Skill set workability Contextual integration	Sufficient training Sufficient support and resources Robust governance	Training not sufficient Inadequate support No additional resources

Key themes	NPT constructs and components	Facilitators	Barriers
		Operational guidelines	
Theme 5: A need for electronic systems to be easier to use than manual systems	**Collective action:** Interactional workability	Light guided Ease of stock management Sufficient number of systems Mobile units nearer the patient	Manual system easier as more patient-focused and less task oriented Workflow issues e.g. time delays in queuing, limited accessibility, inadequate numbers/sizes of units resulting in delayed medication administration
Theme 6: A need for a sense of confidence in system use	**Collective action:** Relational integration	Safety alerts Double checking Clear record Confident with familiarity	Lack of confidence with identifying drugs Substantial time away from patients
Theme 7: A need to use systems as intended	**Reflexive monitoring:** Reconfiguration	Alter system use for efficiency e.g. recheck chart before administration	Not using system as trained e.g. trolley to carry drugs for multiple patients increasing risk of errors
Theme 8: A need to measure and audit practice	**Reflexive monitoring:** Communal appraisal Individual appraisal Systematization	Auditing of practice e.g. cost, time, end-user satisfaction	Limited formal measures Unable to determine actuality from reality

Key themes are now described in more detail with associated subthemes on facilitators and barriers towards system implementation.

Theme 1: Understanding of how electronic systems differ from manual practices and the value of system implementation

Participants had a clear understanding of the aim of implementation, with key concepts of enhanced patient safety and efficiency evident. Concerns over the possible negative consequences of system adoption were also verbalised.

Subtheme 1: Enhanced patient safety and efficiency

Legibility of prescriptions, CDS, accurate drug selection, and reduced medication errors were perceived to improve patient safety with implementation.

> *"There would be less errors in terms of not being able to read what the prescription is and the doses…I think safety has to be the biggest value you can get from it". (Senior nurse N5)*

Stock control, traceability, accountability, cost containment, and integration of systems to enhance patient flow and communication between professionals were other perceived benefits.

> *"If you have the systems right the way through from prescribing to dispensing, then you should have a continuous log that is retrievable". (Consultant doctor D6)*

Limitations of the current manual system articulated by participants supported this theme, with an expectation of improved patient safety and better transfer of information with new work practices.

> *"The current system is designed for loads of errors to occur, either in the prescription with illegibility issues or with the medications given, it is appallingly poor and inherently unsafe. Automated systems would be far more superior from a patient safety and workflow perspective". (Consultant doctor D2)*

Subtheme 2: Negative consequences with electronic system implementation

Participants expressed concern over possible negative variations between electronic and manual systems such as potential time inefficiencies, security issues, and logistics of changing from manual to automatic.

"Any electronic system, it doesn't matter how streamlined you put it, it will be a hindrance because it will slow down processes". (Consultant doctor D5)

Theme 2: A need to work together to build a shared sense of purpose for system implementation and have a clear understanding of individual roles and responsibilities

Participants perceived different professionals had differing ideas of the purpose of the system and that some individuals would work together to build a shared understanding of the reasons for implementation, and others would not.

"I think different people have different ideas about a system. The management idea is often very different to the users' idea, or the pharmacy aspect might be different to the nursing aspect". (Senior pharmacist P1)

"Some would work together and understand the long overdue reasons for implementation. Others just wouldn't want it". (NCHD doctor D1)

Subtheme 1: Understanding dependent on system experience

Participants with system experience had a clear understanding of their roles, including responsibility for planning and monitoring implementation, delivering adequate training to end-users, and becoming familiar with policies and protocols.

"My role is really to assist in planning for the implementation of the system and for monitoring the implementation of the system in relation to nursing practice". (Nurse manager N6)

"Well with pharmacy staff, they are responsible for stocking drugs and ensuring that expiry dates are entered correctly and things like that. With us I suppose our responsibility is to ensure that we are removing the correct amount of drugs and we have put them in properly". (Junior nurse N1)

Participants without system experience had a limited understanding of what was required for implementation.

"It is all theory to me, I know vaguely what electronic prescribing is but how actually it works, I don't, it might be a more arduous task, I don't know yet. So that is the fear I suppose". (Senior nurse N5)

Subtheme 2: Limited communication

A perception of limited communication with colleagues on implementation resulted in participants either unable to determine if there was a shared sense of purpose or believing there was not enough information available to have a comprehensive shared understanding.

> *"Well I don't know because I haven't spoken to my working colleagues about it...this hasn't been generally spoken about among my medical division, so I mean generally the thinking is from my colleagues that we are going down the road of becoming more technological, more IT. But from a perspective of drugs, pharmacy this hasn't been spoken about really". (Nurse manager N2)*

Theme 3: A need for clinical leadership, champions at ward level, and a multidisciplinary implementation team to promote buy-in

Evidence of both key stakeholders driving implementation and resistance to work practice changes with limited end-user involvement was apparent. A multidisciplinary team approach, clinical leadership, and champions at ward level were key concepts perceived to promote engagement with system implementation. Selecting early adaptors was also believed to be of benefit.

> *"I think maybe having champions at ward level, where they are involved in all pre-discussions and planning meetings...try and get protected time for nursing to be part of the project implementation group to be more involved in the policies and reviewing what would work well for their ward." (Senior pharmacist P1)*

Subtheme 1: Evidence of key individuals driving system implementation

It was evident that key individuals in a managerial role were willing to initiate and drive system implementation via engagement with company representatives, business case submissions, and visiting other hospitals who had adopted systems. Having a good team to support implementation with effective communication and information sessions on projected benefits were mechanisms of promoting engagement.

> *"I have a business case submitted into management at the minute for a medication storage and retrieval system and every week I send a reminder of the benefits, the safety implications, and the cost saving implications". (Senior pharmacist P4)*

> *"You know it is getting the consultants from the prescriber's point of view, the nurse prescribers, you know to buy-in and really having a working*

group that actively promote it and look at the advantages and just keep reminding people, it is brain washing really". (Senior nurse N5)

Whilst participants believed it was right for them, and were interested, in getting involved in system implementation, they felt the younger generation could realise the benefits more easily.

"All of the young nurses that are coming out now instead of in my generation, they are all up to speed with technology and it would become second nature to them". (Nurse manager N2)

Subtheme 2: Resistance to work practice changes

Resistance to change due to force of change in practice, limited involvement with end-users, bureaucracy, and lack of prioritisation for implementation were viewed as barriers to active participation.

"The culture of resistance is massive especially in an organisation like this where there are a lot of people employed for a long time". (IT manager IT1)

Nurses felt their professional role should be acknowledged more as a significant contributor to successful implementation.

"I think that nursing staff is a hugely important stakeholder and that they should be on board and they should have that acknowledged. Nursing as a profession doesn't get acknowledged enough with changes and moves". (Junior nurse N7)

Theme 4: A need for adequate training and organisational support

Another key theme that emerged was the need for adequate training and organisational support for successful implementation.

Subtheme 1: Training, resource investment, and robust governance

Small group hands-on training sessions, superuser support, training in areas only applicable to the user, phased training per ward, and sufficient time to train and adjust to new work practices were viewed as beneficial.

"You would have a core group of superusers that are the train the trainers type people and then people taught appropriate to their point of usage, because I don't want training in every aspect of it that I am not going to be using because it will dilute what I remember of what is applicable to me". (Senior nurse N5)

Resource investment and robust governance inclusive of developing and disseminating policies and protocols, contingency plans, and completing risk and competency assessments were also perceived as facilitators for successful system implementation. In addition, responsive end-user feedback during implementation emerged as beneficial.

> *"You are going to need money, you are going to need resources. You would need your policies and protocols and what you are going to change". (Consultant doctor D6)*

> *"I guess feedback is a big thing, we do have a book on the ward where nurses write down any issues and then we would feedback what the result was. Also nurses can feedback to the pharmacy staff or the nurse manager and we always take it on board...if I have any ideas for improvement or think something is not working I tend to feed this back to my manager and it is usually implemented." (Junior pharmacy technician P2)*

Participants perceived operational guidelines assisted with supporting system implementation and understanding the effects of the new system on individuals' roles and responsibilities and training needs.

> *"Omnicell gave us their operational guidelines and then we drafted our own local guidelines where we outline the roles and responsibilities for all staff, from medical staff, nursing staff, pharmacy staff, IT staff, and then the company trainer and the out of hours support". (Senior pharmacist P1)*

<u>Subtheme 2: Inadequate resources and management support</u>

A number of participants believed there were no additional resources provided which slowed down work processes, especially if staff were not trained during initial implementation.

> *"We haven't gained any staff and that was something we had hoped would be looked at...very much the new staff are told 'this is how you log in' and then it is very much the staff on the ward will say 'this is what you need to do'". (Nurse manager N4)*

Participants perceived inadequate management support was provided with little consideration to the effects of system implementation on work practices. It was felt more engagement would have resulted in more responsibility and acceptance of system use.

"I think initially it was very much this is just something you are going to do and it was never really given the amount of thought of how much this was going to change the way the ward worked. So in terms of nursing support I don't feel there was a great deal there". (Junior nurse N8)

Theme 5: A need for electronic systems to be easier to use than manual systems

Ease of use with guiding lights and enhanced efficiency in relation to stock availability were perceived as facilitators to adoption.

"It is a huge turn around and they see the advantages and the time that was wasted every day for nurses sending down requisitions and the pharmacist ringing back questioning it and there was a whole conversation going on". (Nurse manager N9)

However, nurses felt the manual system was easier to use and more patient-focused and interactive. The new system was viewed as more task oriented.

"It is going back to a task, we have got to go and get the drugs from the machine, so it is a task, but before there was more of a subtle dynamic in it and maybe we weren't even as aware of it. The drugs were very linked with patients, you had the visual cues". (Nurse manager N6)

Subtheme 1: Workflow delays

Workflow issues and time delays in queuing to remove drugs from the system resulting in patients waiting for medicines were viewed as substantial barriers to system compatibility with existing practices. This was mainly due to inadequate numbers and sizes of units impacting on administering medication as prescribed, retrieving medications in an emergency, and discharging patients. Further delays in inputting controlled drugs and limited accessibility due to digital biometric fingerprint recognition issues, locum staff and healthcare assistants (HCAs) not having access privileges, and pharmacy technicians stocking the machine were also viewed as frustrating. Instalment of additional systems and mobile units nearer the patient was perceived as a key requirement.

"You might have 31 patients to get their medicines for around that time with one point of access. Previously on the ward we would have had at minimum six points of access. We need more systems in place". (Nurse manager N6)

"The problem is it is not big enough, there is not enough space in them". (Senior pharmacist P5)

Pharmacy participants also believed the new system was more time consuming and involved more work than the manual system, such as two people re-stocking the machine and repeating work if the stock balance was incorrect.

> *"It is more work with Omnicell without a doubt. Even the time it takes to put stuff away. What happens if somebody puts the wrong thing in the wrong place, which can happen easily? So for a long time two people were going up and putting away the top up." (Senior pharmacist P5)*

Theme 6: A need for a sense of confidence in system use

Another key theme was the need for confidence in system use. Mixed perceptions of the system were evident.

Subtheme 1: Confidence in system use with safety alerts and records

Safety alerts such as gentamicin and vancomycin therapeutic drug monitoring and administration instructions, two people double checking stocked items in the machine, and comprehensive records of retrieved medication enhanced a sense of confidence and accountability in using the system.

> *"I was having trouble reading a drug kardex as I often do and I went back to look what the person previously gave and they had given what to me it said". (Junior nurse N8)*

In particular, assurance based on individuals becoming more familiar with the system was evident.

> *"I think as people are getting more familiar and more confident with it they are getting to understand it better...staff who had a lot of angst in the beginning I know with speaking to them they are less anxious about it now". (Nurse manager N6)*

Subtheme 2: Lack of confidence and substantial time away from patients

Lack of confidence with identifying individual drugs when removed from the machine for patient administration was viewed as a key barrier.

> *"When you have retrieved the drugs you are dispensing them into a pot, you actually can't tell the difference between the different drugs unless you are familiar with them". (Nurse manager N6)*

New work dynamics of substantial time away from patients and interruptions were viewed as other safety concerns.

"So now we spend a lot more time away from the patient getting medication for them and then the problem is once you leave that area, you're pulled at for loads of other things. It is very distracting cause it takes your focus away for possibly 10 or 15 minutes...it hasn't helped nursing in relation to one-to-one care with patients." (Nurse manager N4)

Participants felt expectations were not met with system implementation.

"We believed we were going to have this great pharmacy system and that every medication we wanted was going to be in it and there would be no delays administering drugs, there would be no delay in getting medication and it would be a safe system, but actually bar using what we are going to need in the machine the rest of the system stays the same". (Nurse manager N4)

Theme 7: A need to use systems as intended

Nursing and pharmacy participants felt they reflected on work practices following system implementation and adjusted practices accordingly for efficiency purposes. This included discontinuing pre-ordering of drugs, more night time ordering of drugs, re-checking the medication chart at the bedside before drug administration, and altering the method items were double checked by pharmacy technicians when stocking the system.

"Now we make sure that we check the drug kardexes again at the bedside, we had discussed that before, just to try and reduce errors". (Junior nurse N1)

Subtheme 1: Lack of using the system as trained and to its maximum benefit

Various participants felt some individuals did not use the system as trained, such as removing more medication than requested leading to inaccuracies in drug amounts in the machine in comparison to what was reported.

"It is not fool proof, you can find a way round it, so if you go in for Panadol®, you can take out two or three and tell it you took out one...we do know where stock is in theory, but we are still relying on people to remove things as they are supposed to." (Senior pharmacist P5)

Other alterations included accessing pharmacy outside of opening hours for drugs already stocked in the machine, gaining access to prohibited functions of the system, and storing stocked medication outside the machine. The use of a trolley to carry drugs for multiple patients at one time was perceived as

increasing the risk of errors and accessing the system for long periods. This was also viewed as an intermediary step in the electronic process.

> *"In A&E they go from system to patient, but on the medical wards they use trolleys, so they remove the meds, put it into a specific trolley with specific drawers for the patients, so they could hold up the system for maybe an hour... there is an increased risk of errors, it should be system to patient but because of the size of the medical wards and only having one machine there is risk of errors in administering the wrong patient the wrong medication". (Senior pharmacy technician P6)*

Lack of using the system to its maximum benefit was also perceived as a disadvantage, such as availing of CDS and integration of systems.

> *"There are a lot more capabilities that we have yet to implement and there is also the possibility of linking other systems into it". (IT manager IT2)*

Theme 8: A need to measure and audit practice

Whilst not many formal methods of measuring the impact of system implementation were in place, reviewing financial reports, complaints, stock counts, and medication waste were believed to be effective ways of identifying facilitators and barriers to implementation.

> *"We did a financial report in pharmacy in a three month period prior to the systems being installed and a three month period after and there was a cost saving of between 15–17%". (Senior pharmacy technician P6)*

Auditing of practice was perceived as another way of identifying benefits or problems and in understanding the systems value and requirements for future improvements. This included time comparisons between the new and old system, end-user perceptions before and after system implementation, error rates, and level of training.

> *"There was an audit done in the last few weeks and currently we are spending more time on the Omnicell than we would with the manual top up system, but that is because we have two members of staff going to the ward to fill the Omnicell so I think that is an issue around training as well so the managers plan is to get that down to one person". (Junior pharmacy technician P2)*

Measuring and auditing practices were also viewed as important in determining actuality rather than perceptions.

"You have always got to bear in mind, what staff sometimes say isn't always the reality, it could be a perception rather than the reality so that is why we have to bring in more measurement to see is it actually what is happening or is it what they think is happening so I have to do that, the two could be different". (Nurse manager N6)

4.5 Discussion

This section provides an overview of key findings in relation to the research objectives, considers methodology strengths and weaknesses, and interprets findings inclusive of comparisons with published literature.

4.5.1 Statement of key findings

The objective of this phase of the research was to explore the perceptions of local key stakeholders towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework. Twenty-three individual face-to-face semi-structured interviews were conducted with nurses, pharmacists, pharmacy technicians, doctors, and hospital IT managers in three different hospital settings in Ireland. Framework analysis aided data interpretation. Utilisation of NPT enabled systematic identification of key themes and all four constructs and components were significant to topics discussed during the interviews. As coherence and cognitive participation relate more to planning implementation (141), perceptions of participants without system experience dominated these constructs. Participants with system experience predominately provided insight into enactment and reflections on system adoption and use, with the addition of multiple comparisons to the manual medicines management system.

Themes expressed by different professional groups with no experience and with varying levels of experience were on the whole consistent. Patient safety was the primary focus for all professional groups. The main difference included nurses overall rejection of system implementation, and others acceptance. Doctors were more interested in discussing ePrescribing, whilst all other professional groups focused on automated medication storage and retrieval systems. Facilitators and barriers were collectively similar and not dependent on system type or experience. Demographic factors such as age, gender, seniority in role, and years of work experience were inconsequential to response patterns.

Findings from implementers and end-users' perceptions of system adoption draw attention to issues around implementation which are multifactorial and complex at both an individual level and organisational level. Demonstration of coherence and cognitive participation were key drivers for success or failure at the initial stages of implementation. It was clear that individuals would engage and buy-in to implementation if the system was viewed as beneficial in improving work practices. Whilst some participants perceived key individuals were willing to drive implementation, force of change in practice, limited involvement, and lack of understanding of the impact of adoption on services were evident. Negative attitudes acted as obstacles to enrolment, such as beliefs that the system would disrupt the delivery of care, distrust in system use, and a culture of resistance to change. A range of strategies to initiate and legitimise participation in the implementation process included fostering a culture of clinical champions and selecting early adaptors for implementation with the support of a multidisciplinary team.

Further operational work and investment in resources and ongoing staff, contingency, and policy support were needed by individuals and organisations to enhance implementation processes and facilitate collective action, particularly with the nursing profession. Providing a period of transition in which end-users can become familiar with and learn how to use the new system was also required. In terms of ease of use and confidence in the system, resistance was evident due to perceived added complexity, effort, and time. In particular, workflow issues with time away from patients, additional interruptions, and accessibility issues ultimately impinged on delayed administration of medication to patients. Findings from this study highlight the challenges of integrating new systems with existing work processes and the introduction of new risks. Participants felt medicines management would improve with the instalment of additional units nearer the patient. Incorporating workflow analysis into system design, integration of systems into the usual process of care, and minimising workflow interruptions were required to facilitate successful implementation.

Participants understood ways of appraising the system post-implementation in order to consider its effect on work practices. Concerns with system usability led to the development of workarounds by end-users. As limited formal methods of

reviewing facilitators and barriers post adoption were identified, key themes which emerged within this study are predominantly participants' perceptions and may not align with actuality. It is also possible that some benefits such as time savings may have been masked by other frustrations arising from complex work processes. A need to promote reflexive monitoring to evaluate the outcomes of system implementation on patient care and workflow was evident.

4.5.2 Consideration of strengths and limitations

There are numerous strengths to this study. As highlighted in the systematic review findings, limited published qualitative studies exist on facilitators and barriers to implementing electronic systems for medicines in hospitals (337). Findings have generated original knowledge and understanding in processes of system implementation. A rigorous approach was adopted to all aspects of this qualitative research and trustworthiness was evident throughout, as further described in Chapter 2 and Table 4.4 which are based on frameworks from Creswell (183), Stenton (255), and Guba (355). In summary, members of the research team brought vast expertise to development of the methodology, coding of results, and interpretation of the findings; the research design was described clearly; the interview schedules were grounded in theory, reviewed by all research team members and five experts, and developed iteratively; and the coding framework and thematic analysis were independently reviewed by three members of the research team. COREQ was also applied which comprises a 32-item checklist for reporting in-depth interviews.

NPT was considered to be of benefit by all members of the research team in providing an explanatory theoretical framework for identifying factors that promote and inhibit system implementation and in understanding the complexities involved and work needed to be done. This is consistent with a qualitative systematic review of studies using NPT to research implementation processes by McEvoy et al which found strong endorsement of the benefits of using NPT as a conceptual framework to analyse implementation processes and inform recommendations to guide implementation work (344). They also identified scope for NPT to be used during the planning stages of implementation to explore the real-world context in which work will take place and provide data to cease planning if the likelihood of normalisation is low (344).

Triangulation of data sources and investigators involved a variety of hospital sites, heterogeneous participants, and analysts in order to facilitate deeper understanding and ensure data were rich, robust, comprehensive, and well developed (356). Findings from the systematic review were compared with those from the qualitative phase, thereby facilitating triangulation of research methods. Sampling bias was minimised using stratified purposive sampling which is a recognised sampling method (241)(242). Many papers in the qualitative systematic review by McEvoy et al of studies using NPT to research implementation processes included single-stakeholder perspectives with an emphasis on service providers rather than service users which was viewed as a limitation to inform implementation processes (344). This primary research included both implementers and end-users. To minimise reporting bias, participants were clearly informed of the research aim and given sufficient opportunity to contact the researcher and research team to clarify any issues. Participants were assured confidentiality and anonymity of data and informed there was no right or wrong response to questions. Participants were also encouraged to share relevant views and experiences not covered by the interview schedule. It was clear that participants felt comfortable throughout the interviews, with comments such as "*you better delete that*" and "*I probably shouldn't say that but...*" and "*off the record...*". Interviews were audio recorded and transcribed verbatim shortly after each interview by the primary researcher to ensure recorded information accuracy. Transcriptions were thereafter reviewed for dependability by the primary researcher and two members of the research team and participants were also offered the opportunity to review their own interview transcript for further confirmability. In addition, a number of peer reviewed papers including conference proceedings were presented with constructive feedback.

Reproducibility of the method employed can be achieved from clear descriptions of data generation and analysis processes. The phenomenon of interest was described in sufficient detail in order to evaluate the extent to which conclusions drawn can be transferable to other times, settings, situations, and populations. This included describing the structure of NPT constructs and emerging themes and subthemes, as well as the integration of concepts, relationships, and

interpretations. Trustworthiness was further established by comparing and contrasting findings and data interpretation supported by other authors.

A researcher's background and position shapes what they choose to investigate, the angle of investigation, the method judged most adequate, the findings considered most appropriate, and the framing and communication of conclusions (357). From a personal stance, the primary researcher works as an antimicrobial pharmacist in a university teaching hospital in Ireland and has no bias or preconceived ideas to any potential outcomes of the study. Background knowledge into this research was gained through undergraduate and postgraduate degrees in pharmacy, clinical pharmacy, psychology, computer science, and IT; review of the literature; and previous work involvement in implementing an automated medication storage and retrieval system. A planned site visit was also conducted in 2015 in Hackensack University Medical Center, a 900-bed teaching hospital in New Jersey in the USA, to view their award-winning closed loop medicines management system comprising ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems within an integrated EHR.

As the primary researcher's interest in NPT only emerged during this research, bias in defending or justifying or refuting this theory was not an issue. The primary researcher was interested in identifying both facilitators and barriers to system implementation and therefore did not influence participants on either stance. The primary researcher has some experience of conducting individual face-to-face semi-structured interviews and analysing data using the framework approach as part of completing a master's thesis in clinical pharmacy (135). Formal training in qualitative research was also completed, as listed in Appendix 2.1. In addition, pilot interviews conducted with a pharmacy technician, ward nurse, and non-consultant hospital doctor with and without system experience permitted the primary researcher to gain more experience in interview techniques. Standard meetings via phone and videotelephony to discuss research matters and further direction were carried out approximately once weekly with the primary researcher and principal supervisor [SC], and with other members of the research team approximately once monthly or when required.

Some limitations also exist. It is acknowledged that conducting face-to-face interviews is labour intensive and can be costly depending on where interviews take place and how much travel is required. Much effort and time was spent understanding NPT constructs and their differences resulting in an initial concern of possible repetition of coding or miscoding of constructs leading to analysis not reflective of NPT. Similar views have been shared in the application of constructs and the overlap and difficulty of discerning the differences between components (358)(359), in addition to the efforts required in developing each of the constructs within the complexity of current organisational practices (360). However, findings from the qualitative systematic review of studies using NPT to research implementation processes by McEvoy et al assisted in coding participants with no system experience to coherence and cognitive participation and all four constructs to those with system experience (344).

Whilst data saturation was considered to be achieved for the overall sample after 23 interviews with eight nurses, four pharmacists, two pharmacy technicians, six doctors, and two hospital IT managers, there was no certainty that data saturation was achieved for each profession given the relatively small sample size included in the qualitative study. In addition, as the primary researcher was not familiar with all key stakeholders, pharmacy participants in two hospitals were requested to recommend a small number of potential invitees, possibly leading to sampling bias. Another possible limitation to this research was site triangulation from three acute general hospitals in the public sector in Ireland. Even though qualitative research findings do not aim to be transferable, there is a possibility that results may not be transferrable to other hospital settings such as private hospitals, tertiary hospitals, specialist hospitals, and hospitals outside of Ireland. It is hoped, nevertheless, that this robust, theory-driven research will provide relevant and applicable concepts for implementers planning adoption.

4.5.3 Interpretation of findings

Integrating new ways of working in hospitals has been challenging. Findings presented in Chapter 3 derived through analysis of a systematic review were similar to findings from this primary research. Healthcare professionals perceived systems improved patient safety and provided better access to patients' drug records and that team leadership and hardware/software availability and

reliability were essential for successful implementation. Key barriers included hardware and network problems, altered work practices, and weakened interpersonal communication between healthcare professionals and with patients (337). There was more of a focus on ePrescribing systems in the systematic review and automated medication storage and retrieval systems in the primary research.

Another systematic review on factors that promote or inhibit the implementation of eHealth by Mair et al published in 2012 using NPT as a conceptual framework included 37 review papers mainly of poor quality with a high potential for bias and from North America (141). Continued focus on organisational issues and problems related to eHealth systems workability were identified with little consideration to the broader social structures. Comparable with this primary research, little attention was given to work directed at making sense of eHealth systems, effects on roles and responsibilities, methods of engaging with professionals, and ensuring potential benefits of implementation were apparent through ongoing evaluation and feedback.

An updated systematic review of systematic reviews on factors that influence the implementation of eHealth by Ross et al published in 2016 using CFIR as a conceptual framework identified 44 reviews mainly of poor quality and from North America and Europe (138). Similar to this primary research, the review acknowledged the multi-level complexity of eHealth implementation and identified findings were consistent across different eHealth systems. The fit of eHealth systems with existing organisational workflow was a key issue. Ross et al also highlighted the importance of policies, adequate infrastructure and resources, key stakeholder engagement, organisational readiness, and individuals' knowledge and beliefs. Areas which received little attention included system trialability and relative priority of the systems. Expectations, adaptability, and cost were also a focus of the review, again consistent with findings from this primary research. In comparing findings from both systematic reviews by Mair et al (141) and Ross et al (138), many implementation challenges appeared to be consistent over time despite the rapidly changing field of eHealth, such as organisational issues and resourcing. However, there was more of a focus on

reflecting and evaluating implementation in the more recent systematic review (138) suggesting an increased awareness of the importance of this process.

Demonstration of coherence and cognitive participation were key drivers for success, or lack of, at the initial stages of implementation. This is supported by Travaglia et al in 2009 who identified an initial failure to display coherence resulting in end-users not perceiving the new ways of working as helpful or relevant and an unwillingness to engage with the process (361). Several interviewees in this primary research cited legibility as an issue with manual systems which was also described by Cresswell et al in 2014 with regard to the impact of system adoption on individual users when evaluating medium-term consequences of implementing ePrescribing in two 'early adopter' hospitals in the UK (362). They identified advantages of greater legibility of prescriptions and more efficient processes with system implementation. Whilst interoperability was perceived as an advantage to enhance patient flow and communication between professionals in this primary research, a key finding by Cresswell et al involved issues with integration of systems in a more recent study in 2016 investigating the types of workarounds users employed and implications for patient safety in six UK hospitals (363). This led to ineffective information transfer resulting in lack of timely information and duplicate data entry (363). While integrated ePrescribing systems offered better usability, standalone systems provided greater flexibility and opportunity for interoperability with external systems as well as customisability to the needs of different user groups (363).

