The Impact of Regulatory Change on Pharmacy Practice:

The Implementation of the European Union Falsified Medicines Directive in the United Kingdom



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Thesis submitted to the Medical Sciences Division for the degree of
Doctor of Philosophy
Michaelmas 2023

Acknowledgements

My sincere thanks for the unwavering encouragement and brilliance of my supervisors, Professor Trish Greenhalgh, Professor Sue Dopson, Professor Gary Ford and Associate Professor Chrysanthi Papoutsi. They have each provided inspiration and enthusiasm for my work, advice, and insight from their own exceptional examples. In particular Trish, who has from the beginning provided much needed encouragement, funding, and light during the three major blockades encountered with this project.

I have also benefitted from the wisdom and support of two remarkable DGSs. Professor Anthony Harnden, with whom I had the privilege of working as the department's DPhil Representative over six terms. Professor Sir Andrew Pollard, and the Department of Paediatrics, University of Oxford, for the funding for my study.

To all the research participants and sites, this work would not have been possible without your involvement and all who so graciously made the time for interviews and meetings. Thank you to The Royal Pharmaceutical Society and Pharmaceutical Services Negotiating Committee for providing access to their members and resources.

There are so many talented friends, colleagues, fellow DPhils, academic and administrative teams that have each in their own way provided support and encouragement that has made the last four years one that I would not wish to change. In particular, Dr Fatemeh Ghari, who passed away during this time; we completed our undergraduate degree and