Key themes relating to cognitive participation included the need for good leadership and support to facilitate buy-in which is consistent with a qualitative study by Rahman et al in 2010 on system providers and end-users perceptions of implementing a hospital information system (364). A study by Hardeep and collegues in 2015 on implementing ePrescribing and automated medication storage and retrieval systems in a UK hospital also found a well-designed project, multidisciplinary approach, and ongoing engagement facilitated a smooth manual to electronic transition (365). In relation to nursing input, a qualitative case study by Farre et al in 2017 on nurses' role in the medication process prior to ePrescribing implementation identified the contribution of nurses to medicines management needed to be considered further in system design and

implementation, which is again parallel to this primary research finding (366). A similar study by Choo in 2010 found nurses should have a significant role in system design to ensure a smooth transition to system use (367).

In terms of other NPT constructs, there was little evidence of collective action with no clear allocation of the processes of enacting the system. A need for considering adequate training, task allocation, and inter-professional communication was evident. Key stakeholders did not perceive overall time savings. Cresswell et al also found increased workloads related to poor software usability and shortcomings in the provision of a wider technology infrastructure such as difficulties accessing computers and lengthy log-in times (362). Organisational expectations of time savings for clinical staff were not met. In contrast, an Australian study by Westbrook et al published in 2013 reviewing doctors and nurses time spent on direct patient care, medication-related tasks, and interactions before and after the introduction of ePrescribing and automated medication storage and retrieval systems did not result in redistribution of time away from direct care or towards medication tasks (368). Another study by Darwesh et al was published in 2017 on the experience of using automated medication storage and retrieval systems to improve medication safety and management (369). Similar to this primary research, the authors found system implementation was difficult at the initial stages due to inadequate staff training but with familiarity and use it became easier. Recommendations included adequate HR support, a multidisciplinary approach to ensure a smooth transition from manual to electronic, and development of contingency plans (369).

Findings from this primary research highlight the challenges of integrating new systems with existing work processes and the introduction of new risks which are aligned to other research (362)(370)(371)(372)(152). An early study by Redwood et al in 2001 found the introduction of an ePrescribing system in a UK hospital had the potential to give rise to new types of risks to patient safety (373). These included pick list juxtaposition errors, confusion of paper-based and electronic systems, and distractions and interruptions to workflow.

A need to promote reflexive monitoring and evaluate the outcomes of system implementation on patient care and workflow was also evident. As highlighted in

this primary study, concerns with system usability can lead to the development of workarounds by users. Cresswell et al found informal practices not approved by management were employed by users due to perceived changes to professional roles, issues with usability and performance, and challenges relating to inaccessibility of systems (363). Formalised practices were promoted by management and occurred when systems posed threats to patient safety and workflow. Both types of workarounds involved using paper and other software systems as intermediaries, which often created new risks relating to a lack of efficient transfer of real-time information between different users (363).

4.6 Further work

Many potentially transferable themes have been identified and extend the evidence base. This will assist organisations to better plan for implementation of medication-related eHealth systems. A more systematic approach and further consideration to system implementation in hospitals in Ireland is required. Systematic reviews have highlighted papers are generally of poor quality and issues of implementation multifactorial. There may then be value in employing standardised tools such as NPT in the process of implementation. Areas of further research are described in Chapter 6. Findings from the introduction overview in Chapter 1, the systematic review findings in Chapter 3, and the qualitative interviews with local key stakeholders were used to facilitate the next phase of this research. These findings support the requirement to explore national key stakeholders and eHealth leads' perceptions towards the facilitators and barriers of implementing electronic systems for medicines management in a hospital setting.

4.7 Chapter summary

Novel knowledge and understanding with regard to perceptions of local key stakeholders towards the facilitators and barriers of implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in hospitals in Ireland has been generated. The mix of participants comprising senior and junior nurses, pharmacy staff, doctors, and hospital IT mangers with and without system experience perceived enhanced patient safety and efficiency as key facilitators to system implementation. They also felt the need to have clinical champions and a multidisciplinary implementation team to

promote engagement and cognitive participation. Key barriers included inadequate training and organisational support, and the need for ease and confidence in system use to achieve collective action. Integrating new ways of working was perceived as challenging, mainly due to difficulties in understanding the complexity of implementing electronic systems at both an individual level, such as education, training, and defined roles, and an organisational level, such as allocation of resources and ongoing support.

Chapter 5: Interviews with national key stakeholders and eHealth leads

5.1 Introduction

Chapter 5 consists of further in-depth qualitative interviews with national key stakeholders and eHealth leads on their perceptions towards system implementation and complements the systematic review and local key stakeholder's qualitative research findings. It provides depth and novel insight into issues involved in system implementation from a national strategic viewpoint. Underpinned by NPT, a description of the objective, method, results, and interpretation of findings is presented.

5.1.1 Phase three objective

- To explore the perceptions of national key stakeholders and eHealth leads towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework.

5.2 Method

Method and the accompanying rationale for use described in detail in Chapter 4 were similar to those employed in Chapter 5. To avoid repetition, only modifications of the method utilised for this phase are detailed in the following sections.

5.2.1 Research design

Conducting multiple individual face-to-face semi-structured interviews with national key stakeholders and eHealth leads using NPT as a theoretical framework provides rich original data owing to participants' knowledge, experience, and vision for future adoption and adds to the evidence base from phase one and phase two research findings. NPT underpinned the research planning, data generation, and data analysis.

5.2.2 Setting

Interviews were conducted with national key stakeholders and eHealth leads involved in medicines management in a convenient location for participants throughout the country.

5.2.3 Research governance

No national ethics committee for healthcare exists in Ireland. This research was conducted in accordance with the ethics and research governance policies of RGU (339) and the Royal College of Physicians in Ireland (RCPI). The research team agreed that the RCPI was a suitable forum to gain approval as it is broad in scope and ensures research is conducted according to best ethical practice (374). The project was approved initially by the ethical review panel of the School of Pharmacy and Life Sciences, RGU, and thereafter from the Research Ethics Committee in the RCPI (Appendix 5.1) which involved submission of:

- A detailed research ethics application form with a signed declaration
- A letter of invitation; participant information sheet; interview consent and copyright clearance form for participant and researcher; reply slip; letter of invitation reminder; and interview confirmation letter (similar to Appendices 4.3-4.9)
- A current CV
- An ethical approval letter from the School of Pharmacy and Life Sciences at RGU (Appendix 4.11)

5.2.4 Participant inclusion and exclusion criteria

Individuals involved in the advancement of electronic systems for medicines management from a strategic or operational high-level were included in the sample. Hospital-based head of department leads in medicine and pharmacy with a special interest in system implementation were also included. Specialists working outside of this area of interest were excluded.

5.2.5 Participant sample

Purposive sampling was employed in order to identify a range of relevant heterogeneous key stakeholders for participation. Invited to participate were national key stakeholders and eHealth leads from hospital, government, regulatory, and academic settings. Most participants were professionally known to the primary researcher from attendance at various special interest meetings and conferences and were believed to be the most knowledgeable in the subject area of interest irrespective of professional background. The remaining six participants were identified through recommendations from government and

regulatory leads via verbal contact once they had agreed to participate. The research team was confident the risk of sampling bias was minimised as it was anticipated the type of invitees requested to participant would express many positive and negative perceptions of adoption and a clear vision for future implementation.

5.2.6 Sample size

A sample of 19 invitees comprising eight hospital-based leads, seven government leads, two regulatory leads, and two academics were invited to participate. The sample was expected to capture a broad variety of perceptions towards system implementation from the heterogeneous participants and assist the research team in identifying common and diverse themes and reaching data saturation.

5.2.7 Invitation

Project information was posted to national key stakeholders and eHealth leads work addresses. Participants were requested to mail the reply slip either accepting or rejecting participation, with the most convenient date, time, and location for taking part in the interviews along with the consent/copyright clearance form if they were willing to participate. Reminders were sent to non-respondents two weeks after mailing the first invitation. A confirmation mail was then sent to participants who agreed to take part.

5.2.8 Development of interview schedule

An introductory general question around the participants' role was sought followed by more focused semi-structured questions which endeavoured to explore participants' perceptions on the topic. The schedule was developed specific to the four constructs of NPT as previously described: coherence (what is the work?), cognitive participation (who does the work?), collective action (how does the work get done?), and reflexive participation (how is the work understood?). Particular attention was paid to Creswell's key recommendations in developing the qualitative research questions (Table 4.3).

The initial interview schedule was developed by the primary researcher and reviewed several times for rigour and trustworthiness of content by all four other members of the research team [SC, AT, DS, and AS] who are experienced in

research using qualitative methods, as provided in Appendix 5.2. The schedule was then reviewed and refined further by the research team followed by the same five expert reviewers described in Chapter 4 (Appendix 5.3-5.4).

5.2.9 Pilot interviews

Individual face-to-face semi-structured pilot interviews of approximately 40 minutes were conducted with two professionals with an interest in eHealth management. Individuals were identified and recruited by the primary researcher who was familiar with participants. Minor amendments were made to the interview schedule and the pilot interviewees were excluded from data analysis as the research team felt these participants were not as well-informed as the participants purposely selected for interview and therefore may not contribute significantly to data analysis.

5.2.10 Data generation

Interviews were conducted between February and March 2016 post signed informed consent and copyright clearance. Participants were again provided with a background of the qualitative research and why they had been selected for interview. Interviewees were informed they could withdraw from the study at any time without giving a reason and that the audio recorder could be turned off at any time at their request. They were then asked to complete a short background questionnaire similar to Chapter 4 (Appendix 4.19). Interviews were guided by an interview schedule underpinned by NPT which was developed iteratively as the interviews progressed. At the end of each interview, participants were provided the opportunity to contribute any additional information deemed relevant not previously discussed and to review their own transcript for accuracy. All generated data were coded, anonymised, and securely stored. Any records relating to the research will be destroyed after full dissemination of the research findings.

5.2.11 Data management and analysis

Digital audio recordings of each interview were listened to several times and transcribed verbatim shortly after each interview by the primary researcher to allow further refining of the interview schedule as required. Audio recordings and transcribed data were coded for anonymity and verified for accuracy by two

other members of the research team [SC and AS] via allocating each member three transcripts each for review against the recordings.

Framework analysis was adopted to facilitate a neat set of *a priori* codes. Independent analysis was conducted by the primary researcher and three other members of the research team [SC, DS, and AS] to confirm the trustworthiness of emerging themes. No significant discrepancies were identified. Agreed codes were then created by the primary researcher for each NPT component facilitated by NVivo 11© qualitative data management software.

5.2.12 Promoting research quality

The quality employed in this phase of the research is similar to the detailed description provided in Chapter 4. Differences include triangulation of data sources from an array of national key stakeholders and eHealth leads within hospital, government, regulatory, and academic backgrounds.

5.3 Findings from the qualitative interviews: general analysis

5.3.1 Participant demographics

Nineteen hospital, government, regulatory, and academic key stakeholders and eHealth leads were invited to participant in individual face-to-face semi-structured interviews. Three government professionals (one OCIO and two head of national acute public hospital services) did not respond to interview requests despite numerous attempts of contact (Figure 5.1).

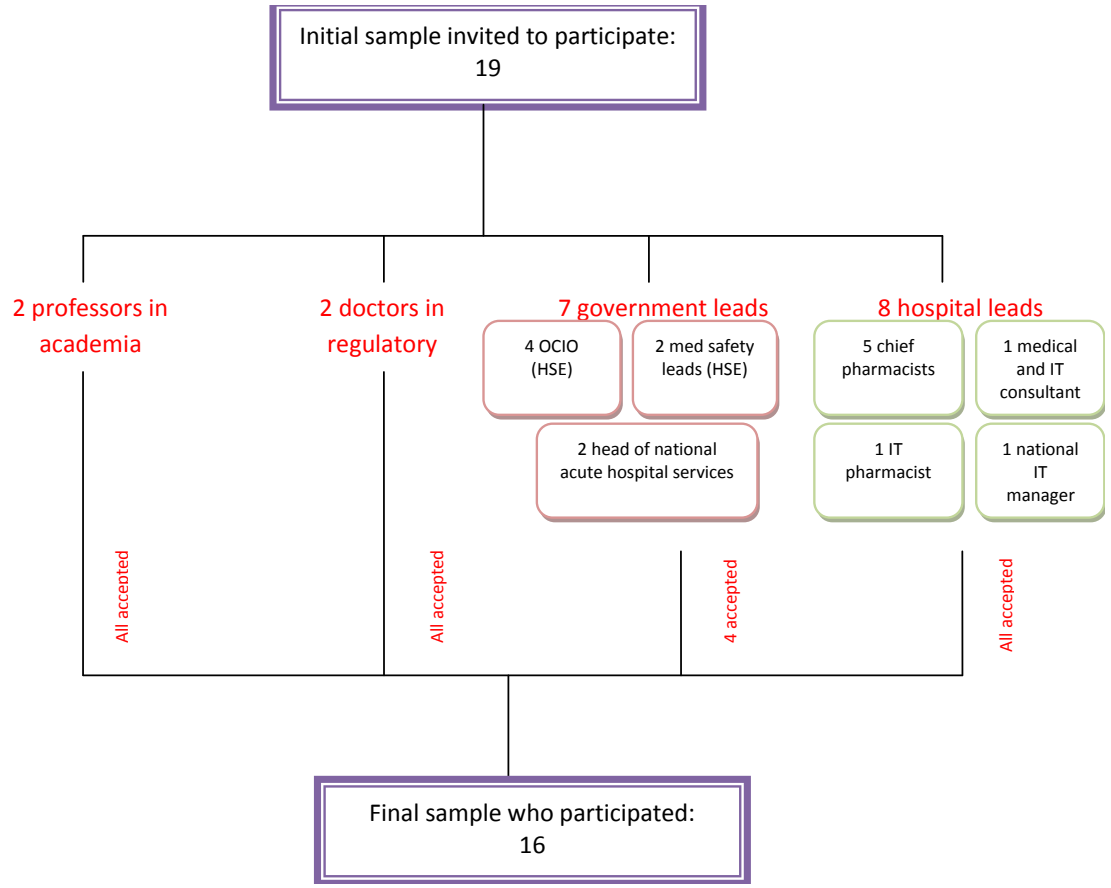

Figure 5.1: Participant sample

After completing transcriptions of the audio recordings, data saturation was deemed to have occurred by the primary researcher and three members of the research team [SC, DS, and AS] in terms of thematic ranges and hence further recruitment was not undertaken as illustrated in Figure 5.2. The variety of included participants' professional characteristics represented a wide range of views and perceptions.

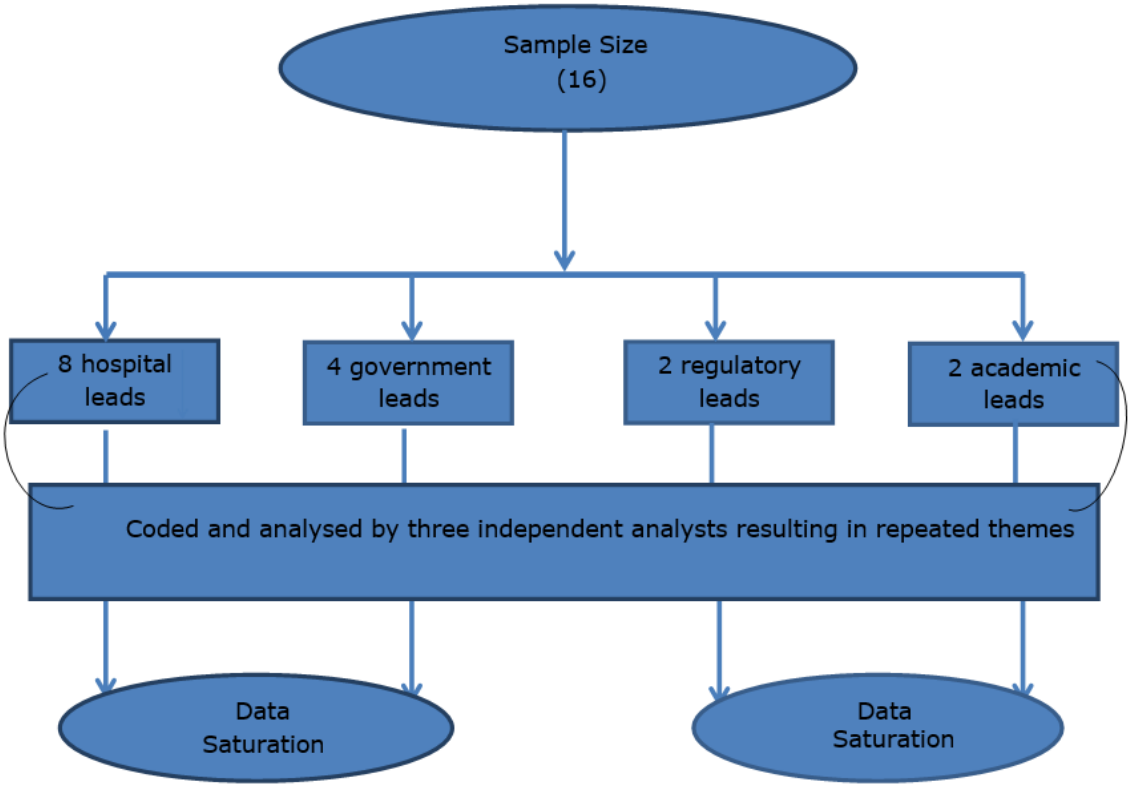

Figure 5.2: Steps towards confirmation of data saturation

All participants who accepted to be interviewed completed the background questionnaire with results summarised in Table 5.1. The median years of professional work experience was 21-25 years and the majority of participants had practiced outside of Ireland and had system experience.

Table 5.1: Participant characteristics

Characteristics	n
Sex	
Female	6
Male	10
Healthcare professionals	
Hospital-based leads	8
Government (HSE) leads	4
Regulatory	2
Academia	2
Years of experience in profession	
1-5 years	1
11-15 years	2
16-20 years	3
21-25 years	3
26-30 years	2
31-35 years	4
>35 years	1
Practised in countries outside Ireland	10
Countries	United Kingdom USA Saudi Arabia Russia New Zealand
Experience of using/implementing ePrescribing	12
Experience of using/implementing a robotic pharmacy system	3
Experience of using/implementing an automated medication storage and retrieval system	3

Table 5.2 provides more detailed demographic data and codes for the 16 participants who agreed to be interviewed. However, to protect anonymity, demographic data is minimal. Hospital-based key stakeholders comprised five chief pharmacists leading on ICT at a local, national, and international level; a medical and IT trained consultant with a special interest in change in complex IT systems, clinical leadership, and process improvement; an IT specialist pharmacist (limited hospital-based IT specialist pharmacists employed in

Ireland); and an IT national lead. Government leads included two national medication safety leads and two healthcare IT experts in the OCIO.

Table 5.2: Demographic data and codes for interviewees

Profession	Sex	Years experience	Experience abroad	Experience with system implementation
Hospital-based leads				
Chief pharmacist 1	Male	26-30 years	No	ePrescribing, pharmacy robotics, and automated storage & retrieval system
Chief pharmacist 2	Male	31-35 years	No	No
Chief pharmacist 3	Male	11-15 years	No	No
Chief pharmacist 4	Male	21-25 years	Yes	ePrescribing
Chief pharmacist 5	Female	26-30 years	Yes	Pharmacy robotics and automated storage & retrieval systems
Medical and IT consultant	Male	21-25 years	Yes	ePrescribing, pharmacy robotics, and automated storage & retrieval systems
IT specialist pharmacist	Female	1-5 years	No	ePrescribing
IT national lead	Male	31-35 years	Yes	ePrescribing
Government leads				
Medication safety lead 1	Female	16-20 years	Yes	ePrescribing
Medication safety lead 2	Male	31-35 years	Yes	ePrescribing
OCIO 1	Male	31-35 years	No	No
OCIO 2	Male	21-25 years	Yes	ePrescribing
Regulatory leads				
Regulatory 1	Male	11-15 years	Yes	No
Regulatory 2	Female	16-20 years	Yes	No
Academic leads				
Academic 1	Female	16-20 years	No	ePrescribing
Academic 2	Female	>35 years	Yes	ePrescribing

5.3.2 Interview and transcription length

Interviews varied in length of time from 35 minutes to 77 minutes and the median time was 55 minutes. Transcriptions differed in length from 5528 words to 13700 words and the approximate time to complete was three months.

5.4 Findings from the qualitative interviews: thematic analysis

Five key themes emerged in this qualitative phase from data analysis, as summarised in Table 5.3.

Table 5.3: Summary of key facilitator and barrier themes related to NPT constructs and components

Themes	NPT constructs and components (141)	Facilitators	Barriers
Theme 1: Safety and efficiency of systems	**Coherence:** Differentiation Internalisation	Enhanced patient safety Enhanced efficiency Ease of use of system Enhanced accountability Interoperability/standardisation Financial gains	Complex with potential to introduce new errors and reduce contact with patients Slow down workflow Legislation Cyber security Data protection Standardisation and integration of systems
Theme 2: Understanding of need for system implementation	**Coherence:** Communal specification Individual specification	Enhanced multidisciplinary collaboration Building block initiatives Finance and autonomy for local implementation	Lack of understanding of system implementation Lack of skills to use technology
Theme 3: Leadership within an organisation	**Cognitive participation:** Enrolment Activation Initiation Legitimation	Effective leadership and drive Site champions Robust iterative process	Lack of leadership and clear vision
Theme 4: Need for system support	**Collective action:** Skill set workability Contextual integration	Adequate training Local initiatives Realisation of building blocks Attaining quick wins National drug database Contingency plans	Inadequate support Lack of emphasise on training Implementation plans short on detail Poor expertise nationally Financial constraints
Theme 5: Adequate system evaluation	**Reflexive monitoring:** Systematization	Ongoing evaluations e.g. prescribing analytics	Auditing with feedback not embedded into system Testing at scale challenging Reconfiguration of work processes

Key themes are now described in more detail with associated subthemes on facilitators and barriers towards system implementation which emerged from data analysis using NPT as a theoretical framework.

Theme 1: Safety and efficiency of systems

Participants felt the current system in healthcare is in crisis and fraught with risk, quality, and efficiency issues mainly due to silo work processes which are largely paper-based. The predominant pharmacy system in hospitals in the public sector was thought to be poor regarding reporting intelligence with limited baseline or quantitative measurement facilities to track data on system performance. Lack of oversight or ability to analyse prescribing practices throughout the hospital setting inclusive of outpatients was also highlighted as an issue. Participants felt suboptimal finance was invested into healthcare IT resulting in no current benefit from ICT.

Subtheme 1: Enhanced patient safety and workflow efficiency linked to electronic systems

The consensus was to lean towards more technically enabled healthcare systems with an ultimate aim to improve patient safety and workflow efficiencies. Participants felt system implementation aligned with the eHealth Strategy which promotes optimising the availability of information at the point of clinical need, capturing information to the benefit of patient care and safety, and enabling integration of work processes and coordination of care in a way that ensures data protection. A perception that system implementation would complement the workforce to deploy healthcare professionals to clinical cognitive tasks and better use of their skill sets was also evident.

> *"It will improve patient care and reduce inefficiencies of the system of walking around looking for pieces of paper, problems with the ambiguity around communication and handover". (Chief pharmacist 3)*

> *"We want a uniform reporting system that allows us to do a better assessment on data analysis and expenditure". (Medication safety lead 2)*

Core functionalities perceived to facilitate successful implementation included systems should be easy to use, intuitive, durable, modifiable, and alerts executed and managed appropriately to support good clinical care and reduce

the risks of adverse events. Visual graphical feedback as to when prescriptions are ordered and processed was viewed as an additional bonus.

> *"It needs to be simple for the user to interact with, if you have to go through 10 screens to get to something, people get lost in it and it is prone to error". (Chief pharmacist 5)*

> *"They need to be good and safe and match the workflow that you need. Understanding the complexity of the alerts issues should be considered with a lot of real consistent effort to try and keep them useful". (Medication safety lead 1)*

Timely access by designated people to the required information with the appropriate security was another key facilitator to maximise patient care. Governance and accountability were also perceived to be enhanced.

> *"These systems create more accountability. You don't have to give lectures, you show staff they are out of line and they will behave differently just by default and that is powerful in itself." (Chief pharmacist 1)*

Financial gains and a return on reputation of how the health service was viewed by the public were other perceived benefits to system implementation.

> *"We spend about €2.14 billion on medicines in this country, 16% of total healthcare expenditure, of which €1.84 is in the community. An upfront cost in terms of millions would critically allow us to intervene in areas where we could improve cost effectiveness of prescribing and invest it back into the service". (Medication safety lead 2)*

> *"An eHealth solution in Ireland can improve the reputation of the health system so whilst we talk about return on investment, there is also a return on reputation if we can have a digital healthcare system that makes it more efficient and safer then maybe we can improve how the health system is seen by the public". (OCIO 1)*

Subtheme 2: Interoperability and standardisation of practices

Interoperability and standardising practices were viewed as central tenets of risk reduction strategies in terms of medication safety. Streamlining ePrescribing processes using standardised communication pathways within secondary care and between primary and secondary care settings was thought to be useful in resolving much of the interface discrepancies and medication reconciliation issues on admission to hospital and in reducing medication wastage. A closed

loop medicines management system incorporated into an EHR with bar coding from the time of receipt of medication to drug administration was a future aspiration and believed to standardise the medicines management process. Easily customisable open technology was also perceived to be of great benefit in order to tailor technology to local needs.

> *"You have got multiple different systems and so you must use technical standards for exchanging information. You can't have everybody involved in making the decisions and yet if you want to get things working seamlessly nationally then you have to standardise some things". (Academic 2)*

> *"Open technology as an approach would allow you to take this catalogue or framework and customise it". (Medical and IT consultant)*

Subtheme 3: Potential reduction in patient safety and workflow issues

Perceived barriers to system implementation included developing a system with complex and multiple functionalities which may distract from the fundamental aim of patient safety and efficiency and introduce new errors and loss of contact between patients and clinical staff.

> *"One concern I would have is that you end up with a massive message centre with hundreds of messages and tasks for that individual clinician and that people get buried by it, so systems that flag the important issues and that basically allow people to only see what is most relevant so that we are not heading into the territory of alert fatigue". (Chief pharmacist 3)*

> *"These systems may reduce contact with the patient by spending more time with a computer screen". (Academic 1)*

Participants felt systems were going to slow down workflow considerably during the initial period of implementation.

> *"In the short run it is going to slow down working practices big time. There will be restriction of services, cancellation of elective procedures, resourcing issues to get us over the initial shock". (Chief pharmacist 3)*

> *"So whilst it needs to be secure, the risk is you turn everybody off because it is a pain to actually remember your password that you have to change every 30 days." (OCIO 1)*

Standardisation and integration of systems were perceived to be difficult as well as managing the transition from manual to electronic. Participants felt it was

important that systems were not implemented in isolation as standalone projects without consideration to how they fit into the overall workflow.

> *"The challenge in all of these projects is how to get national or international standardisation, drug catalogues and local customisation right, because everybody works slightly differently". (Medical and IT consultant)*

> *"Even within the HSE run hospitals, standardising things is difficult never mind taking into account the voluntaries and when you bring trusts along". (Academic 2)*

Other perceived barriers to implementation included legislation, cyber security, and data protection in terms of who should have access to patient information and types of consent.

> *"In Ireland you still require an ink signature and date for a prescription so a digital signature at this point isn't acceptable. So if you want to do away with the paper, you've got to change the law...there is a general consensus that we need to get a bit cleverer with cyber security and accept that at some point something will go wrong so how do we recover if something does go wrong". (OCIO 1)*

> *"What happens if someone wants to opt out of consent so some of the information coming from the Data Protection Commissioner relates to not offering people the opt out clause. Also if somebody does consent to their information going into the system in this hospital, do they consent to their information flowing to other hospitals? There would be research with missing information from population based registries if they are only based on people who consent introducing bias so there is a definite need for legislation". (Chief pharmacist 3)*

Theme 2: Understanding of need for system implementation

Participants had mixed views on whether there was a shared sense of purpose for system implementation.

<u>Subtheme 1: Multidisciplinary collaboration and support</u>

The importance of true multidisciplinary collaboration between professionals was expressed as a key facilitator.

> *"You see a multidisciplinary bunch of professionals and everyone is pulling in the same direction. There are a huge number of health professionals, IT professionals, hospital administrators across the public hospitals who are there to improve patient outcomes and I have seen tremendous levels of*

engagement and consensus reached where I thought there never would be consensus cause everyone is there to improve outcomes for the patient". (Chief pharmacist 3)

Participants felt a shared sense of purpose was improving with HIQA stepping into the medicines management space, the appointment of the CIO to the HSE, and the creation of the national *eHealth Strategy*, eHealth Ireland, and the ePharmacy agenda. The challenge was to make it a current priority.

"Two years ago I would have said there was no shared understanding having struggled to get investment for medicines management for many years, both via the HSE and locally through our hospital. With the advent of the chief information officer into the HSE and the identification of ePharmacy as a key strategy, I think that that is now more realistic". (Chief pharmacist 4)

"We have traditionally lacked a strategic approach to medication in Ireland. The CIO is maybe creating more of a shared sense of purpose than there was before. Also HIQA have done reports so those things give you some sense of shared purpose. I am not 100% sure every hospital accepts that, because we are all still competitive, whoever is the biggest hospital wants to be first with everything". (Chief pharmacist 1)

Subtheme 2: Mixed motivations and maturity with system implementation

Other participants did not believe there was a strong sense of alignment with little understanding of the issues involved in system implementation. Mixed motivations and maturity and a widespread variation on the extent to which people are comfortable with technology was echoed as well as a lack of investment in local technology.

"The hard task of implementation is not well understood here and there is a lot of learning to be done." (Medical and IT consultant)

"The gap is that hospital pharmacy hasn't been recognised as an area where there is a need for a solution fairly quickly and therefore it hasn't been resourced, it has just been stonewalled...there should be a commitment to try and form local technology hotspots for health, it would inform how we are going to do this nationally that is cost effective, that delivers big savings in terms of safety and time, so that hasn't been done, it is not something they are aware of let alone consider important". (Chief pharmacist 5)

Theme 3: Leadership within an organisation

Signs of leadership and a future vision were evident from some key stakeholders.

> *"There is a big push in the whole of Europe around ePharmacy and ePrescribing that I and other eHealth leads are taking part in...we have an ambition to have a full ePharmacy solution across the whole of Ireland by 2020 but it is based a lot on business cases and approval around that space...the Department of Health has bought in to this, the medicines office has bought in to this, we are working with the Director General's team, you know leadership of the HSE describes eHealth as being part of transformation. The secretary general last week stood on stage saying without a digital health solution the health system of Ireland can't transform and therefore can't actually support the people of Ireland, and in less than five years this thing becomes unaffordable without digital solutions". (OCIO 1)*

> *"There is a huge drive among people who work in this area to implement electronic systems, people are starting to see more of the value of these systems and the need to invest in them". (IT pharmacist)*

Methods of implementing systems successfully included having the right leadership with a clear vision and desire as well as good project management abilities. A robust, iterative, and well structured process in place and treating implementation as a clinically led exchange project rather than solely as a technology task were thought necessary for the required outcome. The new public hospital group structure was another perceived opportunity to facilitate such developments.

> *"Coming up with an agreed approach and understanding of what is required in order to make a business case and procure it. You need to link between procurement and eHealth and clinical sides and HR to say well it is not just an IT project. You also need pharmacists and a plan of how you are going to support them". (Medication safety lead 1)*

> *"You need to identify your champions at site level, it cannot be an IT driven project, it will fail if it is an IT driven project, it has to be a business driven project". (Regulatory 1)*

<u>Subtheme 1: Lack of national leadership and a clear vision</u>

Some participants felt there was very little vision from a national strategic viewpoint and lack of understanding of the complexity and governance around implementation ultimately leading to a feeling of inadequate leadership and a lack of willingness to drive system adoption.

"You cannot do something about an issue unless you understand the issue properly. This comes back to national leadership, to understanding, I am not so sure that we have the leadership infrastructure there to harness the benefits of this approach". (Medication safety lead 2)

"We have had the engineers from the HSE out on numerous occasions to look at the same thing on behalf of a number of different hospitals but it is the same people. So there is that kind of replication, duplication, which I guess isn't a great value add nationally. It would be a good idea if this was looked at in a systematic way by somebody or some group of people". (Chief pharmacist 2)

Lack of strong political leadership and having the confidence to make decisions were other perceived rate limiting steps in system implementation.

"Healthcare is so politicised, you need to get that determination and the insistence on fighting for the budget". (Academic 2)

"I think we are very poor at making decisions and ourselves accountable particularly in this system. People are going to have to make decisions that may seem unpopular initially so it is about managing that". (Chief pharmacist 5)

"Reference pricing, which has turned out to be the largest impact we have had on prices of medicines in this country, was implemented in 2013, we first proposed it in 2003. It gives you some idea of the time frame for change, it can be long, laborious and frustrating and this comes down to people, either unwilling or probably unable to actually make a decision". (Medication safety lead 2)

Some individual hospitals had moved the eHealth agenda forward on their own initiative as the consensus was if people waited for a national system it may never happen or delay funding for local innovations.

"The risk here is that if you get a message saying that there is a national EHR coming, people will wait. But what is needed is to stimulate local innovation with funding". (Medical and IT consultant)

"There is going to be no national ePrescribing initiative. So I guess having put ePrescribing in our hospital may have forced other people to follow as against sitting waiting for it to happen nationally when it may never happen. We have been doing our own thing for a long time." (Chief pharmacist 2)

Theme 4: Need for system support

A view that implementation is dependent on national guidance and support at the highest level was evident. Adequate training with regard to the use of electronic systems by means of engagement was viewed as key to successful implementation.

> *"Support and engagement in terms of training and competency assessment for the use of the electronic systems is absolutely key". (Academic 1)*

An agreed approach and developing local initiatives via local multidisciplinary teams with autonomy and adequate finance were other perceived advantages. Gated funding to ensure goals were achieved and for securing finance was another mechanism of gaining financial support. A transformation programme with the addition of staff to assist with implementation was emerging.

> *"Funding needs to be put in place locally with local initiatives instead of waiting for national funding that may never come with its many layers". (Chief pharmacist 2)*

> *"There are 288 staff members that are working along different parts of implementation so there is a big programme of trying to get the whole thing to come together. So we have a national service management team and a national project team that now look after things across the whole of Ireland". (OCIO 1)*

Subtheme 1: Realisation of national key building blocks

Realisation of key building blocks for supporting the safe and secure electronic transfer of information between prescribers and dispensers facilitated by the *Knowledge and Information Strategy* and the *eHealth Strategy* within eHealth Ireland was believed to be central to successful system implementation. Some of the enablers included IHIs, HIQA standards and specifications for exchanging information, a single drug file, and data protection legislation. Attaining quick wins and benefits at the initial stages and then progressively building upon that solid foundation in the future was viewed as a method to normalise system implementation. A good starting point was to review hospitals that have an appetite and track record in relation to implementing ICT and to learn from their successes.

"I think the HIQA standard around electronic transmission of prescriptions, we see other building blocks in terms of national decisions being made with regard to minimum data sets, looking at discharge communications, consideration of the national medicinal product catalogue and a drug dictionary, messaging standards to facilitate interoperability. These things are iterative and in time seeing the iterative realisation of what they can do and then building on the strengths of that and learning". (Academic 1)

Support for development of a national drug database for prescribing, dispensing, and administering medicines that can be interpreted in a standardised format and provides a benchmark for auditing and quality in all hospitals was perceived as another key enabler for successful implementation. This would allow the HSE to use business intelligence to analyse and understand the differences between public hospitals and manage drug budgets. Participants believed the recently published standards and policy documents were not detailed enough to allow sufficient disaggregation of the product description for robust and flexible reporting and that an additional level of complexity should be considered to ensure a clear link between the prescribed drug and the dispensed and administered product.

"The ICT strategies and polices coming out now are short on implementation detail. What we need is to get the pharmacy system right, get the drug file right, and you can link in your prescribing database into the product file and also tag on individualised clinical decision support. Then to make the jump to prescribing and administration is actually quite simple because in terms of prescribing you are linking the drug to the product and creating personalised prescribing lists for doctors. So really the pharmacy system is the building block". (Chief pharmacist 4)

"We would be hoping to put together a national drug file and work with the national falsified drug directive group who are putting together a database with barcodes". (OCIO 2)

Ongoing responsibility for acting and moving the agenda forward and anticipating practice changes and supporting workflow in stages was perceived as significant for successful system implementation.

"The main players are the department who can set the policy, HIQA set the standards and it is up to the HSE to implement. You now also have eHealth Ireland and its programmes". (Regulatory 1)

"All systems will end up going through a peer review evaluation process. There will be a business case built up which will be checked by the eHealth

council before procurement in keeping with international best practice. There is robust structures in place". (OCIO 2)

Disaster recovery with an electronic document management and replications approach operated in a protocol driven environment was also viewed as important. Contingency plans for ongoing resolution of issues were equally viewed as significant.

"You need to have contingency plans for downtime from the start because you are going to have to use paper in that time and how do you manage the patients to continue providing them with care if their electronic record is down". (IT pharmacist)

Subtheme 2: Lack of support by the HSE

Medicines management systems were not perceived to be supported by the HSE. Lack of an emphasis on training staff on the procedures and use of IT systems was viewed as a challenge by participants. This was accentuated by both the complication of turnover of junior doctors every six months using different systems with different protocols and deciding which staff members to train if a phased approach was the preferred option.

"There is going to be industrial relations issues, there are going to be resourcing issues, how do you train all of the staff in a hospital on a system without breaking a hospital? How do you free people up for training? How is that going to happen along with regular patient care? The unions, so engagement, high-level with the main unions that represent staff in the health services". (Chief pharmacist 3)

Participants felt mechanisms of how to implement these systems were short on detail and that there was no opportunity to engage with system implementation from a national viewpoint. There was a sense of lack of expertise in relation to developing and implementing electronic systems for medicines management throughout the country.

"The reason we have an eHealth strategy and are introducing identifiers is because Troika looked at healthcare, it wasn't because the Department of Health was convinced that we desperately needed this. What we suffer from is implementation deficit disorder, so we have strategies to beat the band but when it comes to implementing them we are hopeless." (Academic 2)

"We don't necessarily have that talent, we probably do if we scour the country and put a team together but I still think it is a significant challenge but if we use the people that have done this overseas and put a team together, I think it is very easily achievable and more along the lines of agile programming development". (Chief pharmacist 5)

Capital investment and financial constraints were viewed as significant barriers to system implementation with acknowledgement that Ireland was under resourced in comparison to other EU countries and lacked proper provision for long-term sustainability. Included were organisational and business engineering costs such as HR investment as well as hardware and software costs, licensing costs, and extra funding for additional functionalities and vendor fees. Participants believed there needed to be a better approach by government to invest in developing, testing, implementing, and maintaining systems.

"The HSE has had the budget but because it has been so hard to get stuff through the Department of Finance, the HSE haven't even managed to spend their ICT budget for the last four years...this requires a lot of ongoing maintenance so you have to make sure you have a permanent project team in place that is duly structured within the governance structure of the hospital". (Chief pharmacist 4)

"The biggest barrier has been that hospital pharmacists haven't really figured out the right language to use when making business cases. If we can't find a productivity or a value proposition within the business case then it falls on deaf ears...I am still suspicious that perhaps we might be using large multinationals to solve the problem at the cost of hundreds of millions where in fact if we use local sources and piloted it on a regional level we could demonstrate success very quickly for very little cost". (Chief pharmacist 5)

"If you take an IT project, about 25–30% is the hardware and the software costs, and 75–80% is the actual organisational cost of getting people involved, getting the project team going, doing all the training, the roll out, business process engineering". (Academic 2)

Theme 5: Need for system evaluation

Ongoing risk assessments, benefits measurement, evaluation, validation, and interrogation of data were believed to be powerful mechanisms to establish quality improvement. Quantitative measurement such as collecting baseline metrics and reassessing post system implementation, and qualitative science such as narrative stories from the front line were methods of assessment. Participants felt this was an opportunity for universities to get involved in

presenting and publishing data on comparative studies, compliance rates, system impact, interview findings, and other areas of interest in a systematic manner for future learning. The ultimate aim was to capture data on prescribing analytics and medication use and demonstrate incremental patient-centered improvements over time.

> *"It is not just a case of how it is performing compared to the way things were, it is how it is performing over time. So I think it is a continuous process of tracking a few key safety things, a few key flow things, a few key productivity things and a few quality things, ultimately it's how do patients feel about the way that medicines are managed in hospitals and using their feedback to drive the way that we evaluate the system...in terms of flow, if we had real time communication of need we can be more responsive. We could reduce the time delay between prescription and supply so it would contribute significantly to better inventory management and waste reduction, to quality and productivity, you are not duplicating work." (Chief pharmacist 5)*

> *"The capacity to give consideration to performance use of the system, intermittent appraisal with regard to prevalence of errors and causation, everything in keeping with a progressive safety culture". (Academic 1)*

> *"It would allow us at HSE level to have high visibility of prescribing and at a local level it would allow an overview of appropriate or inappropriate prescribing behaviours." (Medication safety lead 2)*

Some participants felt auditing or communicating feedback to end-users was not strong or embedded into the Irish healthcare system. Testing at scale and reconfiguration of work processes were also perceived as challenging.

> *"We have potential to go out and ask for compliance on standards and do analysis. It is very difficult because it is getting the right scale, if you test 10 items but a million are being sent every day, is it specific?" (Regulatory 1)*

> *"People will find workarounds in an IT system, so trying to get that information is the hard thing to try and stop that from happening so feedback is very important". (IT pharmacist)*

5.5 Discussion

Key findings are presented in this section in addition to the methodology strengths and weaknesses, and interpretation of findings inclusive of comparisons with published literature.

5.5.1 Statement of key findings

The objective of this phase of the research was to explore national key stakeholders and eHealth leads' perceptions towards implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in hospitals in Ireland. Sixteen individual face-to-face semi-structured interviews were conducted with professional leads from hospital, government, regulatory, and academic settings in Ireland. Framework analysis and the application of NPT enabled systematic identification of key themes and aided data analysis and interpretation. Participant characteristics outlined in Table 5.1 did not impact on commonality and variability of interview responses which mostly centred on national and local eHealth initiatives required for implementation accompanied by a strong vision for future adoption, both positive and negative.

System implementation is complex requiring interventions at a macro, meso, and micro-organisational level. Participants focused on integration of electronic systems for prescribing, dispensing, and administering medicines rather than a specific focus on individual systems. Perceived facilitators and barriers to implementing patient-centric EHRs were also volunteered in relation to overall system adoption. Coherence was displayed in the form of key stakeholders understanding the limitations of a manual medicines management system and the reasons for system implementation such as enhanced patient safety; workflow efficiencies; improvements in governance; interoperability and standardisation of work processes; and financial gains. Perceived barriers towards system implementation included the potential to implement complex systems with the introduction of new drug errors; loss of contact between clinical professionals and patients; initial time inefficiencies with new workflow practices; issues with the complexity of integration and standardisation of work processes; the need for legislative change; cyber security concerns; and data protection issues.

Participants felt coherence and a shared sense of purpose was improving with the development of building block initiatives such as HIQA standards, the national eHealth strategy, eHealth Ireland, and the ePharmacy agenda. A clinically led iterative process was thought to facilitate cognitive participation and

successful system implementation. Whilst some participants felt key individuals demonstrated signs of leadership and were willing to collectively drive and enact system implementation and set future goals for ePharmacy solutions, predominant lack of understanding was perceived to prohibit system adoption and result in lack of investment in local technology. A sizable gap between advocating system use and policymakers' perceived vision for widespread implementation inhibited cognitive participation. Participants felt system adoption was not supported at a high-level with inadequate leadership and decision-making capabilities and a limited vision of the need for implementation or of the requirements for implementation.

Work aimed at actively promoting, enacting, and maintaining systems included a requirement for investment in resources and having a multidisciplinary team approach with ongoing staff support, contingency support, and policy support. Disaster recovery and contingency plans for ongoing resolution of issues were also viewed as significant. Change through local delivery teams supported by national resources facilitating local ownership of the implementation process was an additional perceived facilitator. Perceived challenges impeding on cognitive participation and collective action included little opportunity to engage with system implementation, lack of an emphasis on training staff on system use, and a sense of lack of expertise in relation to system development and implementation. Further details on requirements for implementation were needed.

Reflexive monitoring was evident with a clear understanding of ways of appraising systems in order to assess their benefits and drawbacks and reflect on work practices. Automation of data capture for the purpose of records, research, auditing, and benchmarking was thought to facilitate business intelligence and enhance data analysis, improve prescribing practices, and assist with querying data and providing quick turnaround times of service provision and supply of medication in real time with prescribing. These processes were enhanced by investment in appraisal in the Irish healthcare system.

5.5.2 Consideration of strengths and limitations

Numerous strengths and weaknesses detailed in Chapter 4 are comparable to this chapter as a similar methodology was applied. Triangulation of data sources involved a variety of national key stakeholders and eHealth leads from diverse backgrounds of hospital, government, regulatory, and academic settings. Findings from the systematic review and qualitative phase with local key stakeholders were compared with those from this qualitative phase thereby facilitating further triangulation of results. It is evident from the work completed to date that this area is under-researched and that findings will contribute to original knowledge. It is intended that this exploration will provide a unique insight into the various facilitators and barriers towards implementation of ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in hospitals in Ireland and make a significant contribution to the research subject.

5.5.3 Interpretation of findings

Reducing medication errors necessitates restructuring medicines management systems and streamlining patient care. Findings derived from the systematic review presented in Chapter 3 and qualitative interviews with local key stakeholders in Chapter 4 were similar to findings from this phase of the research and highlight comparable issues (337). A number of recurrent themes related to technical issues with implementation, inclusive of interoperability and integration of systems. Participants felt realising system benefits and mitigating safety risks were highly dependent on effective integration of systems to facilitate information exchange.

National key stakeholders and eHealth leads focused more on interoperability and standardisation, building block initiatives, finance, and autonomy for local implementation using a robust agile iterative process. Issues of legislation, cyber security, and data protection were also emphasised as well as limited understanding at a high-level resulting in inadequate leadership and lack of a vision and willingness to drive implementation or make decisions.

The importance of adequate infrastructure and resources and organisational readiness were also highlighted in systematic reviews on factors that promote

and inhibit the implementation of eHealth systems (138)(141). Limited attention was given to work directed at making sense of eHealth systems, methods of engaging with professionals, and ensuring potential benefits of implementation were apparent (141).

In addition to research studies outlined in Chapter 4, Cresswell et al recently conducted round-table discussions with 21 participants from international multidisciplinary backgrounds including policymakers, healthcare organisation officials, and academic researchers (375). The aim was to investigate approaches to realising returns on investment from ePrescribing systems in UK hospitals and lessons that can be learned for future developments and implementation strategies within healthcare settings. Similar to this study, realising financial returns from ePrescribing systems was challenging with recommendations that future strategies should consider generating and analysing local and national data within and across hospitals to measure progress (375). Five key recommendations for the strategic deliberations of policymakers prior to embarking on the implementation of Hospital Electronic Prescribing and Medicines Administration (HEPMA) systems in Scotland were recently provided in another study by Cresswell et al in 2017 (376). These included methods of ensuring flexibility; optimising systems from the outset; developing and centrally sharing expertise; and maximising learning from experience (376). This was echoed in a research based report by KPMG in 2012 on core concepts to support eHealth implementation which involved in-depth interviews with 39 eHealth leaders, planners, experts, and implementers from 15 countries worldwide (139). Similar to findings from Cresswell (376) and this primary research, a high value was placed on collaborative alignment and the importance of active participation in the development and operation of the system. They found aligning the interests and efforts of stakeholders was key to sustainable eHealth adoption.

Evidence from many studies suggests more than half of IT projects fail to meet their estimated budget and/or timelines (377). Similar to this study findings, appropriate planning, an adequate mix of IT implementation team members and non-IT decision makers and end-users, and appropriate training have been recommended to assist in a smooth implementation process (378)(379)(380). Another recent qualitative study by Mozaffar et al published in 2017 aimed to

understand the roots of unintended safety with the introduction of ePrescribing systems in six English hospitals (381). A taxonomy of factors underlying unintended safety threats included suboptimal system design and lack of support for complex medication administration regimens, lack of effective integration between different systems, and lack of effective automated decision support tools. Other factors included inappropriate use of systems and over reliance with the introduction of workarounds, and suboptimal implementation strategies resulting from lack of appropriate training and existence of partial roll outs/dual manual and electronic systems. A need for hospitals and suppliers to implement short term and long-term strategies to minimise unintended safety risks was recommended for successful implementation (381).

Another comparative review of lessons learnt from ePrescribing implementation in Denmark, Finland, Sweden, England, and the USA was published by Samadbeik et al in 2017 (382). Similar to this study findings, recommendations included development of a national prescription database and system implementation to be part of the national healthcare infrastructure inclusive of government, legal, and financial incentives for better acceptance among relevant stakeholders (382). The expansion of standards and terminology to support interoperability frameworks and data exchange was also advocated (382).

Given the continuously varying nature, leadership, and priorities of these complex systems in the health service provision, a key finding from this primary research was the importance of system interoperability and customisation to support changing needs and organisational contexts of use. This is comparable to a systematic review by Alexander and Staggers in 2009 on the designs of clinical technology which included 50 studies emphasising consideration to systems ergonomics (383).

5.5.4 Further work

Future work should explore key stakeholders' experiences and views post system implementation to establish if anticipated benefits have been achieved. This is outlined in Chapter 6.

5.6 Chapter summary

Technologies understood at implementation are more likely to normalise and have a positive impact on work practices than those not valued. System implementation is beginning to gain momentum with the ever increasing recognition of the need to enhance patient safety and improve efficiencies in healthcare delivery with the establishment of national eHealth initiatives. Careful strategic planning to accompany organisational changes with adoption is required in addition to ongoing, critical evaluation of progress.

Chapter 6: General discussion

6.1 Introduction

This chapter provides a brief overview of the aim of the research along with a description of the different phases employed highlighting key findings and overall strengths and limitations of the programme of research. Interpretation, application, and impact of the findings are emphasised with requirements for further work in this pivotal area of medicines management.

6.2 Aim, objectives, and key findings

A reflective approach has been employed throughout this research with consideration to the research aim, objectives, systematic review findings, and implications for phase two and phase three. The overall process driven aim was to explore the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland. ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems were the core systems of interest in this research.

Chapter 1 introduces system implementation with a focus on policy documents from Ireland and internationally and the need for adoption. The aim and objectives are then offered inclusive of its novelty and contribution to original knowledge. Chapter 2 provides a critique of available methodologies and accompanying methods undertaken in research and justification of the choice of a qualitative methodology. A systematic review was conducted in phase one followed by a qualitative design in phase two and phase three. An illustration of the development of the doctoral research is provided in Figure 6.1, comprising international, local, and national explorations.

Figure 6.1: Summary of research phases

6.2.1 Phase one: systematic review

Objectives

- Identify and critically appraise the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.
- Synthesise and present the available evidence on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.

Summary of key findings

A narrative design was used in this phase of the research with key findings of improved patient safety and better access to patients' drug records with system implementation. Team leadership, and hardware/software availability and reliability were essential for successful implementation. Key barriers included hardware and network problems, altered work practices such as time pressure on using the system, remote ordering as a potential risk for errors, and weakened interpersonal communication between healthcare professionals and with patients. Results from the systematic review identified few qualitative studies have been

conducted on the topic of interest and findings assisted in developing the interview schedules for phase two and phase three of the research.

Since completing this review, a systematic review of the literature on EHRs, ePrescribing, and medication errors from 2000-2014 was published by Qureshi et al in 2015 (384). Fifty-five of the 184 included studies focused on ePrescribing with similar key themes of converging evidence that ePrescribing systems supported by CDS resulted in enhanced patient safety, considerable reduction of serious medication errors, and increased workflow and cost efficiencies (384). Initial implementation challenges included high cost, extensive training needs, a variety of new medication errors such as selection errors, and change management issues inclusive of resistance to system use (384). A protocol for a systematic review of qualitative studies on perceptions and experiences of implementing, managing, using, and optimising ePrescribing systems in hospitals was also published by Farre et al in 2016 (385). Other related studies published since 2013 have been described in the interpretation sections in Chapter 4 and Chapter 5.

6.2.2 Phase two: interviews with local key stakeholders

Objective

- To explore the perceptions of local key stakeholders towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework.

Summary of key findings

Interpretive phenomenology was employed to achieve this objective with key themes of enhanced patient safety and efficiency which emerged as core divers to system implementation, as well as the need to have clinical champions and a multidisciplinary implementation team to promote engagement and cognitive participation. Key barriers included inadequate training and organisational support, and the need for ease and confidence in system use to achieve collective action.

6.2.3 Phase three: interviews with national key stakeholders and eHealth leads

Objective

- To explore the perceptions of national key stakeholders and eHealth leads towards the facilitators and barriers to implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems in public hospitals in Ireland using NPT as a theoretical framework.

Summary of key findings

Interpretative phenomenology was also used to achieve this objective with key themes of enhanced patient safety, workflow efficiencies, improvements in governance, and financial gains. The realisation of national key building blocks such as HIQA standards, the national eHealth strategy, eHealth Ireland, and the ePharmacy agenda, as well as a clinically led iterative process was thought to facilitate successful system implementation and collective action. Perceived barriers towards system implementation included the potential to expedite complex systems with the introduction of new drug errors, loss of contact between clinical professionals and patients, initial time inefficiencies with new workflow practices, issues with the complexity of integration and standardisation of work processes, the need for legislative change, cyber security concerns, and data protection issues. Participants felt system adoption was not supported at a high-level with inadequate leadership and decision-making capabilities and a limited vision of the need for implementation or of the requirements for implementation which inhibited coherence, cognitive participation, and collective action.

6.3 Overall strengths and limitations of programme of research

6.3.1 Originality

All research phases are novel and contribute to original knowledge focusing on the structures and processes of implementing ePrescribing, robotic pharmacy systems, and automated medication storage and retrieval systems. There is a paucity of published research in this field internationally, and particularly in Ireland where this research was conducted. The systematic review conducted in phase one is the first published review on healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing ePrescribing,

electronic dispensing, and electronic administration of medicines in hospitals. No published studies have been conducted in Ireland focusing on system implementation processes, further contributing to original research for phase two and phase three. This work will form the basis for more research and contributes to developing system normalisation to support improved patient care and healthcare delivery.

6.3.2 Study design

Strengths include the adoption of a rigorous study design approach to minimise design bias and to ensure trustworthiness was evident in the systematic review and qualitative research components. The alignment of philosophical belief with the research aim and objectives put forward qualitative methodology as the most suitable approach.

The systematic review in phase one of this research employed a narrative design and all studies included were qualitative in nature. Systematic reviews occupy the highest hierarchy in terms of quality of evidence and attempt to cover all known literature on the specific topic with explicit details of its design and method for future quality assessment. Interpretive phenomenology of individual face-to-face semi-structured interviews was selected for phase two and phase three of this research to facilitate in-depth rich data capture and analysis so that the perceptions of key stakeholders involved in system implementation could be fully understood and described within the constructs of NPT. In addition, all papers included in the systematic review used individual interviews as a research method, suggesting this would be a suitable method for data generation.

NPT provided a valuable theoretical approach to identify facilitators and barriers to system implementation in hospitals in Ireland from both a local and national perspective. This sociological theory has been promoted widely to understand implementation and integration of innovation in healthcare settings and is particularly relevant for complex technology requiring a multitude of interactions between healthcare professionals, patients, and managers. The four constructs of coherence, cognitive participation, collective action, and reflexive monitoring were utilised throughout the qualitative phases.

Peer and academic scrutiny of the research project continued to be welcomed in order to refine the methods employed, develop a greater explanation of the research design, and strengthen arguments as necessary.

Limitations included a lack of rigour in some of the included studies in the systematic review. The addition of all qualitative studies may also be viewed as another drawback. However, it is increasingly recognised that qualitative studies which explore implementation of interventions have a significant role in ensuring data are of maximum value to practice (223)(330)(331). Limitations with the qualitative phases of this research are provided in the sections that follow. In addition, the inherent design of conducting face-to-face interviews was very labour intensive.

6.3.3 Trustworthiness

A wide range of databases were used to search the literature for inclusion in the systematic review. Three researchers working independently added to the rigour of the literature inclusion and exclusion decisions and strengthened the review process in terms of data extraction and quality rating. Structured data extraction forms ensured no relevant data were missed. Development of a quality assessment form as per standard guidelines helped to ensure important elements around study quality were properly scrutinised. A narrative synthesis of findings allowed results to be tabulated and categorised in a comprehensive manner. An unambiguous, externally validated protocol documenting the process in every aspect of the systematic review allowed any deviations from the set procedures to be recorded which increased transparency. Trustworthiness was further established by interpretation of data and comparing and contrasting findings supported by other researchers.

Frameworks for ensuring the trustworthiness and rigour of the qualitative research phases were put forward in the form of Guba's four constructs: credibility; transferability; dependability; and confirmability (255).

All aspects of the research were reviewed by the research team who have vast experience in qualitative research. The personal experience and training of the primary researcher continued to broaden during this research to consider a more

naturalistic human approach to system implementation and to understand systems ergonomics and the complexities involved through NPT.

The qualitative method employed was clearly described within the study. Included were the research design; details of data generation, analysis, and interpretation; and reflective appraisal of the research. This in-depth methodological description should allow both studies in phase two and phase three to be repeated. The interview schedules were embedded in theory and were tested and checked by all members of the research team and five expert reviewers. Every transcription was independently reviewed and analysed by members of the research team and participants were given the opportunity to review and comment on their transcripts. Data analysis was considered from within and across different professional groups and settings facilitated by the framework approach and NVivo11© software for data management. Trustworthiness was enhanced from triangulation of data sources via multiple participants from diverse professions and settings, triangulation of data methods from combining the systematic review findings with the qualitative phases, and investigator triangulation from utilisation of several analysts. An initial concern of overlap with some of the NPT constructs and possible miscoding leading to analysis not reflective of NPT were alleviated from reviewing findings from the qualitative systematic review of studies using NPT to research implementation processes by McEvoy et al (344).

A reflective commentary inclusive of progressive subjectivity and monitoring of the primary researchers developments via research experience and expanding research skills assisted in ensuring trustworthiness and credibility. Examination of previous research findings allowed comparisons and contrasts to be made to current findings with related rationale provided. A researcher's background and position shapes what they choose to investigate, the angle of investigation, the methods judged most adequate, the findings considered most appropriate, and the framing and communication of conclusions (357). From a personal stance, the primary researcher works as an antimicrobial pharmacist in a university teaching hospital in Ireland and has minimal bias or preconceived ideas to any potential outcomes of the study. Background knowledge into this research was gained through undergraduate and postgraduate degrees in pharmacy, clinical

pharmacy, psychology, computer science, and IT; review of the literature; and previous work in implementing an automated medication storage and retrieval system. A pre-organised visit was also conducted in 2015 in Hackensack University Medical Center, a 900-bed teaching hospital in New Jersey in the USA, to view their award-winning closed loop medicines management system comprising ePrescribing systems, robotic pharmacy systems, and ward-based automated medication storage and retrieval systems within an integrated EHR.

The primary researcher has some experience in conducting individual face-to-face semi-structured interviews and undertaking framework qualitative analysis, as part of a master's thesis in clinical pharmacy (135). Formal training in qualitative research was also completed, as listed in Appendix 2.1. In addition, pilot interviews conducted in both qualitative phases permitted the primary researcher to gain more experience in interview techniques. Standard meetings via phone and videotelephony to discuss research matters and further direction were carried out approximately once weekly with the primary researcher and principal supervisor, and with other members of the research team once monthly or more if required.

The main limitation was that much effort and time was spent understanding NPT constructs and their differences resulting in an initial concern of possible repetition of coding or miscoding of constructs leading to analysis not reflective of NPT. However, this was overcome by further review of the literature and guidance from the qualitative systematic review of studies using NPT to research implementation processes by McEvoy et al (344).

6.3.4 Participant inclusion

A range of relevant heterogeneous local and national key stakeholders were included for participation in the qualitative phases of this research using pre-specified stratification factors in order to provide unique rich data. The main stratification factors employed in phase two were: potential key implementers and operational end-users working in a hospital before system adoption; key implementers and operational end-users working in a hospital after system implementation; profession; and grade. This included both senior and junior employees from nursing, pharmacy, medicine, and IT.

Individuals involved in the advancement of electronic systems for medicines management from a strategic or operational high-level were included in the sample in phase three of this research. Hospital-based leads in pharmacy and medicine with a special interest in system implementation were also included.

6.3.5 Recruitment

Purposive sampling was employed in order to identify local and national key stakeholders for participation who have knowledge of the investigated experience. This method of sampling was chosen to achieve maximum variability and enhance data quality. Most invitees were known by the primary researcher in both qualitative phases. The remaining professionals from multidisciplinary backgrounds were identified through recommendations from senior pharmacists in phase two and government and regulatory body leads in phase three via verbal contact once they had agreed to participate.

A limitation of this approach is the recognition that this recruitment method is dependent on the opinions of those participants requested on whom they consider to be appropriate participants. The research team was confident the risk of sampling bias was minimised as it was anticipated the type of invitees would express many positive and negative perceptions of adoption and a clear vision for future implementation.

6.3.6 Settings

Three acute general hospitals in the public sector in Ireland were the focus for interviews in phase two of this research due to the nature and maturity of system implementation in order to capture a broad range of perspectives from participants with and without system experience. Site triangulation was achieved by the participation of a range of professionals within these hospitals so as to reduce the effect of local factors particular to one institution. Interviews in phase three were conducted with national key stakeholders and eHealth leads involved in medicines management in a convenient location for participants throughout the country.

6.3.7 Transferability

Reproducibility of methods may be achieved from clear descriptions of data generation and analysis processes. The phenomenon of interest was described in sufficient detail in order to evaluate the extent to which conclusions drawn are transferable to other times, settings, situations, and populations. This included describing the structure of NPT constructs and emerging themes, and the integration of concepts, relationships, and interpretations.

This research was completed in three acute hospitals in the public sector in Ireland with 23 local key stakeholders, and with 16 national key stakeholders and eHealth leads in a variety of locations. Findings are potentially transferable to similar organisations within Ireland and other countries which have comparable healthcare systems.

Limitations of the research data obtained from each phase have been highlighted throughout which include the relatively small sample size per professional group which may limit transferability of findings to other organisations. Another possible limitation in phase two was site triangulation from three acute general hospitals in the public sector in Ireland and the possibility that results may not be transferrable to other hospital settings such as private hospitals, tertiary hospitals, specialist hospitals, and hospitals outside of Ireland.

6.3.8 Bias

To reduce bias of design and data generation, prior to commencing all research phases, the primary researcher attended relevant training (Appendix 2.1). In order to minimise interviewer bias, the primary researcher has no vested interest in findings which impact on either positive or negative perceptions towards system implementation. As the primary researcher's interest in NPT only emerged during this research, bias in defending or justifying or refuting this theory was not an issue. To reduce sampling bias, triangulation from an array of different professions, grades, and hospitals were invited for interview in phase two of this research widening the spectrum of interviewees from those with no system experience to those recently exposed to those with extensive experience. The risk of sampling bias was minimised in phase three of this research by the variety of participants from hospital, government, regulatory, and academic

backgrounds invited for interview as it was anticipated they would express many positive and negative perceptions and experiences of adoption as strategic leads and implementers. Sampling bias was also minimised using stratified purposive sampling which is a recognised sampling method (241)(242). To minimise reporting bias, participants were clearly informed of the research aim and given sufficient opportunity to contact the researcher and research team to clarify any issues. Participants were assured confidentiality and anonymity of data and informed that there was no right or wrong response to questions. Participants were also encouraged to share relevant views and experiences not covered by the interview schedule. However, there is still a potential for participants to respond as they believed 'right' which is inherent in such a study design and may not be possible to overcome.

Whilst data saturation was considered to be achieved for the overall samples in both qualitative phases, limitations included lack of certainty that data saturation was achieved for each profession given the smaller number of participants for each.

6.4 Interpretation of findings within the three research phases

Five papers were deemed appropriate for inclusion in the systematic review after screening 2566 titles. It was clear from this key finding that further explorative qualitative work in the form of individual face-to-face semi-structured interviews with key stakeholders would provide much needed novel in-depth information on facilitators and barriers to system implementation.

Findings from the systematic review and qualitative phases with local and national key stakeholders were compared thereby facilitating further triangulation of results. Table 6.1 provides a summary of the main comparisons with all phases of this doctoral research and the main specific findings with interviews in Ireland.

Similarities throughout the three phases included evidence of coherence with key facilitators of enhanced patient safety and efficiency supported by effective clinical leadership. Key barriers included workflow issues and weakened interpersonal communication between healthcare professionals and patients.

Strong engagement, communication, and getting the requisite buy-in from key stakeholders to proceed with the national strategic direction were needed to promote cognitive participation. Systems were required to be accessible, efficient, and not impact negatively on healthcare providers' interaction amongst themselves and with patients to support collective action. The fit of the eHealth system with existing organisational workflow was another key priority for consideration. Significant resource investment was perceived to be needed for system adoption with early baselines measures to identify and champion progress and quick-wins, and encourage reflexive monitoring. Findings generated from both qualitative phases strongly emphasise the need for coherence, cognitive participation, collective action, and reflexive monitoring.

There was a growing realisation of the need to consider ergonomics and a reciprocal relationship between technical, social, and organisational factors in order for new technology to become effectively embedded in organisational workflow. This is further described by other researchers (140)(386) and depicted in Figure 6.2 adopted from Holden et al (112). The general structure of the human factors model is that sociotechnical work systems produce work processes which shape outcomes.

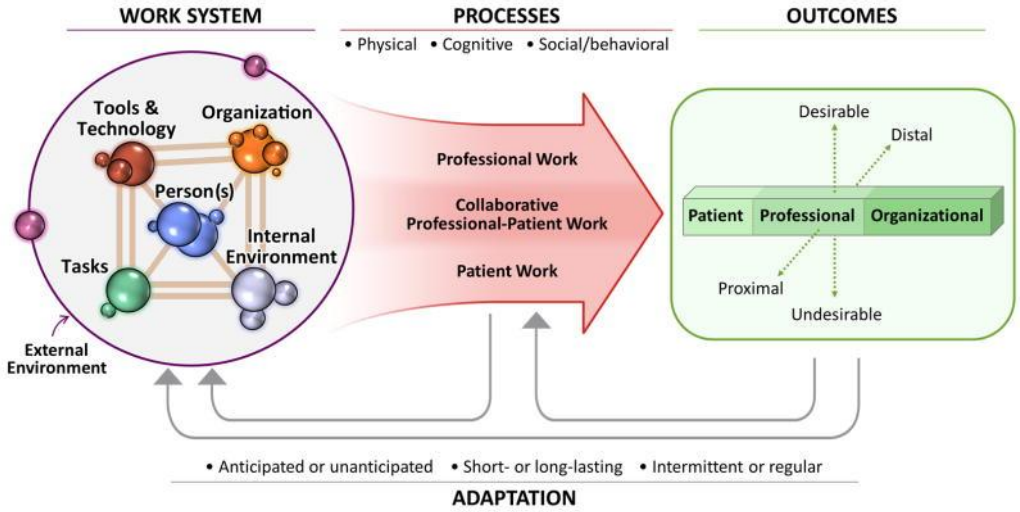

Figure 6.2: Human factors framework adopted from Holden et al (112)

Work system factors consist of healthcare professionals' perceptions towards electronic systems for medicines management. Task factors comprise the complexity of system use. Technology factors include the design of the

technology and its accessibility and reliability. Organisation factors comprise the availability of the technology, the cost of the technology, and the social influence imposed by the technology on healthcare professionals' workflow. Internal environment factors include lighting, clutter, and noise in the area where the technology is placed. External environment factors incorporate financial, motivational, and training support offered by management and clinical leaders. These factors interact to shape the performance of the medication management system. Processes can be decomposed into tasks such as learning how to use the technology, adjusting workflows to compliment the technology, auditing to understand the system and alter processes if necessary, and communicating its impact to implementers, managers, and end-users. Performance of each task may be shaped by unique configurations of work system factors. From a clinical perspective, the main outcomes include accuracy, workflow efficiency, cost reduction, satisfaction with the system, and resultant reduction in medication errors. This research doctoral could be further extended with an emphasis on the above ergonomics specific to electronic systems for medicines management and the need to have a high-quality system design for long-term effectiveness.

Differences in findings from the three research phases included no study in the systematic review utilised NPT as a theoretical framework. National key stakeholders and eHealth leads focused more on realisation of national key building blocks, standardisation of terminology, and interoperability. Issues of legislation, cyber security, and data protection were also emphasised.

These results, inclusive of the current systems in place, suggest that more medication error prevention strategies are required in Ireland such as the effective use of eHealth in the prescribing, dispensing, and administration of medicines in hospitals.

Table 6.1: Main findings in research phases: comparisons with all phases and specific findings with interviews in Ireland

	Comparisons with systematic review and local and national interviews	**Specific findings with local and national interviews in Ireland**
Key facilitators to system implementation	A potential to enhance patient safety Better access to patients' drug records Effective leadership and clinical champions Adequate staff training Hardware/software availability and reliability	A potential to enhance efficiency - Safety alerts - Stock control - Traceability - Accountability - Cost reduction - Integration/ standardisation Multidisciplinary team approach Robust governance Robust iterative process Sufficient support Finance and autonomy for local implementation Early adaptors Attaining quick wins Contingency plans Ongoing auditing and evaluations
Key barriers to system implementation	Technical problems New drug errors Weakened interpersonal communication Workflow issues e.g. time delays in queuing, limited accessibility, inadequate numbers/sizes of units, S substantial time away from patients Not using the system as trained Security issues Inadequate support or	Resist work changes e.g. force of change, bureaucracy, lack of recognition of professional roles Integration and standardisation issues Legislation, cyber security, and data protection issues Implementation plans short on detail Poor expertise nationally Lack of emphasise on

	Comparisons with systematic review and local and national interviews	Specific findings with local and national interviews in Ireland
	resources Implementation roll out Cost and financial constraints	training Testing at scale challenging Lack of confidence with identifying drugs Limited formal audits/measures

6.5 Key recommendations for future system implementation in hospitals in Ireland

The key recommendations points from triangulation of the findings from the three phases in this doctoral research include:

- System implementation provides the potential to enhance patient safety and efficiency in healthcare delivery. It offers the potential to improve governance in the medicines management process by increasing traceability and enhancing accountability
- Work since 2013 has been made with the publication of the *eHealth Strategy* and development of national key building block initiatives to facilitate system implementation such as HIQA standards around interoperability and the ePharmacy agenda. This needs to be further progressed and realised inclusive of consideration to legislation, data protection, and security concerns. A focus on details around implementation is required
- Clinical champions and experts with leadership qualities and a vision for future implementation are required at a national and local level to drive the eHealth agenda forward. An effective multidisciplinary team, staff engagement, and open communication is important for realising a shared sense of purpose and in understanding the benefits of system implementation
- Systems should be designed to facilitate interoperability and be easy to use, reliable, and readily available

- Organisational support in the form of adequate finance and autonomy for local initiatives is needed. The vision is not for duplication but for innovation to assist early adaptors in attaining quick wins which will map future successes or failures of system adoption
- Sufficient training and staffing is required for implementation
- Testing at scale, contingency plans, and ongoing evaluations will assist in determining success or otherwise of system implementation

6.6 Impact of findings

Actively demonstrating the impact of research is significant to ensure continued investment in the research base. The Research Councils UK (RCUK) defines research impact as "*the demonstrable contribution that excellent research makes to society and the economy through fostering global economic performance, increasing effectiveness of public services and policy and enhancing quality of life, health and creative output*" (387). The RCUK Review of Pathways to Impact focuses on various academic, economic, and societal impacts, as provided in Figure 6.3 (387).

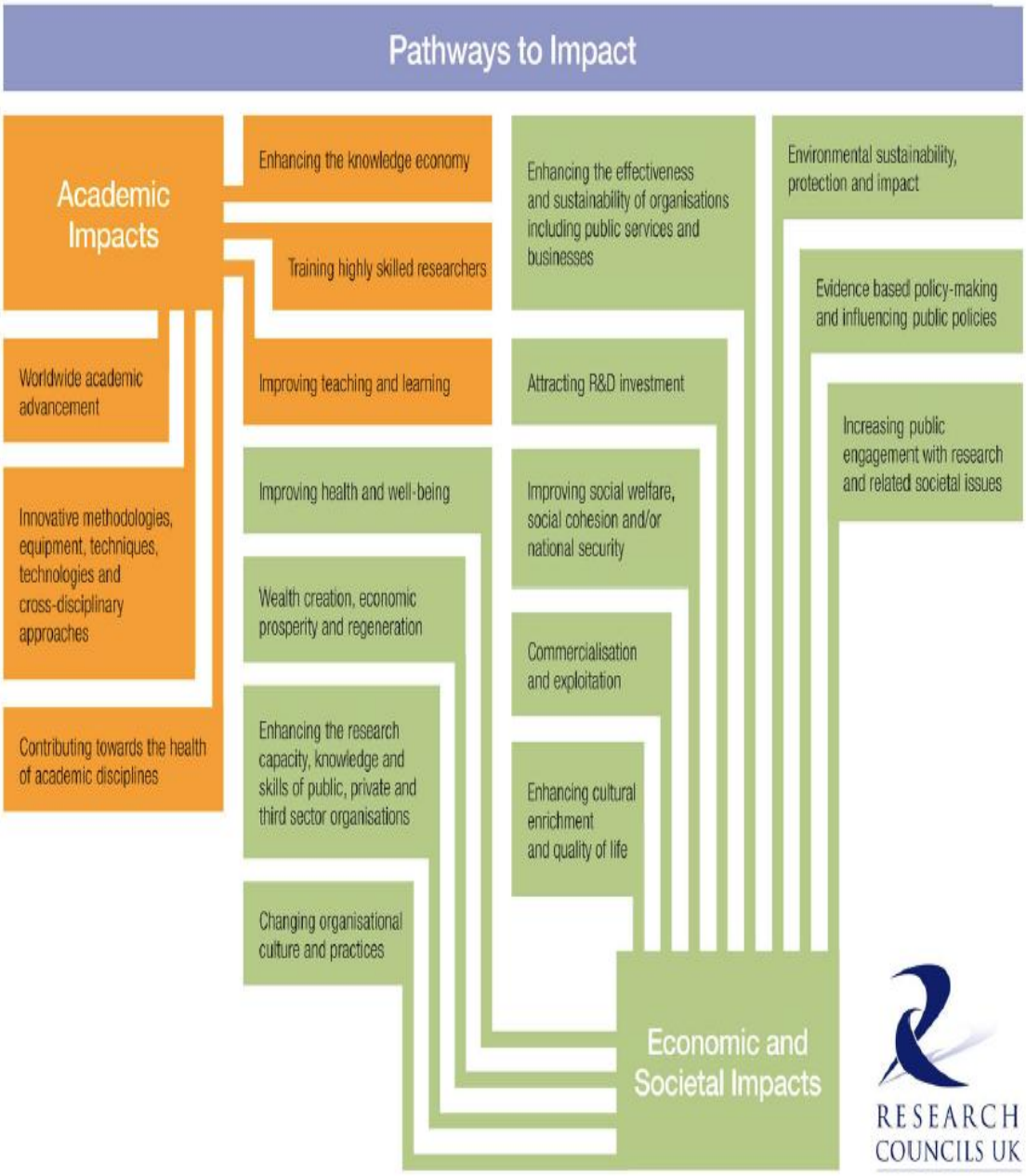

Figure 6.3: Pathways to impact by Research Councils UK

6.6.1 Academic impact

This process-based doctoral research mainly impacted the pathway 'Enhancing the knowledge economy' and has directly impacted on the principal researcher in terms of overall research training inclusive of in-depth understanding of paradigms, qualitative methodology and methods, and NPT. Development of skills included designing, generating, analysing, and interpreting systematic review and qualitative data, use of electronic analysis software NVivo©, use of electronic reference management systems, enhancement of time management

skills, and development of written and oral presentation skills. Multiple individuals were also exposed to this research as a direct consequence of interview participation.

Applying a participatory approach in system design and providing sufficient user support through training were key lessons learnt. System implementers should systematically plan for all aspects of the implementation process inclusive of staff training, support, workflow changes, and communication. This requires a high-level of collaboration and negotiation across departments and between IT, end-users, and management.

6.6.2 Economic and societal impacts

This research mainly impacted 'Improving health and wellbeing' and 'Changing organisational culture and practices' which aligns with the research findings. The economic impact was not within the scope of this work and as such was not considered.

Government initiatives and strategies in recent years in Ireland have recommended system implementation in hospitals to enhance patient safety and improve efficiencies in healthcare delivery. Findings are novel and highlight effective ways of implementing systems in the hospital environment which can be used to inform and influence future policy and practice developments for successful system adoption. It is anticipated that implementers, end-users, and evaluators will use key findings when planning, implementing, and maintaining these systems.

6.6.3 Pathway to impact

The advancement of knowledge has been achieved via a unique exploration of system implementation and transfer of knowledge by sharing findings as described in the output section and with individual participants in phase two and phase three. Dissemination with further peer reviewed paper publications as well as oral and posters presentations at national and international conferences is planned.

6.7 Further work

While there is no overarching framework in relation to the adoption of eHealth innovations, a number of strategies have been found to be effective for successful implementation inclusive of ascertaining end-users' attitudes towards the system; effective communication between implementers and end-users; strategic project management and effective leadership; and continuous evaluation and quality improvement initiatives. Multiple future research areas should be considered both locally and nationally by government bodies. The following key priority research questions emerged from the findings and limitations of this doctoral research.

6.7.1 Healthcare professionals' views and experiences of the impact of implementing an ePrescribing and robotic pharmacy system on work practices in a public hospital in Ireland

Since completing this research, a tertiary hospital in the public sector in Dublin has implemented a robotic pharmacy system and plans to implement ePrescribing throughout the hospital in 2018. Evaluating healthcare professionals' views and experiences of system implementation would facilitate knowledge in this area.

Research Question: What are healthcare professionals' views and experiences of the impact of implementing an ePrescribing and robotic pharmacy system on work practices in a public hospital in Ireland?

Research philosophy: This study adopts an interpretivist paradigm by exploring in-depth perceptions of healthcare professionals.

Methodology and method: Application of a qualitative design with individual face-to-face semi-structured interviews via purposive sampling with doctors, pharmacists, pharmacy technicians, nurses, IT managers, and relevant senior individuals involved in decision-making or implementation across the hospital using TDF as a theoretical framework. The interview schedule will be informed from the findings of this research.

Key outcome measures: These will include participants' views and experiences of: tolerability, implementation, suitability, feasibility, impact on patient care and work processes, and sustainability.

Likely impact: Assist future implementers on learning lessons from early adaptors of ePrescribing and robotic pharmacy systems.

6.7.2 Patient perceptions of an EHR

Patient perceptions were excluded from this research as implementation plans and processes are still at a preliminary stage in Ireland and the research team agreed to first focus on providers directly involved in medicines management processes. In addition, the research team felt patients would be more interested in EHR implementation which encompasses their entire medial history as well as medication history rather than the process of implementation of ePrescibing, robotic pharmacy systems, and automated medication storage and retrieval systems. EHRs enable a fundamental patient-centric connection between healthcare providers and patients by providing the exchange of health information electronically to improved healthcare quality and delivery. Additional research could now centre on patients' perceptions of the facilitators and barriers to EHR implementation.

Research Question: What are patients' perceptions of the facilitators and barriers to the implementation of an EHR in Ireland?

Research Philosophy: This study adopts a pragmatic approach, both quantifying and exploring the effects of system implementation.

Methodology and method: A sequential mixed methodology combining a cross-sectional survey followed by phenomenology with individual interviews will be employed to establish patients' perceptions of EHR implementation. A quantitative design questionnaire will be provided to patients via convenience sampling using NPT as a theoretical framework. Post analysis of questionnaire data, qualitative interviews using purposive sampling will further explore patients' perceptions facilitating triangulation of methods with findings from the survey.

Key outcome measures: Patient perceptions of the facilitators and barriers to system implementation inclusive of aim and purpose, involvement in the process, data protection, and implications of EHR.

Likely impact: Improve the future adoption of EHR with an ultimate aim to enhance patient care.

6.8 Conclusion

Findings have generated original data which can inform future policy and practice developments for successful system implementation in the hospital environment. The use of NPT has highlighted individual and organisational facilitators and barriers to the normalisation of these complex electronic systems into routine work which requires consideration to interventions inclusive of engagement, education, training, and support. Findings generated from both qualitative phases strongly emphasise the need for coherence, cognitive participation, collective action, and reflexive monitoring. Similarities throughout the research phases included key facilitators of enhanced patient safety and efficiency and key barriers of workflow issues. Assessing and fostering readiness for technological innovation also appears to be particularly important for successful adoption. There was more of an emphasis on realisation of national key building blocks, standardisation of terminology, and interoperability verbalised by national key stakeholders and eHealth leads. While this research was conducted in Ireland, there is potential for wider impact which will be facilitated by ongoing dissemination of the research findings. Many potentially transferable themes have been identified and extend the evidence base. This will assist organisations to better plan for implementation of medication-related eHealth systems.

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Appendices

Appendix 2.1: Relevant training completed by primary researcher during the course of the PhD

Relevant certificates completed since commencing doctoral research

- PgCert in Research Methods Module 1 & Module 2 Aberdeen (2014, 2012)
- Research Board Critical Appraisal Certificate Dublin (2013)
- Advanced Statistical Modeling Certificate Dublin (2013)
- Introduction to Evidence-Based Healthcare - Joanna Briggs Institute Certificate Aberdeen (2013)
- EBSCOhost Research Database Tutorials (2013)
- EBSCOhost Health Tutorials (2013)
- Statistical Research Methods and Sample Size Certificate Dublin (2012)
- The Social Research Association Designing a Qualitative Study Certificate London (2012)
- The Social Research Association Qualitative Data Collection: Interviewing Certificate London (2012)
- Hospital Pharmacy Association of Ireland Clinical Skills Certificate Part 1, Part 2, and Part 3 Dublin (2012)
- Certificate on the Audit Cycle Dublin (2012)

Relevant conference and meeting attendance since commencing doctoral research

- Galway University Hospitals Research Day 2017
- Hospital Pharmacy Association of Ireland Annual Conference Dublin (2017, 2016, 2015, 2014, 2013, 2012)
- Healthcare Informatics Society of Ireland Annual Conference, Scientific Symposium & Exhibition Dublin (2016, 2014, 2012)
- Royal Academy of Medicine in Ireland Healthcare Informatics Meeting Dublin (2016, 2015)
- Royal Pharmaceutical Conference Birmingham (2016)
- 7th Annual National Hospital Pharmacy Forum Dublin (2016)
- All Staff Meeting Council of the Clinical Information Officers Galway (2016)
- Council of the Clinical Information Officers Dublin (2016)
- All Ireland Pharmacy Workshop and Conference Dundalk (2015, 2012)
- eHealth Ireland Ecosystem Meeting Dublin (2015)
- Health Services Research & Pharmacy Practice Conference Aberdeen/Lancaster/Cork (2014, 2013, 2012)
- European Society of Clinical Pharmacy Symposium Copenhagen (2014)
- Reducing Medication Errors in Healthcare Services Conference Dublin (2014)
- Health Economics and Outcomes Research for the 21st Century Pharmacist Galway (2014)
- International Pharmaceutical Federation (FIP) World Congress Dublin (2013)
- Critical Analysis Workshop Dublin (2013)
- Electronic Prescribing in hospitals: moving forward. Healthcare Conferences London (2013)
- Irish Centre for Continuing Pharmaceutical Education Meetings Dublin (2013, 2012)

- Workshop of Research Methods Dublin (2012)

Appendix 3.1: Systematic review protocol registered with PROSPERO

Healthcare professionals' perceptions of the facilitators and barriers to implementing electronic prescribing, dispensing, and administration of medicines in hospitals: a systematic review

Diana Hogan-Murphy, Scott Cunningham, Antonella Tonna, Alison Strath

Citation

Diana Hogan-Murphy, Scott Cunningham, Antonella Tonna, Alison Strath. Healthcare professionals' perceptions of the facilitators and barriers to implementing electronic prescribing, dispensing, and administration of medicines in hospitals: a systematic review. PROSPERO 2013:CRD42013004427 Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42013004427

Review question(s)

What are healthcare professionals' perceptions of the barriers and facilitators to implementing electronic prescribing, dispensing, and administration of medicines in hospitals?

Searches

The following electronic databases will be searched for relevant studies:

- MEDLINE
- CINAHL
- PsycINFO
- International Pharmaceutical Abstracts
- Pharmline
- The Cochrane Library (all databases)
- DARE
- The Health Technology Assessment Database
- PsycARTICLES

Without too many different search concepts, a wide variety of search terms will be combined within each concept. Both free-text and subject headings will be used such as Medical subject heading (MeSH) descriptors including electronic prescribing or e-prescribing or ePrescribing or electronic dispensing or automated dispensing systems or electronic administration and the descriptor medicines management and/or eHealth or health information technology or health information and communications technology or health ICT and the text words facilitators, barriers, perceptions, attitudes, views, beliefs, experiences, healthcare professionals, clinicians, nurses, pharmacists and hospitals.

The bibliographies of included studies will be scrutinised for additional references not identified by other means. Studies will also be retrieved by citation searching, hand-searching key journals and conference proceedings and, if necessary, contacting study

authors for full texts if abstracts are only available. It is anticipated that searching databases and registers that include unpublished studies, such as records of ongoing research, conference proceedings and theses, will reduce the impact of publication bias.

Alternative spellings including US and British English variants, abbreviations, synonyms, geographical variation, and changes in terminology over time will be accounted for when selecting free text terms.

Study selection:

- Stage 1: The titles and abstracts of identified studies will be screened by the primary researcher and the principal supervisor for relevance to the topic. Studies considered not relevant will be excluded. Studies involving the topic, but perhaps considered not relevant, will be passed to the research team for consideration.
- Stage 2: Full text/papers will be sought for all studies appearing to meet the inclusion criteria and a final selection will be made by the full team before data extraction and synthesis by the primary researcher and principal supervisor.

A flow chart will be produced to facilitate transparency of the process.

Language: studies published in the English language will be considered.

Types of study to be included

Inclusion criteria:

The types of studies to be included in this review will consist of any study which has researched healthcare professionals' perceptions of the various barriers and facilitators to implementing electronic prescribing, dispensing, and administration of medicines in the hospital setting. It is planned at the outset to search for a broad range of study types including any:

- evaluative study design e.g. randomised controlled trials (RCTs) and derivatives
- quasi-experimental studies e.g. non-RCTs, before, and after studies
- observational studies e.g. cohort, case-control, case series, and cross-sectional studies
- qualitative studies
- qualitative/narrative reviews
- systematic reviews

Where relevant qualitative/narrative/systematic reviews are identified, these will be summarised and results will be supplemented with results from relevant primary studies not included in the reviews.

Exclusion criteria:

Summaries of the literature for the purpose of information or commentary, editorial discussions and papers whose abstracts identify them as reviews but lack supporting evidence in the main text will be excluded.

Condition or domain being studied

Implementation of information technology in healthcare is influenced at the micro-level by interpersonal factors such as individuals' attitudes and beliefs; at the meso-level by the operational aspects of implementation such as readiness and resources; and at the macro-level by socio-political forces. At a macro-level, many countries including Australia, Canada, the US and the UK have been at the forefront of attempts to embed eHealth into routine healthcare, with the UK investing £12.4 billion over 10 years. However, despite political commitment and substantial investment, there has been significant variability in the success of different eHealth implementations across the NHS. Difficulties in eHealth implementation are an international phenomenon, with similar problems being widely reported. An important theme in much recent work has been the problem of resistance or refractory behaviours of healthcare professionals and the assumption that their attitudes to eHealth are the root problem. This systematic review therefore aims to explore healthcare professionals' perceptions of the various barriers and facilitators to implementing electronic prescribing, dispensing, and administration of medicines in the hospital setting. As there is much published literature on the impact of information technology in medicines management, such as effects on medication errors and cost, implementation processes rather than outcomes will be the main focus of this research.

Participants/ population

Inclusion criteria:
All clinicians, nurses, pharmacists, and allied healthcare professionals such as dieticians, podiatrists physiotherapists, and pharmacy technicians involved in prescribing, dispensing, and/or administration of medicines.

Exclusion criteria:

Non-healthcare professionals and healthcare professionals not working in the hospital environment.

Intervention(s), exposure(s)

Inclusion criteria:

An exploration of healthcare professionals' perceptions of the various barriers and facilitators to implementing electronic prescribing, dispensing, and administration of medicines in the hospital setting. Perceptions include healthcare professionals' attitudes, beliefs and views.

Exclusion criteria:

This phenomenon of interest is limited to healthcare professionals' perceptions towards the implementation of electronic prescribing, electronic dispensing and electronic administration of medicines and excludes other eHealth strategies such as electronic medical records, unique patient identifiers, clinical decision support systems,

computerised provider order entry and electronic discharge prescriptions. Other medicines management strategies are excluded such as the monitoring of patients. Studies that focus on perceptions of eHealth and medicines management other than implementation, for example, clinical and fiscal outcomes and effects on patients and resources will also be excluded.

Comparator(s)/ control

Not applicable.

Context

Inclusion criteria:

Any hospital setting.

Exclusion criteria:

Non hospital setting including nursing homes, rehab and step-down units.

Outcome(s)

Primary outcomes

Identify and review the literature to explore healthcare professionals' perceptions, attitudes, and views of the barriers and facilitators to implementing electronic prescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.
Synthesize available evidence to identify, describe and understand healthcare professionals' perceptions, attitudes and views of the barriers and facilitators to implementing electronic prescribing, electronic dispensing and/or electronic administration of medicines in the hospital setting.

Secondary outcomes
None.

Data extraction, (selection and coding)

Citations will be downloaded into RefWorks and screened by the primary reviewer. All papers deemed relevant will be double screened by the principal supervisor. In case of disagreement about inclusion or exclusion of a given paper, all reviewers (four in total) in the research team will read the paper and reach agreement through discussion.

Data will be extracted from studies identified using Microsoft Word on the basis of review objectives and methods; databases searched within the review; inclusion and exclusion criteria of the review; number of papers identified, and number included in the review.

Risk of bias (quality) assessment

The primary researcher will review the literature to identify studies relating to healthcare professionals perceptions' of the various barriers and facilitators to implementing electronic prescribing, dispensing, and administration of medicines in the hospital setting. All types of studies in the inclusion criteria will be independently assessed for quality by the primary researcher and a proportion of the assessments will be double-checked by the principal supervisor. Disagreement will be resolved by consensus or by consulting the remaining research team members if necessary. Study quality will initially be critically appraised using key concepts from the Joanna Briggs Institute reviewers' manual and the Joanna Briggs Institute comprehensive systematic review training programme, the Centre for Reviews and Dissemination guidance for undertaking systematic reviews in healthcare, the Cochrane Handbook for Systematic Reviews of Interventions, and the Critical Appraisal of Systematic Reviews. Thereafter, studies will be critically appraised using the Critical Appraisal Skills Programme (CASP) of qualitative studies, systematic reviews, randomised controlled trials, cohort, and case-controlled studies. If necessary a table will be used to record study quality or risk of bias.

Strategy for data synthesis

Data synthesis will involve the collation, combination, and summary of the findings. Findings will most likely be synthesised through a narrative approach using text and tables. If both quantitative and qualitative studies are identified, these results will be reported separately and will follow the Centre for Reviews and Dissemination guidance for undertaking reviews in healthcare for tabulating study type. A separate table may be used to record study quality or risk of bias. In view of these studies and the data that will be included, a meta-analysis is unlikely to be necessary or possible.

Analysis of subgroups or subsets

Depending upon the literature findings, a sub-group analysis will be considered, for example, comparing the perceptions of both medical clinicians and pharmacists.

Dissemination plans

- Presentations to the Senior Management Team and Drugs and Therapeutics Committee in local hospital
- Abstract submissions to the Healthcare Informatics Society of Ireland, Hospital Pharmacy Association of Ireland, Health Services Research in Pharmacy Practice

Review team

Ms Diana Hogan-Murphy, Robert Gordon University
Dr Scott Cunningham, Robert Gordon University
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Professor Alison Strath, Robert Gordon University

Anticipated or actual start date: 09 May 2013

Anticipated completion date: 11 December 2013

Conflicts of interest: None known

Language: English

Country: Ireland

Subject index terms status
Subject indexing assigned by CRD

Subject index terms: Electronic Prescribing; Health Personnel; Humans; Pharmacy Service, Hospital

Stage of review: Ongoing

Date of registration in PROSPERO: 14 May 2013

Date of publication of this revision: 24 March 2014

Stage of review at time of this submission	**Started**	**Completed**
Preliminary searches	Yes	Yes
Piloting of the study selection process	No	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Appendix 3.2: Medline search string

MEDLINE	Search terms (limit English language)	# retrieved
	MH healthcare professionals+	10131
	MH health care professionals+	55845
	MH healthcare providers+	11311
	MH health care providers+	56554
	Healthcare N8 profession*	8735
	Health care N8 profession*	18849
	Health profession*	53526
	Healthcare N8 provider*	8663
	Health care N8 provider*	22783
	Health provider*	27832
	MH doctors+	256
	doctor*	85559
	MH clinicians+	852
	Clinician*	117975
	MH physicians+	69339
	Physician*	356522
	MH pharmacists+	8848
	Pharmacist*	18896
	Chemist	1171
	Druggist*	94
	Apothecary*	130
	Hospital N8 pharmacist*	1605
	Dietician*	861
	Nutritionist*	1470
	Pharm* N8 technician*	638
	Chiropodist*	111
	Podiatrist*	535
	Physiotherapist*	3427
	MH nurse+	517
	Nurse OR nurses	204514
	Dentist OR dentists	32841
	Radiographer*	861
	Optometrist*	1503
	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 (MH healthcare professionals+ OR MH health care professionals+ OR MH healthcare providers+ OR MH health care providers+ OR Healthcare N8 profession* OR Health care N8 profession* OR Health profession* OR Healthcare N8 provider* OR Health care N8 provider* OR Health provider* OR MH doctors+ OR doctor* OR MH clinicians+ OR Clinician* OR MH physicians+ OR Physician* OR MH pharmacists+ OR	801733

MEDLINE	Search terms (limit English language)	# retrieved
	Pharmacist* OR Chemist OR Druggist* AND Apothecary* OR hospital N8 pharmacist* OR Dietician* OR Nutritionist* OR Pharm* N8 technician* OR Chiropodist* OR Podiatrist* OR Physiotherapist* OR MH nurse+ OR (Nurse OR nurses) OR (Dentist OR dentists) OR Radiographer* OR Optometrist*)	
35	MH electronic prescribing+	386
36	e-prescri* OR eprescri*	697
37	Robot* AND pharmacy OR medic*	1190
38	Electronic transfer of prescription*	9
39	ETP	552
40	Electron* N8 prescri*	1085
41	E N8 prescri*	484
42	MH electronic administration+	11941
43	electronic administ*	466
44	automated dispens*	259
45	automated dispens* system*	57
46	((electronic administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*))	379
47	((bar N5 code N5 administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*))	69
48	electron* N8 prescrib*	791
49	e N8 prescrib*	386
50	((e N8 admin*) AND (medic* OR drug* or tablet OR remed* OR treat* OR dos*))	7340
51	Ehealth*	915
52	E health*	4160
53	Health information technolog*	2603
54	HIT	13138
55	Mobile technolog*	801
56	Mobile health*	2287
57	35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 (MH electronic prescribing+ OR e-prescri* AND eprescri* OR robot* AND pharmacy OR medic* OR electronic transfer of prescription* OR ETP OR Electron* N8 prescri* OR E N8 prescri* OR MH electronic administration+ OR electronic administ* OR automated dispens* OR automated dispens* system* OR ((electronic administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR ((bar N5 code N5 administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR electron* N8 prescrib* OR e N8 prescrib* OR ((e N8 admin*) AND (medic* OR drug* or tablet OR remed* OR treat* OR dos*)) OR Ehealth* OR E health* OR Health information technolog* OR HIT OR Mobile technolog*	23743

MEDLINE	Search terms (limit English language)	# retrieved
	OR Mobile health*)	
58	34 + 57 ((MH healthcare professionals+ OR MH health care professionals+ OR MH healthcare providers+ OR MH health care providers+ OR Healthcare N8 profession* OR Health care N8 profession* OR Health profession* OR Healthcare N8 provider* OR Health care N8 provider* OR Health provider* OR MH doctors+ OR doctor* OR MH clinicians+ OR Clinician* OR MH physicians+ OR Physician* OR MH pharmacists+ OR Pharmacist* OR Chemist OR Druggist* AND Apothecary* OR hospital N8 pharmacist* OR Dietician* OR Nutritionist* OR Pharm* N8 technician* OR Chiropodist* OR Podiatrist* OR Physiotherapist* OR MH nurse+ OR (Nurse OR nurses) OR (Dentist OR dentists) OR Radiographer* OR Optometrist*) AND (MH electronic prescribing+ OR e-prescri* AND eprescri* OR robot* AND pharmacy OR medic* OR electronic transfer of prescription* OR ETP OR Electron* N8 prescri* OR E N8 prescri* OR MH electronic administration+ OR electronic administ* OR automated dispens* OR automated dispens* system* OR ((electronic administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR ((bar N5 code N5 administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR electron* N8 prescrib* OR e N8 prescrib* OR ((e N8 admin*) AND (medic* OR drug* or tablet OR remed* OR treat* OR dos*)) OR Ehealth* OR E health* OR Health information technolog* OR HIT OR Mobile technolog* OR Mobile health*))	2881
59	MH hospital+	21481
60	Hospital*	2447403
61	Secondary N3 care	4526
62	Tertiary N3 care	24932
63	Ward*	69871
64	59 or 59 or 60 or 61 or 62 or 63 (MH hospital+ OR hospital* OR secondary N3 care OR tertiary N3 care OR ward*)	2497834
65	58 AND 64 ((MH healthcare professionals+ OR MH health care professionals+ OR MH healthcare providers+ OR MH health care providers+ OR Healthcare N8 profession* OR Health care N8 profession* OR Health profession* OR Healthcare N8 provider* OR Health care N8 provider* OR Health provider* OR MH doctors+ OR doctor* OR MH clinicians+ OR Clinician* OR MH physicians+ OR Physician* OR MH pharmacists+ OR Pharmacist* OR Chemist OR Druggist* AND	991

MEDLINE	Search terms (limit English language)	# retrieved
	Apothecary* OR hospital N8 pharmacist* OR Dietician* OR Nutritionist* OR Pharm* N8 technician* OR Chiropodist* OR Podiatrist* OR Physiotherapist* OR MH nurse+ OR (Nurse OR nurses) OR (Dentist OR dentists) OR Radiographer* OR Optometrist*) AND (MH electronic prescribing+ OR e-prescri* AND eprescri* OR robot* AND pharmacy OR medic* OR electronic transfer of prescription* OR ETP OR Electron* N8 prescri* OR E N8 prescri* OR MH electronic administration+ OR electronic administ* OR automated dispens* OR automated dispens* system* OR ((electronic administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR ((bar N5 code N5 administ*) AND (medic* OR drug* or tablet* OR remed* OR treat* OR dos*)) OR electron* N8 prescrib* OR e N8 prescrib* OR ((e N8 admin*) AND (medic* OR drug* or tablet OR remed* OR treat* OR dos*)) OR Ehealth* OR E health* OR Health information technolog* OR HIT OR Mobile technolog* OR Mobile health*) AND (MH hospital+ OR hospital* OR secondary N3 care OR tertiary N3 care OR ward*))	

Appendix 3.3: Blank data extraction form

Heading	Subheading		For completion by reviewers
	Citation		
	Name of Reviewer		
	Eligible?	Does the evidence fit within the scope of the review?	Yes No Unclear
	Reviewers' rating	As matrix	
	Typology		
	Participants	Evidence from HC professionals	
	Study aims	What were the study's aims and purpose?	
	Key findings	What are the key study findings?	
	Evaluation summary	Draw together brief comments on the study as a whole and its strengths and weaknesses. Is further work required? What are its implications for policy, practice and theory, if any?	
	HC professionals' perspective	Does the study report on the experience of HC professionals? How were they involved in the study (e.g. as advisors for the research, in the design and execution of the study, in dissemination)?	
Ethical standards		Was ethical committee approval obtained? Was informed consent obtained? Does the study	Ethical approval: Yes No Unclear Informed consent: Yes No Unclear Ethical issues addressed: Yes No Unclear

Heading	Subheading		For completion by reviewers
		address ethical issues adequately? Has confidentiality been maintained?	Confidentiality maintained: Yes No Unclear
Context	Aims	Are the aims and purpose of the study clearly stated?	Yes No Unclear
Setting	Setting	What is the geographical and care setting for the study?	Urban Rural Mixed Tertiary Specialised General Community Regional UNKNOWN
	Rationale	What is the rationale and appropriateness for this choice?	
	Detail	Is there sufficient detail about the setting?	Yes No Unclear
	Timing	Over what period did the data collection take place?	
Sample	Inclusion criteria	Who was included in the study? Setting? Process	
	Exclusion criteria	Who was excluded from the study?	
	Selection	How was the sample selected? Were there any factors that influenced how the sample was selected (e.g. access, timescale issues)?	
	Size	What is the size of the sample and groups comprising the study?	
	Appropriateness	Is the sample appropriate in terms of its ability to meet the aims of the study, the depth of data that it enabled to be collected, and its	Yes No Unclear

Heading	Subheading		For completion by reviewers
		breadth?	
Data collection	Methods	What data collection methods were used? Was the data collection adequately described and rigorously conducted?	Interview Focus group Observation Mixed methods Yes No Unclear
	Role of researcher	What is the role of the researcher within the setting? Are there any potential conflicts of interest?	
	Data analysis	How is the data analysed? How adequate is the description of the data analysis? Is adequate evidence provided to support the analysis (e.g. use of original data, iterative analysis, efforts to establish validity and reliability)? Is the study set in context in terms of findings and relevant theory?	
	Researcher's potential bias	Are the researchers' own position, assumptions, and possible biases outlined? Indicate how they could affect the study in terms of analysis and interpretation of the data	
	Reflexivity	Are the findings substantiated by the data and has consideration been given to any	Yes No Unclear

Heading	Subheading		For completion by reviewers
		limitations of the methods or data that may have affected the results?	
Outcomes	Outcomes	What outcome measures were adopted? What was the impact of the study for HC professionals, organisation responsible for service?	
Findings	Themes		
	Conclusions		
	Opinions	What this person argues	
Policy & practice	Generalisability	To what extent are the study findings generalisable? What is the country of study? How applicable are the study findings to the system in the UK/Ireland? Are the conclusions justified?	
	Implications for policy		
	Implications for practice		
Other comment	Format		
	Links to other references to be followed up		
Decision	Name of second reviewer		
	Agreement with reviewer		
	Inclusion		
	Date		

Appendix 3.4: Data extraction form for included paper (310)

Heading	Subheading		For completion by reviewers
	Citation		Physicians' perceptions of possibilities and obstacles prior to implementing a computerised drug prescribing support system
	Name of Reviewer	Diana Hogan-Murphy and Scott Cunningham	
	Eligible?	Does the evidence fit within the scope of the review?	Yes No Unclear
	Reviewers' rating	As matrix	8
	Typology		Primary research case studies Descriptive accounts
	Participants	Evidence from HC professionals	Physicians
	Study aims	What were the study's aims and purpose?	To identify physicians' perceptions of possibilities and obstacles prior to implementing a computerised drug prescribing support system
	Key findings	What are the key study findings?	Possibilities: patient drug history, pharmacological knowledge, information access, and time saving. Obstacles: technical problems, shortage of computers, diminishing patient contact, routines and habit Gaining access to patient drug history enables physicians to carry out work in a professional way – a need the computerised prescription support system was not developed for and thus cannot fulfil. Alerts and producer-independent drug information are valuable in reducing workload. However, technical prerequisites form the base for a successful implementation. Time must be given to adapt to new ways of working.
	Evaluation	Draw together brief	Excellent detail on methods

Heading	Subheading		For completion by reviewers
	summary	comments on the study as a whole and its strengths and weaknesses. Is further work required? What are its implications for policy, practice and theory, if any?	and data collection and analysis. Implications for policy practice and theory are unknown as setting in an ED and not a general medical or surgical ward but a good mix of patients? No documentation of bias and little mention of limitations bar 'we do not argue that the results can be generalised to a large group'. Themes in line with other research A useful qualitative study that seems well described and executed. It only includes physicians from one setting. Limited detail on recruitment and other aspects of method. Clear description of approach to analysis.
	HC professionals' perspective	Does the study report on the experience of HC professionals? How were they involved in the study (e.g. as advisors for the research, in the design and execution of the study, in dissemination)?	Yes – physicians. Possible end-users if system implemented but not clear
Ethical standards		Was ethical committee approval obtained? Was informed consent obtained? Does the study address ethical issues adequately? Has confidentiality been maintained?	Ethical approval: **Yes** No Unclear but unclear why done retrospectively A retrospective application was sent to the Ethics Committee at Karolinska Institute which raised no objections to the study Informed consent: **Yes** No Unclear Participants were informed of the aims of the study and that participation was voluntary and could be discontinued if they wished Ethical issues addressed: Yes No **Unclear** Confidentiality maintained:

Heading	Subheading		For completion by reviewers
			Yes No Unclear
Context	Aims	Are the aims and purpose of the study clearly stated?	**Yes** No Unclear
Setting	Setting	What is the geographical and care setting for the study?	**Urban** Rural Mixed Tertiary Specialised **General** Community Regional UNKNOWN General Hospital in Stockholm city in the largest ED in the Nordic countries
	Rationale	What is the rationale and appropriateness for this choice?	Not stated but possibly to explore physicians' perceptions of possibilities and obstacles prior to implementing a computerised drug prescribing support system in ED. Largest ED in the Nordic countries with approximately 90,000 visitors per year
	Detail	Is there sufficient detail about the setting?	**Yes** No Unclear
	Timing	Over what period did the data collection take place?	Autumn 2002 for 30 minutes – individual interviews
Sample	Inclusion criteria	Who was included in the study? Setting? Process	21 ED physicians competent in handling internal medicine, general surgery, orthopaedics, gynaecology and ENT
	Exclusion criteria	Who was excluded from the study?	Not stated – all agreed to participant
	Selection	How was the sample selected? Where there any factors that influenced how the sample was selected (e.g. access, timescale issues)?	Physicians who were trained in the Janus prescribing support system Says 21 inv in A&E project – not clear if extra or same as those mentioned above
	Size	What is the size of the sample and groups comprising the study?	21 ED physicians
	Appropriateness	Is the sample appropriate in terms of its ability to meet the aims of the study, the depth of data that	**Yes** No Unclear 21 qualitative interviews should reach saturation

Heading	Subheading		For completion by reviewers
		is enabled to be collected, and its breadth?	
Data collection	Methods	What data collection methods were used? Was the data collection adequately described and rigorously conducted?	**Interview** Focus group Observation Mixed methods Yes No Unclear A semi-structured interview manual with 3 main questions. Interviews were carried out at the physicians workplace and tape recorded for later verbatim transcription. The identity of the informants was removed during transcription to guarantee confidentiality. All physicians agreed to participate and weer interviewed individually for approximately 30 minutes. They could discontinue if they wished and retrospective ethical approval was sought with no objections
	Role of researcher	What is the role of the researcher within the setting? Are there any potential conflicts of interest?	Data collection, analysis and dissemination but not stated
	Data analysis	How is the data analysed? How adequate is the description of the data analysis? Is adequate evidence provided to support the analysis (e.g. use of original data, iterative analysis, efforts to establish validity and reliability)? Is the study set in context in terms of findings and relevant theory?	Clear steps and description but no mention of who was inv ? multiple people to check / validate – not clear An inductive thematic analysis was performed. Analysed in 5 steps by 3 independent individuals with different backgrounds. 1. Transcripts were read to acquire a good grasp of the whole and quotations relevant to the research questions were marked 2. The marked text was sorted into different themes. When opinions differed between group members, they returned to the texts and discussed

Heading	Subheading		For completion by reviewers
			them until an agreement was reached (negotiated consensus) 3. The group identified 15 themes initially: These were then classified as 'possibilities' or 'obstacle' 4. Themes were combined into 4 descriptive categories for both possibilities and obstacles: thus, certain themes were considered to have a common origin and/or to be related 5. Description categories were named from an overall perspective
	Researcher's potential bias	Are the researchers' own position, assumptions, and possible biases outlined? Indicate how they could affect the study in terms of analysis and interpretation of the data	No potential researchers bias outlined but researchers not directly involved with implementation
	Reflexivity	Are the findings substantiated by the data and has consideration been given to any limitations of the methods or data that may have affected the results?	Yes No **Unclear** Not much limitations considered re methods
Outcomes	Outcomes	What outcome measures were adopted? What was the impact of the study for HC professionals, organisation responsible for service?	Categories / themes from analysis … relating to possibilities and obstacles … To provide a rich picture of the opinions of physicians from the ED of a computerised prescription support system. Important impact as findings in line with other research
Findings	Themes		Theme 1: Possibilities: patient drug history, pharmacological knowledge, information access, and time saving.

Heading	Subheading		For completion by reviewers
			Theme 2: Obstacles: technical problems, shortage of computers, diminishing patient contact, routines and habit
	Conclusions		Basic need to gain access to DH, alerts valuable …tech prerequisites that form basis of success imp… no matter how useful the system…time must be given to users to adapt Physicians need to gain access to the drug history of patients. Alerts for interactions/pregnancy/breast-feeding and producer-independent drug information are seen as valuable functions to reduce the workload of physicians workload. However, it is technical pre requisitions that form the base for successful implementation, n matter how useful the system is perceived to be. Time must be given to users to adapt to new ways of working
	Opinions	What this person argues	There are no shortcuts in the implementation of a computerised prescription support system
Policy & practice	Generalisability	To what extent are the study findings generalisable? What is the country of study? How applicable are the study findings to the system in the UK/Ireland? Are the conclusions justified?	Authors themselves indicate limited generalisability due to one location Setting in an ED department – however all types of patients seen in this environment therefore generalisable. Good number of participants included. Study in Sweden. Different system but general comments and results in line with other studies. Conclusions are justified in line with research conducted
	Implications for policy		Yes – clear messages for policymakers – tech imp and

Heading	Subheading		For completion by reviewers
			time / resource needed for adaptation … Possible
	Implications for practice		Useability v tech / time to imp Possible
Other comments	Format		Very well formatted and constructed
	Links to other references to be followed up		None
Decision	Name of second reviewer		SC
	Agreement with reviewer		Yes
	Inclusion		YES
	Date		17 Dec 2013 DHM and SC

Appendix 3.5: Blank quality assessment form

Citation
1) Was there a clear statement of the aim of the research? Yes / No / Partial
2) Was a qualitative methodology appropriate? Yes / No / Partial
3) Was the research design appropriate to address the aim of the research? Yes / No / Partial
4) Was the recruitment strategy appropriate to the aim of the research? Yes / No / Partial
5) Were data generated in a way that addressed the research issue? Yes / No / Partial
6) Was the relationship between researcher and participants adequately considered? Yes / No / Partial
7) Were ethical issues taken into consideration? Yes / No / Partial
8) Was the data analysis sufficiently rigorous? Yes / No / Partial
9) Was there a clear statement of findings? Yes / No / Partial
10) How valuable is the research?
Summary
Inclusion/Exclusion in SR

Appendix 3.6: Quality assessment form with included paper (310)

Citation: Rahmner BP, Andersén-Karlsson E, Arnhjort T, Eliasson M, Gustafsson L, obsson L, Ovesjo M, Rosenqvist U, Sjoviker S, Tomson G, Holmstrom I. Physicians' ceptions of possibilities and obstacles prior to implementing a computerised drug scribing support system. *International Journal of Health Care Quality and Assurance orporating Leadership in Health Services*. 2004;17:173–9.

1) Was there a clear statement of the aim of the research?

Yes / No / Partial

The aim of the research was clearly stated inclusive if it's relevance and importance in the background information. The aim of the study is set in the context of existing knowledge and understanding. New areas for investigation are not outlined.

2) Was a qualitative methodology appropriate?

Yes / No / Partial

A qualitative method is appropriate in order to identify and interpret physicians' perceptions of possibilities and obstacles prior to implementing a computerised prescription system with decision support.

3) Was the research design appropriate to address the aim of the research?

Yes / No / Partial

The researchers have justified the research design and discussed how they decided which method to use in order to identify physicians perceptions and obstacles. However, no limitations of research design outlined. The implications for the study evidence is evident as well as the use of quality criteria inclusive of credibility, dependability, confirmability and transferability as explained in the discussion of the method section.

4) Was the recruitment strategy appropriate to the aims of the research?

Yes / No / Partial

The researchers have explained how the ED participants were selected which was after training in the prescribing support system. They have not explicitly explained why physicians were the most appropriate participants to provide access to the type of knowledge sought by the study - presumably because they prescribe. They have discussed recruitment and that all physicians in the ED agreed to participate. A comprehensive description of the study location characteristics is provided but no detail is provided of exactly how and why this hospital and ED were chosen. The rationale for the selection of target sample and settings are not provided such as the basis for inclusions and exclusions. Sample size is discussed.

5) Were data generated in a way that addressed the research issue?

Yes / No / Partial

The setting for data collection was justified and it is clear how data were collected using individual interviews. The researchers have justified the methods chosen and have made the methods explicit using a semi-structured interview manual and that interviews took place in the physicians' workplace. It is unknown if the methods were modified during the study and the researchers have not discussed saturation of data. The form of data is clear which was tape recorded and they have discussed who conducted data collection and demonstrated, through portrayal and use of data, that depth, detail and richness were achieved in collection.

6) Was the relationship between researcher and participants adequately considered?

Yes / No / Partial

The researchers appear to have critically examined their own role, potential bias and influence during formulation of the 3 main research questions (not leading) and data collection, including sample recruitment and choice of location which was clearly detailed. However, no reasons provided why only physicians were interviewed. There is no evidence of how the researchers responded to events during the study and whether they considered the implications of any changes in the research design.

7) Were ethical issues taken into consideration?

Yes / No / Partial

There are sufficient details provided of how the research was explained to participants for the reader to assess whether ethical standards were maintained. The researchers have partially discussed issues raised by the study around informed consent and confidentiality but not on how they have handled the effects of the study on the participants during and after the study or of data management and protection. Ethical approval was applied for retrospectively which 'raised no objections' to the study - not documented why a retrospective application was sought.

8) Was the data analysis sufficiently rigorous?

Yes / No / Partial

There is an in-depth description of the analysis process provided using an inductive thematic analysis and it is very clear how the categories and themes were derived from the data. The researchers have explained how the data presented were selected from the original sample to demonstrate the analysis process using verbatim quotes. There is sufficient data presented to support the findings. Whilst contradictory data are not taken into account, the researchers have critically examined their own role, potential bias and influence during analysis and selection of data for presentation using 3 independent individuals with different backgrounds and increasing the study's reliability.

9) Was there a clear statement of findings?

Yes / No / Partial

The findings are explicit and there is adequate discussion of the evidence for the researcher's findings but not against. The researchers have discussed the credibility of their findings using triangulation but not in relation to respondent validation. The findings are discussed in relation to the original research aim and the background literature review summarises knowledge to date and key issues raised by previous research. There is a description of an appraisal criteria used in the quality in the discussion of the method section. A clearly constructed thematic account is provided with key messages highlighted and summarised. There is no discussion of the limitations of study in meeting aims.

10) How valuable is the research?

The researchers discuss the contribution the study makes to existing knowledge and understanding as well as the value of the findings in relation to current practice and relevant research-based literature. They have not identified new areas where research is necessary. The researchers have discussed how the findings can be transferred to other populations by stating that they do not argue that the results can be generalised to a larger group other than ED. The strengths of the data sources and methods are discussed but not the weaknesses or limitations of evidence and what remains unknown and unclear.

Summary

Excellent detail on methods and data collection and analysis. Implications for policy practice and theory are unknown as setting in an ED and not a general medical or surgical ward but a good mix of patients enter ED. No documentation of bias and no mention of limitations. Themes in line with other research. Overall, a very useful qualitative study well described and executed with a clear description of approach to analysis.

Inclusion/Exclusion

Inclusion

Appendix 3.7: Data extraction form summary of papers excluded

Source	Reason for exclusion	Rating
A network collaboration implementing technology to improve medication dispensing and administration in critical access hospitals (313)	Not much detail or depth into methods or analysis. Conclusions based on literature rather than primary qualitative research results/analysis. Some insightful aspects to successful implication for policy and practice but robustness appears to be an issue therefore drawing conclusions difficult. Seems to draw many conclusions that are possibly not directly relating to the results. Difficult to determine how these conclusions were drawn. Also refers to some aspects such as improved safety which are difficult to quantity since insufficient data is provided. The key message appears to be to employ HIT to improve patient care quality and safety but much of the conclusion refers to references rather than the primary qualitative research conducted	4
Learning lessons from electronic prescribing implementations in secondary care (313)	No great depth in methods e.g. how many interviewers, how many interviewees declined, how data collected and analysed, confidentiality, results generic ie no account on who said what or comparisons/contracts of themes from different disciplines. Future work required. Possible implications for policy, practice and theory	3-4
E-Prescribing Collaboration in Massachusetts: Early Experiences from Regional Prescribing Projects (314)	Not really a primary research paper – first part on primary care is largely descriptive not inclusion of aim/ objective/methods. Second part is the same but some useful background information relating to barriers but since again not done with robust research methods this would be of use simply for information not inc in SR. Vague descriptions of pilot sites, no clarification if views were from the	3-4

Source	Reason for exclusion	Rating
	authors, clinicians or 'office staff'. No mention of selection number, interviews or focus groups in 3 sites.	

Appendix 4.1: Research project proforma

SCHOOL OF PHARMACY
RESEARCH PROJECT PROFORMA FOR ETHICAL APPROVAL

Title
Exploring the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

Academic Staff
Diana Hogan-Murphy, Dr Scott Cunningham (principal supervisor), Antonella Tonna, Derek Stewart, Alison Strath

External Collaborator(s)
Anita Weidmann

Research question, aim and objectives

Research question
What are the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland?

Research aim
To explore the various facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

Objectives

Phase 1 Objective - Systematic Review
Identify and critically review the literature to explore healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing electronic prescribing, electronic dispensing, and/or electronic administration of medicines in the hospital setting.

Synthesise available evidence to identify, describe, and understand healthcare professionals' perceptions, attitudes, and views of the facilitators and barriers to implementing electronic prescribing, electronic dispensing and/or electronic administration of medicines in the hospital setting.

Phase 2 Objective – National and Local Exploration
To explore the perceptions of eHealth national leads, national key stakeholders and local key stakeholders towards the facilitators and barriers to system implementation in hospitals in Ireland.

To explore the experiences and vision of eHealth national leads, national key stakeholders, and local key stakeholders towards system implementation in hospitals in Ireland.

It is anticipated that end-users, implementers, and evaluators will use these recommendations when planning, implementing and maintaining these systems post communication of results to relevant stakeholders in the Department of Health, the Health Service Executive and all hospital trusts. As this area is dynamic in nature, implementation recommendations need to take the evolving nature of systems into account.

Background

There are increasing opportunities in the hospital setting to improve medicines management due to advances in eHealth such as the use of electronic prescribing and automated dispensing systems in order to reduce medication errors. Whilst numerous studies advocate the use of eHealth in improved efficiency and effectiveness of information management and decision-making within the health service, their rate of adoption in practice to date has been slow.

Prompted by the lack of qualitative research into healthcare professionals' perceptions of the various facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals, the aim of this research is to explore the various facilitators and barriers towards system implementation in hospitals in Ireland. Mixed methods are utilised to gain original insight into the views of healthcare professionals, eHealth national leads, national key stakeholders, and local key stakeholders on system implementation.

A systematic review of the literature was conducted using the Cochrane Handbook for Systematic Reviews of Interventions and the PRISMA statement as a guide in order to enhance trustworthiness and robustness. Key facilitators to system implementation identified from the review included increased patient safety and better access to patients' drug history whilst key barriers involved technical problems such as perceptions of a slow system and poor functionality as well as weakened interpersonal communication between healthcare professionals and with patients.

The next phase of this research will involve conducting individual face-to-face interviews with eHealth national leads, national key stakeholders and local key stakeholders in order to explore their views and experiences for system implementation. Results from the systematic review and qualitative methods will be amalgamated and recommendations developed for successful system implementation. It is hoped that findings will be used to improve the current system in hospitals in Ireland and maximise the implementation and potential use of these systems in the future.

Ethics

Prior to commencing data collection, ethical approval will be sought by the Ethical Review Panel of the School of Pharmacy & Life Sciences at Robert Gordon University, the Regional Health Research Advisory Committee in the North East in Ireland,, and any other committee deemed necessary. Throughout this study, the research ethics and governance policies at Robert Gordon University and the participating

organisations and hospitals will be adhered to by prioritising the dignity, rights, safety and well being of the participants at all times and by using and protecting the research data appropriately (41-42). The Irish Data Protection (Amendment) Act 2003 will also be adhered to. This primarily states that data may only be used for the specific purposes for which it is collected, that data must not be disclosed to other parties without the consent of the individual to whom it concerns, that individuals have a right of access to the information held about them, and that adequate security measures are in place for holding personal information. Furthermore, in accordance with this Act, data will not be retained for longer than necessary in order to fulfil the purpose for which the data was originally collected.

Setting

Interviews will be conducted in hospitals, offices, or in a convenient location for the participants.

Sampling

Both purposive sampling and snowball sampling will be employed in order to identify a range of relevant heterogeneous eHealth national leads, national key stakeholders and local key stakeholders for participation. This method yields a sample through referrals made among individuals who share characteristics that are of interest to the investigator. As part of the development process, the primary researcher will initially invite for interview eHealth national leads followed by national key stakeholder and finally local key stakeholders.

For the purpose of this research, eHealth national leads are defined as individuals from the Department of Health and the Health Executive Service who are primarily involved in national hospital eHealth strategies, policies, guidelines and projects. National key stakeholders are individuals who are involved in/have a special interest in the implementation of eHealth strategies both nationally and regionally. Local key stakeholders are individuals who are involved in/have a special interest in the implementation of eHealth strategies locally. XX General Hospital and two other comparable general hospitals with a similar case-mix will be the focus for interviews with local key stakeholders.

The primary researcher and supervisory team do not feel that bias has been introduced by the type of participants invited for participation as the objectives of this qualitative research are to explore both the facilitators and barriers and experiences of eHealth national leads, national key stakeholders and local key stakeholders towards implementation of electronic prescribing, dispensing, and administration of medicines in Ireland. Whilst participants are involved in/have a special interest in system implementation and are most likely interested in progressing and advancing these systems, it is anticipated that they will express many positive and negative views and experiences of adoption.

With a sample frame of approximately 50, it is expected that this purposive and snowball technique will capture a broad variety of attributes, behaviours and experiences from different participants and assist the primary researcher and supervisory team in identifying common and diverse themes evident across the sample. In addition, the adoption of research methods and theories well established as well as the development of an early familiarity with the culture of participants

prior to data collection will promote confidence. This will be achieved via consultation of appropriate documents.

Method of data collection

An individual face-to-face semi-structured interview will be conducted with national eHealth leads, national key stakeholders and local key stakeholders until data saturation has been reached. It is anticipated that up to ten national eHealth leads, 20 national key stakeholders and 20 local key stakeholders will be included. Interviewing both national eHealth leads and national key stakeholders on the various facilitators and barriers to system implementation will provide rich original data owing to their knowledge, experience and vision for future adoption. From a local perspective, the supervisory team believed that local key stakeholders would be of equal benefit in understanding their views of system implementation from an individual and organisational viewpoint. Site triangulation will be achieved by the participation of a range of professionals within several comparable hospitals so as to reduce the effect of local factors particular to one institution. Findings can then be understood within the context of the particular characteristics of the organisation.

Conducting face-to-face individual interviews was believed to be more superior in this setting than employing other methods such as individual phone interviews or focus groups as it facilitates more detailed data sharing and data retrieval by participants. However, it is acknowledged that this method is both labour intensive and costly.

Piloting & trustworthiness of research

As part of the piloting and trustworthy exercise, an interview schedule will be developed by the primary researcher and agreed with the supervisory team in order to facilitate the individual face-to-face interviews. This will be informed by a literature search. In order to establish if the semi-structured questions in the interview schedule appear to be trustworthy to the research objective, and to verify if these questions reflect relevant data from the systematic review and literature review, it will be tested for face and content trustworthiness by all members of the supervisory team. Through an inductive approach amendments will be made as necessary.

A local consultant doctor, senior pharmacist and senior management team member will be requested to pilot and comment on the format and content of the open-ended and closed-ended questions. Data from the pilot will not be included in the final dataset. Amendments will be made as necessary in consultation with the supervisory team.

Data generation

Participants will initially be invited to participate in the research via a letter of information which will provide an overview of the study. If they accept to be interviewed, they will then be requested to sign two consent forms, a copy for the participant and a copy for the primary researcher, confirming that they have agreed to participate in the study, that the interview will be audio-recorded and that use of anonymous quotations may be used in this research and/or further publications. A follow-up telephone conversation will ensue and once a convenient time and location is arranged for each of the individual face-to-face semi-structured interviews to take place, all participants will be sent a confirmation email of the time and place of the scheduled interview and a reminder to bring the signed consent forms. To assist in

ensuring the honesty and integrity of participants, the independent status of the interviewer will be emphasised in order to encourage frankness. Reassurance that all information provided by the participants will be strictly confidential and that withdrawal from the study at any time is permissible will be documented in the information letter and reiterated verbally during the interview schedule. Participants will also be informed that this research has been approved by the ethical review panel of the School of Pharmacy & Life Sciences at Robert Gordon University, the Regional Health Research Advisory Committee in the North East and any other committee as necessary. If the signed consent forms have not been delivered, the participants will be requested to sign them again.

Individual interviews will then be carried out with each participant over approximately 45 minutes by the primary researcher. An interview schedule will be used to facilitate each of the interviews in order to maintain consistency between participants and to retrieve reliable data. Questions will be both open-ended and closed-ended based on results from the systematic review, literature review and relevant questions relating to their views and experiences for system implementation inclusive of facilitators and barriers to successful implementation. Where contradictions emerge through iterative questioning, the primary researcher will discard that data. Frequent debriefing and collaborative sessions between the primary researcher and the supervisory team in order to develop ideas and interpretations and receive constructive criticism will take place.

Discussions will be audio-recorded, transcribed verbatim within 48 hours of each interview, read several times and analysed by the primary researcher using the Normalisation Process Theory. Data will be coded to the 4 constructs and overall degree of normalisation in order to develop a coding framework. This framework will then be tested and if necessary refined by the research team and reapplied to the previously coded interviews and all subsequent interviews by the research team. NVivo 10 will be used to facilitate data management. This software provides a range of analysis frameworks for importing, classifying and arranging data.

To enhance the trustworthiness and reduce any bias of the findings, 10% of the transcripts will be independently reviewed by the principal supervisor who has experience in qualitative analysis.

Data storage and analysis

All data collected and analysed will be stored on a personal password protected computer with encryption, firewall protection and anti-virus software only accessible by the primary researcher. Consent forms will be scanned, saved and destroyed in accordance with the Irish Data Protection (Amendment) Act 2003.

Digital recordings of interviews will be on SD media card; media files will be transferred immediately after interviews for storage & transcription and media cards will be wiped clean. The recordings of all interviews will be destroyed after transcription has been checked. Transcriptions will be stored in a locked cupboard and destroyed 5 years after publication. All computer files will be password protected. Names will not be recorded as part of the interviews – each participant will be allocated a code and described by that code throughout. Participants can also ask that the recorder is switched off at any time and can also withdraw from the study at

any time, without giving any reason.

Outcome measures

Outcome measures will include analysis of the various views, experiences and vision of interviewees inclusive of the facilitators and barriers to system implementation in hospitals in Ireland. Results from the systematic review and qualitative methods will be amalgamated and recommendations developed for successful system implementation.

Dissemination of results

Results will be communicated via post and an email to all participants and thereafter presented at both national and international conferences and published in appropriate high impact factor journals.

Theoretical underpinning

The research objective terms inclusive of *explore, views, experiences, barriers, facilitators,* reject the positivist paradigm which is typically quantitative in nature and reflects the interpretivist/constructivist paradigm which is typically qualitative in nature. This allows reality to be socially constructed where the researcher tends to rely upon the participants' views of the phenomenon of interest. Although interpretive, which can be considered subjective, the primary researcher will make every effort to represent the participant's voice. Triangulation, independent reviewing of a proportion of the transcripts and the extent to which the primary researcher admits her own predispositions will be emphasised in order to reduce the effect of bias. This will help to ensure that research findings are the result of the experiences and ideas of the participants rather than the characteristics and preferences of the primary researcher.

Frameworks for ensuring the trustworthiness and rigour of this qualitative research will be addressed in the form of Guba's four constructs: credibility, transferability, dependability and cofirmability.

Triangulation involving the use of mixed methods inclusive of findings from the systematic review, individual semi-structured interviews and supporting data will be integrated to enhance credibility. This will assist in understanding the views, attitudes and behaviours of both system end-users and professionals responsible for the management and delivery of these systems and to enhance the contextual data relating to the individual organisations.

Peer and academic scrutiny of the research project will continue to be welcomed in order to refine the methods employed, develop a greater explanation of the research design and strengthen arguments as necessary. A reflective commentary inclusive of progressive subjectivity and monitoring of the primary researchers developments via research experience and expanding research skills will assist in ensuring trustworthiness and credibility. Examination of previous research findings will allow comparisons and contrasts be made to current findings with reasons provided.

A description of contextual factors such as participants working environment is important to assist in transferability. Information such as the number of participants involved and where they are based, any restrictions in the type of participants who will participate, the number and length of the data collection sessions and the time

period over which the data will be collected will be provided in order to convey the boundaries of the study.

Dependability will be offered through the use of mixed methods and detailing the processes within the study. Included will be the research design and its implementation, details of data gathering and reflective appraisal of the research. This in-depth methodological description will allow the study to be repeated.

The audit trail inclusive of how recommendations were gathered and processed as well as how the theoretical concepts inherent in the research objectives were applied throughout the research will be represented schematically.

The personal experience and training of the primary researcher has continued to broaden during this research to consider a more naturalistic human approach to system implementation and to understand the complexities involved through the Normalisation Process Theory (NPT). This sociological theory has been widely promoted to understand implementation and integration of innovation in healthcare settings. It focuses on work that individuals and organisations must execute for a new technology or practice to become embedded and sustained in routine practice and is used as a conceptual framework to explore the gap between health research evidence, policy and practice.

The four concepts of the theory include:
Coherence: the process and work of sense-making and understanding that individuals and organisations have to experience in order to promote or inhibit the routine embedding of a practice.
Cognitive Participation: the process and work that individuals and organisations have to experience in order to enrol individuals to engage with the new practice.
Collective Action: the work that individuals and organisations have to execute to enact the new practice.
Reflexive Monitoring: the work inherent in the informal and formal appraisal of a new practice when implemented in order to assess its advantages and disadvantages and develop users' comprehension of the effects of a practice.

Given its sociological origins, this theory does not focus on the relationship between individual attitudes, intentions and behavioural outcomes but pays attention to how knowledge is held, transferred and created within and across professional groups. It also seeks to understand the work that clinicians, implementers and patients alike have to engage in to implement new knowledge in practice.

The provisions described above and throughout this ethical performa report using appropriate paradigms and theories will be embedded within this qualitative research in order to enhance its trustworthiness.

Novelty of research

All phases of this research are novel inclusive of the systematic review and qualitative methods. It is evident from the work completed to date that this area is under-researched and that findings will contribute to original knowledge. It is intended that this exploration will provide a unique insight into the various facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland and make a significant contribution

to the research subject.
Impact of research It is anticipated that findings will be used to improve the current system and maximise the potential use of electronic prescribing, dispensing, and administration of medicines in the hospital setting in Ireland in the future. It is planned that end-users, implementers and evaluators will use the recommendations provided when planning, implementing and maintaining these systems.

Appendix 4.2: RESSA form

The aim of the University's *Research Ethics Policy* is to establish and promote good ethical practice in the conduct of academic research. The questionnaire is intended to enable researchers to undertake an initial self-assessment of ethical issues in their research. Ethical conduct is not primarily a matter of following fixed rules; it depends on researchers developing a considered, flexible and thoughtful practice.

The questionnaire aims to engage researchers discursively with the ethical dimensions of their work and potential ethical issues, and the main focus of any subsequent review is not to 'approve' or 'disapprove' of a project but to make sure that this process has taken place.

The *Research Ethics Policy* is available at:
www.rgu.ac.uk/credo/staff/page.cfm?pge=10193

Research Student Name	Diana Hogan-Murphy
Study Coordinator	Scott Cunningham
Research Project Title	Exploring the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland
Research Institute/ School/Centre	Robert Gordon University – IHW

Parts 1-5: To be completed by the Research Student

Part 6: To be completed by the Principal Supervisor

	PART 1: DESCRIPTIVE QUESTIONS		
	Does the research involve, or does information in the research relate to: *[see Guidance Note 1]*		
	(a) individual human subjects		
	(b) groups (e.g. families, communities, crowds)		

	(c) organisations		
	(d) animals?		
	Please provide further details:		
	• Individual face-to-face semi-structured interviews will be conducted with eHealth national leads and both national and local key stakeholders in order to explore their perceptions and experiences towards the implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland		
	Will the research deal with information which is private or confidential? *[see Guidance Note 2]*		
	Please provide further details:		
	eHealth national leads and key stakeholders will initially be invited to participate in the research via a letter of invitation which will provide an overview of the study. Included in this letter will be a participant information sheet, two consent and copyright clearance forms and a reply slip stating a convenient time and location for the interview to take place. If the invitee accepts the invitation to be interviewed, they will be requested to sign two consent forms, a copy for themselves and a copy for the primary researcher, confirming that they have agreed to participate in the study, that the interview will be audio-recorded and that use of anonymous quotations may be used in this research and/or further publications. All data collected will be anonymised, stored on a password protected PC with anti-virus software and firewall protection, encrypted and and only accessible by the research team within a secure university network. The names of all the interviewees will be coded with numbers in order to protect their identity. The codes will only be known to the primary researcher and interviewees will only be referred to by number during the audio digital recordings and transcripts.		

	PART 2: THE IMPACT OF THE RESEARCH		
	In the process of doing the research, is there any potential for harm to be done to, or costs to be imposed on: *[see Guidance Note 3(i)]*		
	(a) research participants?		
	(b) research subjects? *[see Guidance Note 3(ii)]*		
	(c) you, as the researcher?		
	(d) third parties? *[see Guidance Note 3(iii)]*		

	Please state what you believe are the implications of the research:		
	When the research is complete, could negative consequences follow:		
	(a) for research subjects		
	(b) or elsewhere? *[see Guidance Note 4]*		
	Please state what you believe are the consequences of the research:		

	PART 3: ETHICAL PROCEDURES		
	Does the research require informed consent or approval from: *[see Guidance Note 5(i)]*		
	(a) research participants?		
	(b) research subjects? *[see Guidance Note 5(ii)]*		
	(c) external bodies? *[see Guidance Note 5(iii)]*		
	If you answered yes to any of the above, please explain your answer:		
	This project will be approved by the ethical review panel at Robert Gordon University and the Dublin North East ethical advisory board. Once approved, a written informed consent and copyright form will be posted to each participant which will need to be completed, signed and returned to the primary researcher prior to the face-to-face interviews being conducted. Receipt of the completed consent and copyright form will signify informed consent.		
	Are there reasons why research subjects may need safeguards or protection? *[see Guidance Note 6]*		
	If you answered yes to any of the above, please state the reasons and indicate the measures to be taken to address them:		

	Are specified procedures or safeguards required for recording, management, or storage of data? *[see Guidance Note 7]*		
	If you answered yes to any of the above, please give details:		
	All data collected will be anonymised, stored on a password protected work PC with anti-virus software and firewall protection, encrypted and only accessible by the research team via a secure university network. The names of all the interviewees will be coded with numbers in order to protect their identity. The codes will only be known to the primary researcher interviewees and will only be referred to by number during the audio digital recordings and transcripts.		

PART 4: THE RESEARCH RELATIONSHIP			
	Does the research require you to give or make undertakings to research participants or subjects about the use of data? *[see Guidance Note 8]*		
	If you answered yes to the above, please outline the likely undertakings:		
	Reassurance that all information provided by the participants will be strictly confidential and that withdraw from the study at any time will be stated.		
	Is the research likely to be affected by the relationship with a sponsor, funder or employer? *[see Guidance Note 9]*		
	If you answered yes to the above, please identify how the research may be affected:		

PART 5: OTHER ISSUES			
	Are there any other ethical issues not covered by this form which you believe you should raise?		

STATEMENT BY STUDENT			
I believe that the information I have given in this form is correct, and that I have addressed the ethical issues as fully as possible at this stage.			
Signature:	Diana Hogan-Murphy		28/10/2014

If any ethical issues arise during the course of the research, students should complete a further RESSA form.

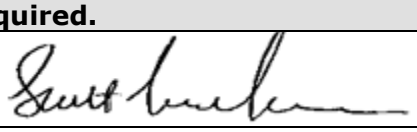
The *Research Ethics Policy* is available at www.rgu.ac.uk/credo/staff/page.cfm?pge=10193.

PART 6: TO BE COMPLETED BY THE PRINCIPAL SUPERVISOR			
	Does the research have potentially negative implications for the University? *[see Guidance Note 10]*		
	If you answered yes to the above, please explain your answer:		
	Are any potential conflicts of interest likely to arise in the course of the research? *[see Guidance Note 11]*		
	If you answered yes to the above, please identify the potential conflicts:		
	Are you satisfied that the student has engaged adequately with the ethical implications of the work? *[see Guidance Note 12]*		

If you answered no to the above, please identify the potential issues:	

	Appraisal: Please select one of the following	
	i. The research project should proceed in its present form – no further action is required	
	ii. The research project requires ethical review by the University's Research Ethics Sub-Committee	
	iii. The project needs to be returned to the student for modification prior to further action	
	iv. The research project requires ethical review by an external body (N.B. Question 5 above). If this applies, please give these details:	

Title of External Body providing ethical review	
Address of External Body	
Anticipated date when external Body may consider project	

AFFIRMATION BY PRINCIPAL SUPERVISOR			
I have read the student's responses and have discussed ethical issues arising with the student. I can confirm that, to the best of my understanding, the information presented by the student is correct and appropriate to allow an informed judgement on whether further ethical approval is required.			
Signature:		**Date:**	23/11/2014

Appendix 4.3: Letter of invitation

THE
ROBERT GORDON
UNIVERSITY
ABERDEEN

Date

Key stakeholders' perceptions towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting.

Dear
As part of research for a PhD through The Robert Gordon University in Scotland, I am a senior pharmacist in Cavan General Hospital currently undertaking a study on the above title. The objectives of this qualitative research are to explore your perceptions and experiences on the various facilitators and barriers towards system implementation. Your participation will help inform successful system implementation in order to reduce medication errors and cost and optimise patient care and efficiency. Taking part will involve an individual face-to-face semi-structured interview not lasting more than 45 minutes at a location convenient to you. Enclosed are further details of the study and information regarding your participation in the interview. If you are interested in participating in this study, please return the enclosed consent and copyright clearance form as well as the reply slip regarding a suitable time and place to conduct the interview in the enclosed envelope.

If you have any questions, please do not hesitate to contact me on 0868114674 or email dianahoganmurphy@gmail.com. Alternatively, you can contact my primary supervisory Dr Scott Cunningham on +44122462533 or email s.cunningham@rgu.ac.uk.

Yours sincerely,

_____

Diana Hogan-Murphy, PhD Student, School of Pharmacy & Life Sciences, The Robert Gordon University
Research team: *Diana Hogan-Murphy, Dr Scott Cunningham*, *Dr Antonella Tonna, Prof Derek Stewart, Prof Alison Strath*

Appendix 4.4: Participant information sheet

Before you decide to take part in this study, I kindly request you to carefully read the information provided below relating to this project. This will assist you in understanding why the research is being conducted and what it will involve. Please feel free to discuss this with others or ask me about any matters you may find unclear. Thank you for your time in reading this.

1. What is the purpose of the study?
The aim of this research is to explore your perceptions and experiences on the various facilitators and barriers towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting. The study and your participation will help inform successful implementation in order to reduce medication errors and cost and optimise patient care and efficiency.

2. Why have I been chosen?
You have been selected because you are a key stakeholder in the area of electronic prescribing, dispensing and/or administration of medicines and could provide very useful information on the subject matter.

3. Do I have to take part?
Participation in the interview is voluntary. Your decision to participate will not affect your relationship with the University or the research team. If you decide to take part, you will be requested to sign a consent and copyright clearance form. You are still free to withdraw from the study at any time and without giving a reason.

4. What should I do if I take part?
If you are willing to take part, please complete and return the consent and copyright clearance form as well as the reply slip specifying a suitable date, time and venue convenient to you in the envelope provided. You will have agreed to participate in an individual face-to-face interview that will last no longer than 45 minutes.

5. What will happen to the results of the research study?
Results of the research study will be disseminated at conferences and submitted for publication to healthcare journals. A brief report of the result of the study will be available in 2017 and you may obtain a free copy from the RGU contact list provided below.

6. What are the possible benefits of taking part?
You will have the opportunity to express your views and experiences on the facilitators and barriers to system implementation. Your views may play an important role relating to the future provision of system implementation.

7. Will my taking part in this study be confidential?
With your permission, data will be audio recorded and transcribed into an electronic document. All transcripts, data analysis and reporting of the study results will be anonymous and stored securely with password protection on a computer only accessible to me and the research team.

8. Who has reviewed the study?
This study has been reviewed and approved by the Ethical Review Panel of the School of Pharmacy & Life Sciences at Robert Gordon University and three Irish Regional Ethics Committees.

9. Who is organising and funding the research?
This research is being organised by the School of Pharmacy and Life Sciences, The Robert Gordon University, Aberdeen. The PhD student is not supported by a grant.

10. What if I have a complaint?
If you have a complaint about the way you have been approached or treated during this study, please contact me or alternatively my principal supervisor Dr Scott Cunningham.

Appendix 4.5: Interview consent and copyright clearance form for participant

Title of the project: Key stakeholders' perceptions towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting.

Name of the principal researcher: Diana Hogan-Murphy, School of Pharmacy & Life Sciences, The Robert Gordon University, Aberdeen. Email: dianahoganmurphy@gmail.com

1.	I confirm that I have read and understand the information sheet dated 15/01/2016 for the above study. I have had the opportunity to consider the information and ask questions with satisfactory answers.	☐
2.	I understand that my participation includes my involvement in an individual face-to-face interview lasting 45 minutes or less.	☐
3.	I agree that the interview will be audio recorded and transcribed into an electronic document.	☐
4.	I understand that my name will not be included anywhere in the report of the findings and grant copyright permission on the understanding that my confidentiality will be protected.	☐
5.	I understand that all material will be preserved for the life of the research project and may be used in publications, education, lectures and broadcasting. I understand that all contributions will be anonymised and that all data collected will be stored on a password protected computer with anti-virus software and firewall protection, encrypted and only accessible by the research team.	☐
6.	I understand that my participation in this study is entirely voluntary and I am free to withdraw at any time without giving a reason.	☐
7.	I agree to take part in the above study.	☐

_____ _____ _____

Name of participant Date Signature

_____ _____ _____

Researcher Date Signature

Appendix 4.6: Interview consent and copyright clearance form for researcher

Title of the project: Key stakeholders' perceptions towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting.

Name of the principal researcher: Diana Hogan-Murphy, School of Pharmacy & Life Sciences, The Robert Gordon University, Aberdeen. Email: dianahoganmurphy@gmail.com

1. I confirm that I have read and understand the information sheet dated 15/01/2016 for the above study. I have had the opportunity to consider the information and ask questions with satisfactory answers.	☐
2. I understand that my participation includes my involvement in an individual face-to-face interview lasting 45 minutes or less.	☐
3. I agree that the interview will be audio recorded and transcribed into an electronic document.	☐
4. I understand that my name will not be included anywhere in the report of the findings and grant copyright permission on the understanding that my confidentiality will be protected.	☐
5. I understand that all material will be preserved for the life of the research project and may be used in publications, education, lectures and broadcasting. I understand that all contributions will be anonymised and that all data collected will be stored on a password protected computer with anti-virus software and firewall protection, encrypted and only accessible by the research team.	☐
6. I understand that my participation in this study is entirely voluntary and I am free to withdraw at any time without giving a reason.	☐
7. I agree to take part in the above study.	☐

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Researcher	Date	Signature

Appendix 4.7: Reply slip

I will be available on the following date, time and place

Date: _____ Time: _____

Venue:_____

Telephone number:
_____(work/mobile/home)

Email address: _____

Appendix 4.8: Letter of invitation reminder

Date

Dear

This is a reminder to invite you to take part in an individual face-to-face interview. To date, I have not received a reply from you. I apologise if you have recently returned the reply slip. As outlined in the first letter, the aim of this research is to explore your views and experiences on the various facilitators and barriers towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting. The study and your participation will help inform successful system implementation in order to reduce medication errors and cost and optimise patient care and efficiency. The interview will last no longer than 45 minutes. If you are willing to take part, please complete and send the consent and copyright clearance form as well as the reply slip in the pre-paid envelope by....(date).

If you have any questions, please do not hesitate to contact me on 0868114674 or email dianahoganmurphy@gmaul.com. Alternatively please contact my principal supervisor Dr Scott Cunningham on +44122462533 or email s.cunningham@rgu.ac.uk.

Yours sincerely,

_____

Diana Hogan-Murphy, B.A., H.Dip(Comp.Sci.); M.A.(I.T.); B.Sc.(Pharm); M.Sc.(Clinical Pharm)
PhD Student
School of Pharmacy & Life Sciences
Research team: *Diana Hogan-Murphy, Dr Scott Cunningham*, *Dr Antonella Tonna, Prof Derek Stewart, Prof Alison Strath*

Appendix 4.9: Interview confirmation letter

Date

Dear

Thank you for agreeing to take part in an individual face-to-face interview on Thursday at approximately 1.30pm. As previously advised, the aim of this research is to explore your views and experiences on the various facilitators and barriers towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting. The study and your participation will help inform successful system implementation in order to reduce medication errors and cost and optimise patient care and efficiency.

If you cannot attend for any reason, please contact me on 0868114674 or via email dianahoganmurphy@gmail.com. Thank you again for agreeing to take part. I look forward to meeting you on Thursday.

Yours sincerely,

_____

Diana Hogan-Murphy, PhD student
School of Pharmacy & Life Sciences

Appendix 4.10: Response from ethical approval application in RGU

ROBERT GORDON UNIVERSITY
SCHOOL OF PHARMACY AND LIFE SCIENCES
ETHICAL APPROVAL FORM FOR UNDERGRADUATE, TAUGHT MSc, PhD AND EXTERNAL PROJECTS

SECTION 1 – to be completed

Research Student Name	Diana Hogan-Murphy
Study Coordinator	Scott Cunningham
Research Project Title	Exploring the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

SECTION 2 – to be completed by the School Research Ethics Committee Date submitted to panel: 24.11.14

Indicate Yes or No to each question and comment as appropriate.	**Panel member 1**	**Panel member 2**	**Panel member 3**	**Student Response**
Is the research question clear?	Yes	YES	Yes	No change
Is the project scientifically robust?	Yes	YES	Yes. However, the letter of information for the interviews claims that it is "planned that end-users implementers and evaluators will use these findings… but the how is not shown.	Please note addition highlighted in red on page 2 Letter of information has altered to: - Letter of Invitation - Letter of Invitation Reminder (if

Indicate Yes or No to each question and comment as appropriate.	Panel member 1	Panel member 2	Panel member 3	Student Response
				applicable) - Interview Confirmation Letter - Interview Participant Information Sheet - Interview Consent and Copyright Clearance Form - Interview Schedule
Are the procedures for obtaining informed consent clear and appropriate? If an audit does the student have approved access to information?	No, why is consent not being sought initially and reiterated if needed at each stage. From the executive summary appears consent is not obtained until interview. Confirmation of ethic approval is surely required prior to this data collection. The Letter of information does provide this information but it is not apparent from the executive summary or the RESSA form.	YES – WOULD BE USEFUL FOR CONSENT FORM TO BE INCLUDED IN THE SUBMISSION	Yes.	Please note changes in red on page 8 under data generation and: - Letter of Invitation - Letter of Invitation Reminder (if applicable) - Interview Confirmation Letter - Interview Participant Information Sheet - Interview Consent and Copyright Clearance Form - Interview Schedule
Is the extent of participant involvement clear?	No, "multiple individual face-to-face- semi-structured interviews" No information provided on number of interviews each participant will be	YES	Yes.	Please note changes in red on page 6 under method of data collection. As this is a qualitative

Indicate Yes or No to each question and comment as appropriate.	Panel member 1	Panel member 2	Panel member 3	Student Response
	involved with. Or the actual number of participants involved or required to provide POWER to the study.			study, the team felt that power is not a factor.
Are the recruitment procedures ethical and appropriate?	No, a degree of clarity required in both the RESSA form and Executive summary. Why is everything being passed by to the head of ethics?	NO – NOT CLEAR HOW MANY PEOPLE MAY BE APPROACHED AND WHO KEY STAKEHOLDERS ARE	Yes. What is the difference between the local/ national stakeholders and health professionals?	Panel member 1: please note change in red on page 4 under ethics and data generation on page 12 as well as addition of ethics to the participation information sheet and interview schedule Panel member 2 and 3: Please note change in red to sampling page 4 and method of data collection page 6
Are the inclusion and exclusion criteria relevant and appropriate?	No	NO – NO CLEAR STATEMENT OF INCLUSION/EXCLUSION CRITERIA APPARENT IN SUBMISSION. IN FULL PROPOSAL THERE ARE CRITERIA FOR SYSTEMATIC REVIEW OF LITERATURE ONLY.	Mainly implied. Does the choice of participants not introduce a bias if they have a "special interest" in the introduction or advancement of electronic prescribing etc?	Panel member 1 and 2: Please note change in red under setting and sampling on page 4 Panel member 3: The team felt that the invitees represent a population who are experts or very knowledgeable in this

Indicate Yes or No to each question and comment as appropriate.	Panel member 1	Panel member 2	Panel member 3	Student Response
				area and so would hugely contribute to this field. We felt no bias would be apparent as these participants have no doubt been faced with many obstacles and barriers as well as facilitators
Is the extent and type of participant involvement ethical? (consider issues of unnecessary invasiveness, exposure, undue stress, anxiety and concern, inappropriate time commitments)	Partially, the information provided in the letter of information makes no reference to follow up with the participants	YES	Yes	The team felt due to the limitation of a PhD re time and personnel, no follow up could be facilitated. However, please note number 6 in the participant information sheet and mention of results in the interview schedule
Are there clear procedures for ensuring compliance with the Data Protection Act?	Yes	YES	Mostly yes. Where will the password protected PC be based (is it work related or personal)?	Please note change in red to data storage and analysis page 8 – work is better as information is also stored on network in case the hardware on a personal PC is destroyed and not retrievable

Please check the boxes below with your decision	**Panel member 1**	**Panel member 2**	**Panel member 3**
1. Approved – submit to LREC / MREC as appropriate and provide copy of approval letter to supervisor OR provide supervisor with evidence that submission not necessary	☐	☐	☐
2. NOT Approved – MINOR ISSUES approval subject to submitting a response, to ethics review panel via supervisor, addressing minor issues outlined above	☒	☒	☒
3. NOT approved – MAJOR ISSUES serious issues of concern to be addressed and whole proposal to be resubmitted via supervisor for further ethical review.	☐	☐	☐
4. NOT approved – UNETHICAL the study is unethical and a re-submission will not be considered.	☐	☐	☐
Comments: Please pay careful attention to the comments, particularly with reference to participant information before resubmission.			

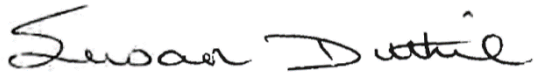
SECTION 3 - OVERALL ETHICAL DECISION to be completed by Chair of School Research Ethics Committee

1. Approved – submit to LREC / MREC as appropriate and provide copy of approval letter to supervisor OR

   provide supervisor with evidence that submission to LREC / MREC not necessary ☐

2. NOT Approved – MINOR ISSUES: subject to submitting a response, to ethics review panel via supervisor, addressing minor issues outlined above ☒

3. NOT approved – MAJOR ISSUES: there are serious issues of concern to be addressed and whole proposal to be resubmitted via supervisor for further ethics panel review. ☐

4. NOT approved – UNETHICAL: the study is completely unethical and a re-submission will not be considered. ☐ **Signed (on behalf of the School Research Ethics Committee)** **Dr**  **Date: 16.12.14**

Appendix 4.11: Ethical approval RGU

School of Pharmacy and Life Sciences Research Ethics Committee

Date 26th January 2015

Research Project Title	Exploring the facilitators and barriers towards implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland

Dear Diane,

The School Research Ethics Committee has reassessed your application and the decision is that there are no ethical issues with your project.

I can now confirm that you are able to proceed with your research and any further ethics applications.

Should there be any amendments to this project during the research we would advise you to consult with the convener of the ethics committee as to whether a further ethical review would be required.
We wish you success with your project.

Regards

Convener of the School Ethics Review Panel

Appendix 4.12: Letter to the general manager on research for information

General Manager
Address

Date

Re: Key stakeholders' perceptions towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting.

Dear

As part of research for a PhD through the Robert Gordon University in Scotland, I am a senior pharmacist in Cavan General Hospital currently undertaking a study on the above title. The objective of this qualitative research is to explore the perceptions of key stakeholders on the various facilitators and barriers towards system implementation.

I would like to inform you that I wish to invite local key stakeholders in XX General Hospital to participant in a short individual face-to-face interview for this study. Participation will help inform successful system implementation in order to reduce medication errors and cost and optimise patient care and efficiency. It is planned that end-users, implementers and evaluators will use these findings when planning, implementing and maintaining electronic systems for prescribing, dispensing, and administering medicines in hospitals in Ireland.

If you have any queries, please do not hesitate to contact me on 0868114674 or email dianahoganmurphy@gmail.com. Alternatively, you can contact my primary supervisory Dr Scott Cunningham on +44122462533 or email s.cunningham@rgu.ac.uk.

Yours sincerely,

_____

Diana Hogan-Murphy, PhD Student, School of Pharmacy & Life Sciences, Robert Gordon University, Aberdeen, UK
Research team: *Diana Hogan-Murphy, Dr Scott Cunningham*, *Dr Antonella Tonna, Prof Derek Stewart, Prof Alison Strath*

Appendix 4.13: Ethical approval Hospital A

11TH January 2016

Ms. Diana Hogan-Murphy
Senior Pharmacist – Antimicrobial
Pharmacy Department
Cavan General Hospital

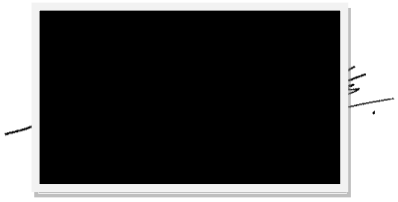
Re: Key Stakeholders perceptions, experiences and vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in the hospital setting.
==========

Dear Diana,

With reference to application listed above, your application has been considered by members of [redacted] and I am happy on behalf of [redacted] Hospital Ethics Committee to grant Chairman's approval.

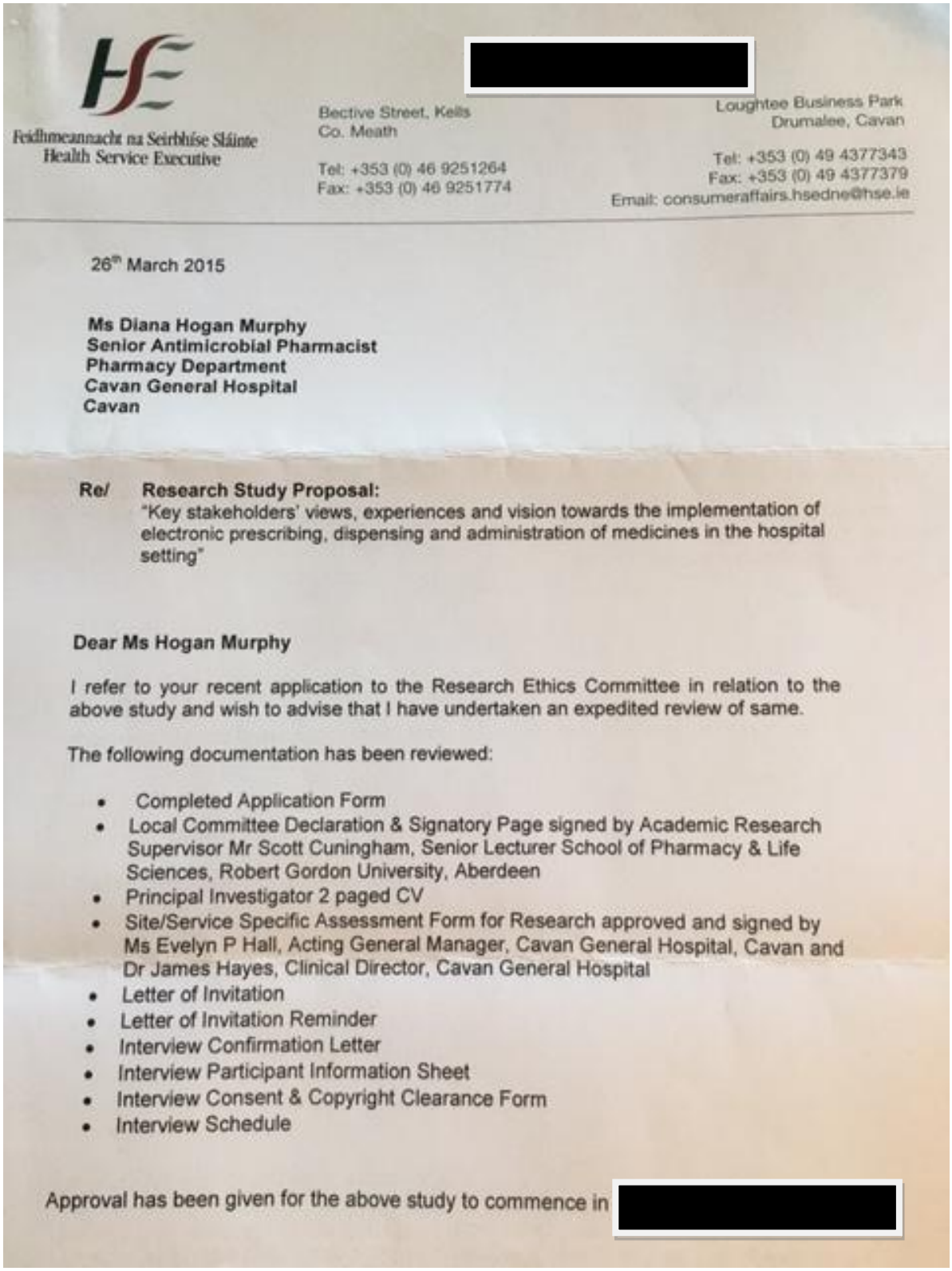
Please do not hesitate to contact me if you require any further information.

Yours sincerely



General Manager

Appendix 4.14: Ethical approval Hospital B



Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

[redacted]

Bective Street, Kells
Co. Meath

Tel: +353 (0) 46 9251264
Fax: +353 (0) 46 9251774

Loughtee Business Park
Drumalee, Cavan

Tel: +353 (0) 49 4377343
Fax: +353 (0) 49 4377379
Email: consumeraffairs.hsedne@hse.ie

26th March 2015

Ms Diana Hogan Murphy
Senior Antimicrobial Pharmacist
Pharmacy Department
Cavan General Hospital
Cavan

Re/ Research Study Proposal:
"Key stakeholders' views, experiences and vision towards the implementation of electronic prescribing, dispensing and administration of medicines in the hospital setting"

Dear Ms Hogan Murphy

I refer to your recent application to the Research Ethics Committee in relation to the above study and wish to advise that I have undertaken an expedited review of same.

The following documentation has been reviewed:

- Completed Application Form
- Local Committee Declaration & Signatory Page signed by Academic Research Supervisor Mr Scott Cuningham, Senior Lecturer School of Pharmacy & Life Sciences, Robert Gordon University, Aberdeen
- Principal Investigator 2 paged CV
- Site/Service Specific Assessment Form for Research approved and signed by Ms Evelyn P Hall, Acting General Manager, Cavan General Hospital, Cavan and Dr James Hayes, Clinical Director, Cavan General Hospital
- Letter of Invitation
- Letter of Invitation Reminder
- Interview Confirmation Letter
- Interview Participant Information Sheet
- Interview Consent & Copyright Clearance Form
- Interview Schedule

Approval has been given for the above study to commence in [redacted]

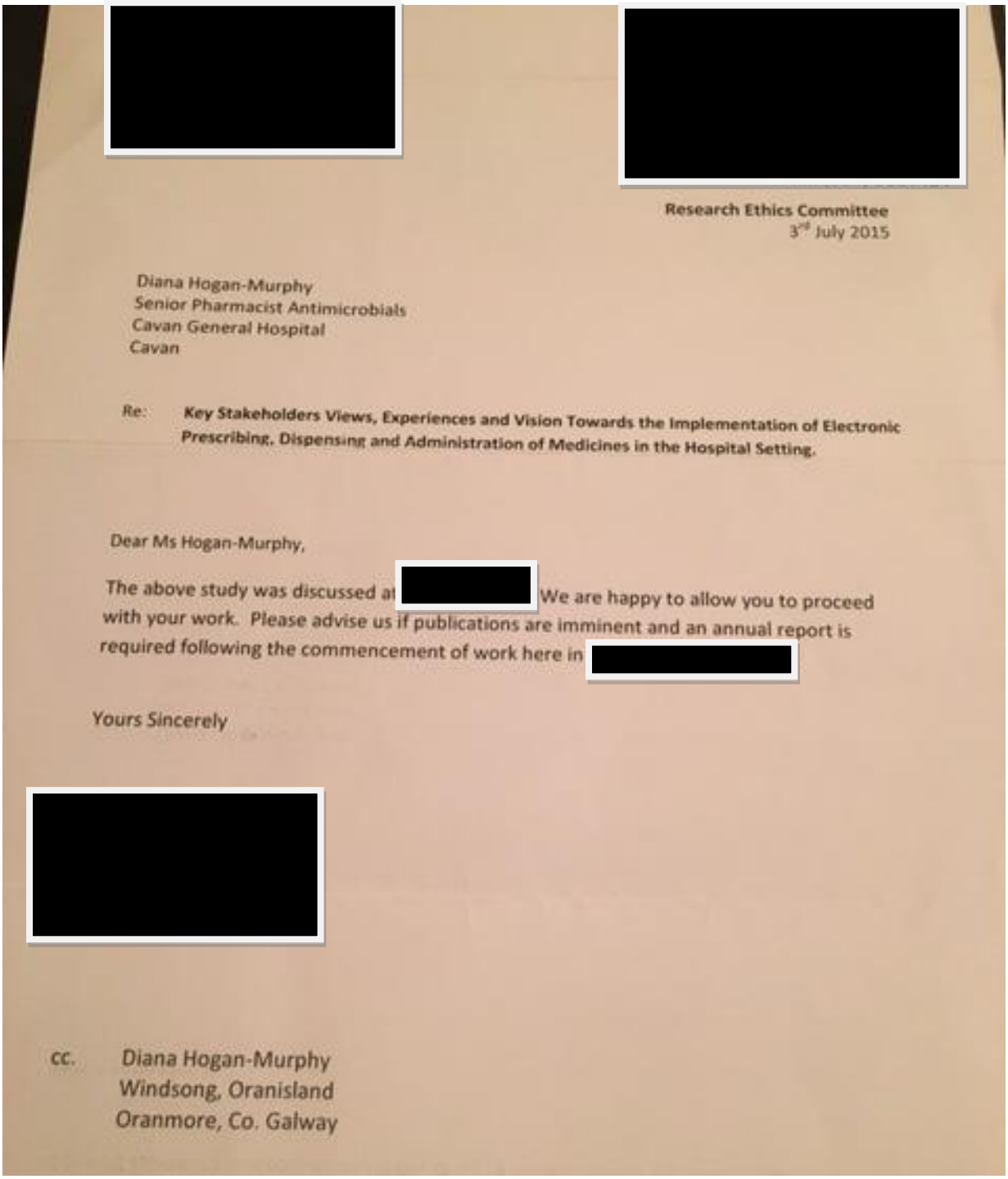
Your study will be formally noted by the HSE North East Area Research Ethics Committee at their next meeting.

Yours sincerely

[redacted]

Copied to/ [redacted]

Appendix 4.15: Ethical approval Hospital C



[redacted]

[redacted]

Research Ethics Committee
3rd July 2015

Diana Hogan-Murphy
Senior Pharmacist Antimicrobials
Cavan General Hospital
Cavan

Re: **Key Stakeholders Views, Experiences and Vision Towards the Implementation of Electronic Prescribing, Dispensing and Administration of Medicines in the Hospital Setting.**

Dear Ms Hogan-Murphy,

The above study was discussed at [redacted] We are happy to allow you to proceed with your work. Please advise us if publications are imminent and an annual report is required following the commencement of work here in [redacted]

Yours Sincerely

[redacted]

cc. Diana Hogan-Murphy
Windsong, Oranisland
Oranmore, Co. Galway

Appendix 4.16: Initial draft of interview schedule

Initial Questions

1. Do you have any experience of implementing or using electronic prescribing, dispensing and/or administration systems in this hospital or other hospitals?
2. IF YES AND ONLY FOR ONE MANAGEMENT INTERVIEWEE: Can u inform me how the project was initiated? How was the functional specification agreed? What was the procurement process e.g. business case? What was the contracting process?
3. IF NO AND ONLY FOR MANAGEMENT INTERVIEWEES: How do you anticipate the project would be initiated? How do you feel the functional specification would be agreed? What would you envisage the procurement process to be e.g. business case? How would you envisage the contracting process? How would you envisage it to be implemented e.g. phased or all at once?
4. What functionality do you feel is required for optimisation?

Agree with interviewee on which aspect/systems will be the primary focus of the remaining questions - however each part cannot be viewed in isolation but are likely to have an impact on other parts of the system

Local Key stakeholders

Coherence:

1. Can you highlight the differences between the traditional paper-based system and the electronic system? How did you/will you envisage organising your workload prior to, during and after implementation? [Differentiation - Distinguish the intervention from current ways of working].
2. What have you done/will you do to ensure that you/end users understand the benefits of the system for you/them and your/their work practices? How did you/will you work with staff in order to build a shared understanding of the aims, objectives, and expected benefits of these systems? Is there anything in particular that you have done/will do to promote or facilitate the implementation process? What sort of barriers did you/would you expect to encounter? [Communal specification – collectively agree the purpose of the intervention].
3. What have you done/will you do to help you understand your specific tasks and responsibilities around implementing these systems? [Individual specification – individually understand what the intervention requires of them].

4. What do you think are the values, benefits, importance with the implementation of these systems in; this hospital or any hospital, for the patient, for you individually, for your profession, for the organisation. [Internalisation – construct potential value of the intervention for their work].

Cognitive participation:

1. Who were/will be the key people responsible for implementing these systems and bringing them into practice? How was this/will this be completed e.g project initiation, identifying functional specification, system choice, business case, procurement, implementation, setting up systems, procedures, and protocols and engaging with others to ensure success? [Initiation].
2. How did you/will you promote end users to engage with the process and encourage them to be involved and that they can make a valid contribution? [Enrolment].
3. How did you/will you consider that staff may need to reorganize their work practices in order to contribute to the work involved in these new systems and join in on delivering these systems? [Legitimisation].
4. How did management promote the use of these systems and did you feel this engaged you with the process? What were/will be the actions and procedures needed to sustain the system? [Activation].

Collective action:

1. How did/will you and end users work together and allocate certain tasks required by the system in order to embed this system into routine practice? [Interactional workability].
2. What sort of training did/will you/end users receive in order to be accountable and maintain confidence in using the system and in each others work capabilities? Was/Will the training be adequate? [Relational integration].
3. Who allocated/will allocate the role end users would have in using the system? Was there/do you feel there will be any difference in capabilities between staff e.g. all had the same amount of training/responsibilities or were there super users? [Skill set workability].
4. Who managed and allocated/will manage and allocate material and human resources for the implementation of this system? How were/will protocols, policies and procedures be executed? Was the system/do you feel the system will be adequately supported by the hospital? [Contextual integration].

Reflexive monitoring:

1. Do you think these systems are of value and important? What sort of priority was/is implementing these systems for you? How was/will effectiveness and usefulness of the system be determined e.g. end user satisfaction survey, cost analysis, time analysis? How was/will measurement of clinical outcomes and adherence to formulary be measured? [Systemization].
2. How did/will you and end users work together to evaluate if the system was working adequately and the effects are worthwhile for themselves? How was the change implemented e.g. phased, all one go? [Communal appraisal].
3. How did/will you assess whether the effects of the system are worthwhile for you individually? How did/will you evaluate the impact of the system on other tasks? [Individual appraisal].
4. Did you/will you redefine procedures or modify work practices for you or end users in response to their appraisal of the system? If so how did/will you do this? [Reconfiguration].

FUTURE VISION

1. What is your vision towards the implementation of electronic prescribing, dispensing, and administration in Ireland/this hospital in the future?
2. How can this vision be realised?
3. What do you feel is necessary to support the planning, implementation and use of these IT systems prior to their introduction nationally/regionally/locally?

Appendix 4.17: Interview schedule with expert comments

SEMI-STRUCTURED INTERVIEW SCHEDULE – LOCAL KEY STAKEHOLDERS' PERCEPTIONS TOWARDS THE IMPLEMENTATION OF ELECTRONIC SYSTEMS FOR MEDICINES IN THE HOSPITAL SETTING **ELECTRONIC SYSTEM IMPLEMENTED** BASED ON THE NORMALIZATION PROCESS THEORY		
Reviewer 1: Add the below comment re introduction Can you tell me a little bit more about your role in this organization and in relation to the implementation of electronic systems for prescribing/dispensing/administration of medicines? **Action/Revised questions:** Added above comment		
Core Questions	**Probe Questions** (will also include: *can you elaborate/tell me a bit more about that* for close-ended questions if required) For external reviewers, probe questions are detailed. Final probe questions may just have words rather than long questions	**Comments and revised questions after external review comments**
1. Can you highlight what difference the electronic system has made to work practices in comparison to the traditional system?	□ What are the overall aims of the electronic system in relation to the manual system? □ What sort of benefits did you expect from using/implementing the electronic system in comparison to the traditional system? Have they been realised? □ What sort of challenges did you expect from using/implementing the electronic system in comparison to the traditional system? Have they been realised? If so how were they overcome? How do you feel they can be prevented?	**Comment on:** Did you have to make significant changes to your work practices in order to use/implement the system? **Reviewer 2 – if so what were they and did you anticipate them necessary? Benefits and disbenefits.** **Research team action/revised question**

	□ Did you have to make significant changes to your work practices in order to use/implement the system?	Did you have to make significant changes to your work practices in order to use/implement the system? If so what were they?
2. From your personal perspective, do you believe there is a shared sense of its purpose among users?	□ Do you feel there was a rationale for implementing the system? □ Do you feel system-users understand the aims and expected benefits of the system? □ How was the rationale for implementing the system promoted and disseminated? □ Has this been effective in involving system-users with the process? □ Do you feel system-users engage with it easily? □ What facilitators/barriers were encountered and actions taken?	**Comments on:** From your personal perspective, do you believe there is a shared sense of its purpose among system users? **Reviewer 4: specify 'its'** Do you feel system-users engage with it easily? **Reviewer 5: I am not too clear what this question is asking – is system easy to use or are users keen to use the system?** What facilitators/barriers were encountered and actions taken? **Reviewer 4: in relation to implementation?** **Research team action/revised question** From your personal perspective, do you believe there is a shared sense of the purpose of these systems among system users? Do you feel system-users engage with

		the system willingly? What facilitators were encountered and actions taken in relation to implementation? What barriers were encountered and actions taken in relation to implementation?
3. Can you describe to me how the system was implemented in your hospital?	□ What training have you received in order to use the system? □ What training have you organised in order to implement the system? (*for managers)* □ Is training compulsory for all users? □ Who provided the training? □ How did you find the training? □ What did the training involve? □ What parts of the training worked well and what did not? □ Has the training assisted you in using/implementing the system? □ What has the training been like since implementation? □ How often is it provided? □ Is the training adequate? □ Do all system-users have the same amount of training and responsibilities? Are there super users e.g. select staff in pharmacy or on the wards?	**Comments on:** □ How did you find the training? **Reviewer 5: Perhaps – was sufficient training provided or how was the level of training- not enough, about right or too much?** □ What has the training been like since implementation? **Reviewer 5: Is this additional training for existing users or training for new users? So perhaps had training been provided since implementation and ask more details about existing or for new users?** **Research team action/revised question** □ Can you describe to me the training that was provided in your hospital in order to facilitate implementation?

		□ How did you find the training? Was sufficient training provided? □ What has the training been like since implementation? Has your training been updated? Are you aware what training is provided for new staff members?
4. Do you feel the system is adequately supported by the hospital?	□ Were there any extra resources provided for implementation e.g. staff, time for training? □ Are there any protocols or policies on the roles and responsibilities of pharmacy/nursing/management/IT/system provider in implementing/using/sustaining the system? □ How are these protocols or policies implemented locally? □ How is competency in using the system assured? □ How do you work together in order to embed this system into routine practice? □ What barriers/facilitators were encountered and actions taken?	**Comment on:** □ What barriers/facilitators were encountered and actions taken? **Reviewer 4: In relation to?** **Research team action/revised question** □ What facilitators were encountered and actions taken in relation to implementation e.g. contingency plans, system support for ongoing system sustainability? □ What barriers were encountered and actions taken in relation to implementation e.g. contingency plans, system support crucial for ongoing system sustainability?

5. How do you and your work colleagues evaluate if the system is working effectively?	□ How is the effectiveness, efficiency and usefulness of the system determined e.g. end-user satisfaction surveys, cost analysis, time analysis?	**Comment on:** □ How is the effectiveness, efficiency and usefulness of the system determined e.g. end-user satisfaction surveys, cost analysis, time analysis? **Reviewer 5: Any impact on patients?** **Supervisory team action/revised question** □ How is the effectiveness, efficiency and usefulness of the system determined e.g. end-user satisfaction surveys, cost analysis, time analysis, impact on patients?
6. How have you evaluated whether the system is beneficial for you personally?	□ What sort of priority was implementing/using the system for you? □ What impact has using the system had on other work tasks? □ How has the system been working? □ Do you think the system is of benefit? □ Do you think the system has enhanced patient safety? □ What functionality of the system do you feel is required for optimising drug administration?	**Comments on:** □ How has the system been working? **Reviewer 5: Perhaps -have you encountered any difficulties with the system and if so can you describe them? Could you resolve them?** □ Do you think the system has enhanced patient safety? **Reviewer 2 - Does this question tie up with main question which relates to "beneficial for you personally" This relates to patient benefit?**

		Research team action/revised question □ Remove question □ Do you think the system has enhanced your ability to provide improved quality of care?
7. What were your perceptions of the system once it had been implemented for a while?	□ What advice would you give to other hospitals thinking of implementing the system?	**No comments**
8. Have you/system users been given an opportunity to provide feedback about the system?	If so in what manner? Have work practices been modified since feedback?	**No comments**
Future vision Looking towards the future, what is your vision towards the implementation of eHealth in general?	**No comments** □ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in Ireland? □ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in this hospital? □ How do you feel this can be realised e.g financial support, policies, protocols, leadership, buy-in, penalties for poor performance, money follows the patient?	

Appendix 4.18: Interview schedule after expert comments

SEMI-STRUCTURED INTERVIEW SCHEDULE – <u>LOCAL KEY STAKEHOLDERS'</u> PERCEPTIONS TOWARDS THE IMPLEMENTATION OF EELCTRONIC SYSTEMS FOR DISPENSING AND ADMINISTERING MEDICINES IN THE HOSPITAL SETTING **ELECTRONIC SYSTEM IMPLEMENTED** BASED ON THE NORMALIZATION PROCESS THEORY		
Introduction: Can you tell me a little bit more about your role in this organisation and in relation to the implementation of electronic systems for prescribing/dispensing/administration of medicines?		
Core Questions	**Probe Questions**	**Constructs**
1. Based on your experiences, can you highlight what difference the electronic system has made to your working practices in comparison to the traditional system?	□ What are the overall aims/vision/mission/values of the electronic system in relation to the manual system? □ What sort of benefits did you expect from using/implementing the electronic system in comparison to the traditional system? Have they been realised? □ What sort of challenges did you expect from using/implementing the electronic system in comparison to the traditional system? Have they been realised? If so how were they overcome? How do you feel they can be prevented? □ Did you have to make significant changes to your work practices in order to use/implement the system? If so what were they?	**COHERENCE –** Differentiation **COGNITIVE PARTICIPATION –**

		Enrolment
2. From your personal perspective, do you believe there is a shared sense of the purpose of these systems among users?	□ Do you feel there was a rationale for implementing the system? □ Do you feel system-users understand the aims and expected benefits of the system? □ How was the rationale for implementing the system promoted and disseminated? □ Has this been effective in involving system-users with the process? □ Do you feel system-users engage with the system willingly?	**COHERENCE** - Communal specification and Internalization **COGNITIVE PARTICIPATION–** Activation **COGNITIVE PARTICIPATION -** Legitimation
3. Can you describe to me the training that was provided in your hospital in order to facilitate implementation?	□ What training have you received in order to use the system? □ What training have you organised in order to implement the system? (*for managers)* □ Is training compulsory for all users? □ Who provided the training? □ How did you find the training? Was sufficient training provided? □ What did the training involve? □ What parts of the training worked well and what did not? □ Has the training assisted you in using/implementing the system? □ What has the training been like since implementation? Has your training been updated? □ Are you aware if new staff members are provided the same amount of training as staff that were trained when the system was first introduced? □ How often is it provided? □ Do all system-users have the same amount of training and responsibilities? Are there super users e.g. select staff in pharmacy or on the wards?	**COHERENCE** - Individual specification **COGNITIVE PARTICIPATION –** Initiation **COLLECTIVE ACTION** - Relational integration **COLLECTIVE ACTION** - Skill set workability

4. Do you feel the system is adequately supported by the hospital?	□ Were there any extra resources provided for implementation e.g. staff, time for training? □ Are there any protocols or policies on the roles and responsibilities of pharmacy/nursing/management/IT/system provider in implementing/using/sustaining the system? □ How are these protocols or policies implemented locally? □ How is competence in using the system assured? □ How do you work together in order to embed this system into routine practice? □ How are changes in drug dictionaries/formularies maintained? □ What facilitators were encountered and actions taken in relation to implementation e.g. contingency plans, system support crucial for ongoing system sustainability? □ What barriers were encountered and actions taken in relation to implementation?	**COLLECTIVE ACTION** - Contextual integration **REFLEXIVE MONITORING** - Communal appraisal
5. How do you and your work colleagues evaluate if the system is working effectively?	□ How is the effectiveness, efficiency and usefulness of the system determined e.g. end-user satisfaction surveys, cost analysis, time analysis, impact on patients?	**COLLECTIVE ACTION** - Interactional workability + **REFLEXIVE MONITORING –** Systemization
6. How have you evaluated whether the system is beneficial for you personally?	□ What sort of priority was implementing/using the system for you? □ What impact has using the system had on other work tasks? □ Have you encountered any difficulties with the system and if so can you describe them? Could you resolve them? □ Do you think the system is of benefit? □ Do you think the system has enhanced your ability to improve the quality of patient care? □ What functionality of the system do you feel is required for optimising drug administration?	**REFLEXIVE MONITORING -** Individual appraisal

7. What were your perceptions of the system once it had been implemented for a while?	□ What advice would you give to other hospitals thinking of implementing the system?	**REFLEXIVE MONITORING -** Systemization
8. Have you/system users been given an opportunity to provide feedback about the system?	□ If so in what manner? □ Have work practices been modified since feedback? □ Has there been reporting of medication administration improvements since system implementation?	**REFLEXIVE MONITORING -** Reconfiguration
Future vision Looking towards the future, what is your vision towards the implementation of eHealth in general?	□ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in Ireland? □ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in this hospital? □ How do you feel this can be realised e.g financial support, policies, protocols, leadership, buy-in, penalties for poor performance, money follows the patient?	

Appendix 4.19: Background questionnaire

1. You have been practising in your profession for

□ < 1 year □ 11-15 years □ 26-30 years

□ 1-5 years □ 16-20 years □ 31-35 years

□ 6-10 years □ 21-25 years □ >35 years

2. You have also practised in countries other than Ireland

□ No □ Yes, please specify countries:_____

3. You have experience of implementing/using ePrescribing systems

□ No □ Yes, please specify where and what systems:_____

4. You have experience of implementing/using eDispensing systems e.g pharmacy robotic systems

□ No □ Yes, please specify where and what systems:_____

5. You have experience of implementing/using automated medication storage and retrieval systems e.g. Pyxis or Omnicell

□ No □ Yes, please specify where and what systems:_____

Appendix 5.1: Ethical approval RCPI

ROYAL COLLEGE OF PHYSICIANS OF IRELAND

Frederick House
19 South Frederick Street, Dublin 2
Telephone: +353 1 863 9700
Facsimile: +353 1 672 4707
Website: www.rcpi.ie

January 22 nd 2016

Ms Diana Hogan-Murphy
Cavan General Hospital
Lisdarn Road
Cavan

RCPI REC SAF 39: Key stakeholders' perceptions, experiences and vision towards the implementation of electronic prescribing, dispensing and administration of medicines in the hospital setting

Dear Ms. Hogan-Murphy,

Thank you for submitting your research proposal to the Research Ethics Committee at the Royal College of Physicians for expedited review.

The Research Ethics Committee's opinion is **FAVOURABLE.**

The REC advises the following

- pilot the interview schedule
- take care not to guarantee anonymity. It may be impossible with small numbers in a specialised area. Reassure on confidentiality and privacy.
- find a quiet / suitable place to interview
- The researcher may not be able to write directly to the participant on the first approach, if they are not the data controller of the 'list'. The data controller should make the first approach. This may be an academic point as there may only be one of a particular post or their identity may be publicly available

Please note that the committee requires the following to be submitted:

- A yearly update report.
- A premature termination report (if the research is stopped early).
- A completion report.

Also in the event of any adverse event occurring in the course of this research (e.g. breach of confidentiality), the committee should be informed as soon as practicable via the chair of the committee.

The committee would like to wish you every success with this project.

Yours Sincerely,

Dr. Una B Fallon MB, MA, MSc, MICGP, MRCGP, FFPH, FFPHMI
Chair RCPI Research Ethics Committee
MCRN 014313

Appendix 5.2: Initial draft of interview schedule

Initial Questions

5. Do you have any experience of implementing or using electronic prescribing, dispensing and/or administration systems in this hospital or other hospitals?
6. IF YES AND ONLY FOR ONE MANAGEMENT INTERVIEWEE: Can u inform me how the project was initiated? How was the functional specification agreed? What was the procurement process e.g. business case? What was the contracting process?
7. IF NO AND ONLY FOR MANAGEMENT INTERVIEWEES: How do you anticipate the project would be initiated? How do you feel the functional specification would be agreed? What would you envisage the procurement process to be e.g. business case? How would you envisage the contracting process? How would you envisage it to be implemented e.g. phased or all at once?
8. What functionality do you feel is required for optimisation?

Agree with interviewee on which aspect/systems will be the primary focus of the remaining questions - however each part cannot be viewed in isolation but are likely to have an impact on other parts of the system

Cognitive participation:

5. Who were/will be the key people responsible for implementing these systems and bringing them into practice? How was this/will this be completed e.g project initiation, identifying functional specification, system choice, business case, procurement, implementation, setting up systems, procedures, and protocols and engaging with others to ensure success? [Initiation].
6. How did you/will you promote end-users to engage with the process and encourage them to be involved and that they can make a valid contribution? [Enrolment].
7. How did you/will you consider that staff may need to reorganize their work practices in order to contribute to the work involved in these new systems and join in on delivering these systems? [Legitimisation].
8. How did you promote the use of these systems to others? What were/will be the actions and procedures needed to sustain the system? [Activation].

Collective action:

5. How did/will you and end-users work together and allocate certain tasks required by the system in order to embed this system into routine practice? [Interactional workability].
6. What sort of training did/will you and end-users receive in order to be accountable and maintain confidence in using the system and in each others work capabilities? Was the training be adequate? [Relational integration].
7. Who allocated/will allocate the role end-users would have in using the system? Was there/do you feel there will be any difference in capabilities between staff e.g. all had the same amount of training/responsibilities or were there super users? [Skill set workability].
8. Who managed and allocated/will manage and allocate material and human resources for the implementation of this system? How were/will protocols, policies and procedures be executed? Was the system/do you feel the system will be adequately supported by the hospital? [Contextual integration].

Reflexive monitoring:

5. Do you think these systems are of value and important? What sort of priority was/is implementing these systems for you? How was/will effectiveness and usefulness of the system be determined e.g. end-user satisfaction survey, cost analysis, time analysis? How was/will measurement of clinical outcomes and adherence to formulary be measured? [Systemization].
6. How did/will you and end-users work together to evaluate if the system was working adequately and the effects are worthwhile for themselves? How was the change implemented e.g. phased, all one go? [Communal appraisal].
7. How did/will you assess whether the effects of the system are worthwhile for you individually? How did/will you evaluate the impact of the system on other tasks? [Individual appraisal].
8. Did you/will you redefine procedures or modify work practices for you or end-users in response to their appraisal of the system? If so how did/will you do this? [Reconfiguration].

FUTURE VISION

4. What is your vision towards the implementation of electronic prescribing, dispensing, and administration in Ireland/this hospital in the future?
5. How can this vision be realised?
6. What do you feel is necessary to support the planning, implementation and use of these IT systems prior to their introduction nationally/regionally/locally?

Appendix 5.3: Interview schedule with expert comments

SEMI-STRUCTURED INTERVIEW SCHEDULE – <u>NATIONAL KEY STAKEHOLDERS/eHEALTH LEADS</u> PERCEPTIONS TOWARDS THE IMPLEMENTATION OF ELECTRONIC SYSTEMS FOR PRESCRIBING, DISPENSING, AND ADMINISTERING MEDICINES IN THE HOSPITAL SETTING BASED ON THE NORMALIZATION PROCESS THEORY		
Core Questions	**Probe Questions** (will also include: *can you elaborate/tell me a bit more about that* for close-ended questions if required) For external review, probe questions are detailed. Final probe questions may just have words rather than long questions	**Comments and Revised Questions after external review comments**
Introduction: Can you tell me a little bit more about your specific national role with regard to electronic prescribing/dispensing/administration of medicines in hospitals in Ireland?		
1. Given your role, from a national viewpoint, can you highlight what difference you think electronic systems would make to working practices in hospitals in Ireland in comparison to the current manual systems?	□ What are the overall aims/vision/mission/values of these systems in relation to the manual systems? □ How do these align to the EHealth strategy for Ireland? □ What advantages can these systems bring in comparison to the manual systems? □ Do you have concerns regarding the transition from manual to electronic systems? □ What functionality of these systems do you feel is	**Comments on:** □ What functionality of these systems do you feel is required? **Reviewer 2 – potentially a very long answer** **Reviewer 4 – I do not understand the**

	required?	**question** **Supervisory team action/revised question:** □ Question removed
2. From a strategic national viewpoint, to what extent do you believe there is a shared sense of its purpose among national and local key stakeholders?	□ What steps have been taken to ensure/develop/embed a shared sense of its purpose? □ Have any issues been encountered/overcome in relation to its shared sense of purpose? □ To date how has the aim/vision/mission been disseminated nationally? □ What barriers/facilitators have been encountered/anticipated and actions taken?	**Comments on:** □ From a strategic national viewpoint, to what extent do you believe there is a shared sense of its purpose among national and local key stakeholders? **Reviewer 4 – Explain 'its'** □ What steps have been taken to ensure/develop/embed a shared sense of its purpose? **Reviewer 4 – Explain 'its'** □ Have any issues been encountered/overcome in relation to its shared sense of purpose? **Reviewer 4 – Explain 'its'** □ To date how has the aim/vision/mission been disseminated nationally? **Reviewer 4 – In relation to?** □ What barriers/facilitators have been

		encountered/anticipated and actions taken? **Reviewer 4 – In relation to?** **Supervisory team action/revised question:** □ From a strategic national viewpoint, to what extent do you believe there is a shared sense of purpose for system implementation among national and local key stakeholders? □ What steps have been taken to ensure/develop/embed a shared sense of purpose for system implementation? □ Have any issues been encountered/overcome in relation to this shared sense of purpose? □ To date how has the aim/vision/mission regarding system implementation been disseminated nationally? □ What facilitators/barriers have been encountered/anticipated and actions taken in relation to system implementation?
3. From a national perspective, what is in place to support the development, implementation and sustainability of these systems at local levels?	□ What has been put in place at a national level or to guide local levels? In relation to… ○ Project initiation ○ Identifying functional specification ○ System choice ○ Business case ○ Procurement ○ Setting up systems ○ Procedures/protocols	**Comments on:** □ From a national perspective, what is in place to support the development, implementation and sustainability of these systems at local levels? **Reviewer 4 – What are 'these'?** □ What has been put in place at a national level or to guide local levels? In relation to……

		Reviewer 5 - Staffing requirements for system support?
		
		System maintenance and upgrades?
		
		- What barriers/facilitators have been encountered/anticipated and actions taken?
		
		Reviewer 4: In relation to all of the above?
		
		Supervisory team action/revised question:
		
		From a national perspective, what is in place to support the development, implementation and sustainability of these systems at local levels?
		
		- What has been put in place at a national level or to guide local levels? In relation to…
		  - Project initiation
		  - Identifying functional specification
		  - System choice
		  - Business case
		  - Procurement
		  - Setting up systems
		  - Procedures/protocols
		  - Staffing requirements for system support
		  - System maintenance and upgrades
		- What facilitators/barriers have been encountered/anticipated and actions taken in relation to supporting system implementation e.g. contingency plans, system support for

		ongoing system sustainability?
4. Given your national role, do you feel these systems are adequately supported locally through national initiatives?	□ Are there any policies/standard operating procedures that have been developed at the national level to support implementation? □ Is there any guidance on the roles and responsibilities for different professionals/staff grades? □ Is there any guidance on the specific tasks to be undertaken? □ What barriers/facilitators have been encountered/anticipated and action taken?	**Comments on:** □ Are there any policies/standard operating procedures that have been developed at the national level to support implementation? **Reviewer 1: to support and monitor implementation** **Reviewer 4: to support implementation of?** □ Is there any guidance on the roles and responsibilities for different professionals/staff grades? **Reviewer 4: in terms of implementation?** □ Is there any guidance on the specific tasks to be undertaken? **Reviewer 4: in terms of implementation?** □ What barriers/facilitators have been encountered/anticipated and action taken? **Reviewer 4: in terms of implementation?** **Reviewer 4: Does this section only refer to**

		implementation? Need to specify **Supervisory team action/revised question:** - What national initiatives do you feel need to be in place to support local implementation? - Are there any policies/standard operating procedures that have been developed at the national level to support and monitoring local system implementation? - Is there any guidance on the roles and responsibilities for different professionals/staff grades in terms of implementation? - Is there any guidance on the specific tasks to be undertaken in terms of implementation? - What facilitators have been encountered/anticipated and actions taken in relation to implementation? - What barriers have been encountered/anticipated and actions taken in relation to implementation? - Merge question 3 and question 4
5. What is your view on how these systems will be evaluated?	- Are there any plans/is there any guidance or specification on how the effectiveness, efficiency and usefulness of these systems will be determined? - What barriers/facilitators have been encountered/anticipated and actions taken?	**Comments on:** - What barriers/facilitators have been encountered/anticipated and actions taken? **Reviewer 4: in relation to evaluation?** **Supervisory team action/revised question:**

		□ What barriers have been encountered/anticipated and actions taken in relation to evaluating theses systems? □ What facilitators have been encountered/anticipated and actions taken in relation to evaluating theses systems?
6. Post-implementation, what do you feel are the expectations for effects on the health services?	□ Patient care/safety □ Staff working practices □ Resources	Comment on: Reviewer 4: other? **Supervisory team action/revised question:** □ Patient care/safety □ Staff working practices □ Resources □ Other
7. From a national perspective, what sort of challenges have you encountered in implementing these systems?	□ Did you anticipate these barriers ? □ How do you feel they can be overcome /used to beneficial effect? □ How do you feel they can be prevented /enhanced? □ What have been the main lessons learned?	**No comments**
8. To what extent have national and local key stakeholders been given an opportunity to provide feedback on these electronic systems or are we not at that stage yet?	□ If so in what manner? □ How did you/national leads react to the feedback?	**No comments**

Future vision Looking towards the future, what is your vision towards the implementation of eHealth in general?	□ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland? □ How do you feel this can be realised e.g financial support, policies, protocols, leadership, buy-in, penalties for poor performance, money follows the patient?

Appendix 5.4: Interview schedule after expert comments

SEMI-STRUCTURED INTERVIEW SCHEDULE – <u>NATIONAL KEY STAKEHOLDERS/eHEALTH LEADS</u> PERCEPTIONS TOWARDS THE IMPLEMENTATION OF ELECTRONIC SYSTEMS FOR PRESCRIBING, DISPENSING, AND ADMINISTERING MEDICINES IN THE HOSPITAL SETTING BASED ON THE NORMALIZATION PROCESS THEORY		
Core Questions	**Probe Questions**	**Constructs**
Introduction: Can you tell me a little bit more about your role with regard to electronic prescribing/dispensing/administration of medicines in hospitals in Ireland?		
1. Given your role, from a national viewpoint, can you highlight what difference you think electronic systems would make to working practices in hospitals in Ireland in comparison to the current manual systems?	□ What are the overall aims/vision/mission/values of these systems in comparison to manual systems? □ How do these align to the eHealth strategy for Ireland? □ What advantages can these systems bring in comparison to the manual systems? □ Do you have concerns regarding the transition from manual to electronic systems? □ What functionality of these systems do you feel is required to be effective?	**COHERENCE** - Differentiation
2. From a strategic viewpoint, to what extent do you believe there is a shared sense of purpose for system implementation among national and local key stakeholders?	□ What steps have been taken to ensure/develop/embed a shared sense of purpose for system implementation? □ Have any issues been encountered/overcome in relation to this shared sense of purpose? □ To date how has the aim/vision/mission regarding system implementation been disseminated nationally? □ What facilitators have been encountered/anticipated and actions taken in relation to system implementation?	**COHERENCE** - Communal specification and Internalization **COGNITIVE PARTICIPATION** - Activation

	□ What barriers have been encountered/anticipated and actions taken in relation to system implementation?	
3. From a national perspective, what has been put in place to support the development, implementation and sustainability of these systems at local levels?	□ In relation to…… ○ Project initiation ○ Identifying functional specification ○ System choice ○ Business case ○ Procurement ○ Setting up systems ○ Procedures/protocols ○ Staff roles and responsibilities ○ Staffing requirements for system support ○ System maintenance and upgrades □ What national initiatives do you feel need to be in place to support local implementation? □ What facilitators have been encountered/anticipated and actions taken in relation to supporting system implementation e.g. contingency plans, system support crucial for ongoing system sustainability? □ What barriers have been encountered/anticipated and actions taken in relation to supporting system implementation?	**COGNITIVE PARTICIPATION** – Initiation **COLLECTIVE ACTION** – Relational integration **COHERENCE** – Internalization **COLLECTIVE ACTION** – Contextual integration
4. What is your view on how these systems will be evaluated?	□ Are there any plans/is there any guidance or specification on how the effectiveness, efficiency and usefulness of these systems will be determined? □ What facilitators have been encountered/anticipated and actions taken in relation to evaluating theses systems? □ What barriers have been encountered/anticipated and actions taken in relation to evaluating theses systems?	**COLLECTIVE ACTION** - Interactional workability + **REFLEXIVE MONITORING –** Systemization

5. What are your expectations post system implementation on its effects on the health services?	□ Patient care/safety □ Staff working practices □ Resources □ Other	**REFLEXIVE MONITORING** - Individual appraisal
6. From a national perspective, what sort of challenges have you encountered in implementing these systems?	□ Did you anticipate these barriers? □ How do you feel they can be overcome /used to beneficial effect? □ How do you feel they can be prevented /enhanced? □ What have been the main lessons learned?	**REFLEXIVE MONITORING** - Systemization
7. To what extent have national and local key stakeholders been given an opportunity to provide feedback on these electronic systems or are we not at that stage yet?	□ If so in what manner? □ How did you/national leads react to the feedback?	**REFLEXIVE MONITORING** - Reconfiguration
Future vision Looking towards the future, what is your vision towards the implementation of eHealth in general?	□ What is your vision towards the implementation of electronic prescribing, dispensing, and administration of medicines in hospitals in Ireland? □ How do you feel this can be realised e.g financial support, policies, protocols, leadership, buy-in, penalties for poor performance, money follows the patient?	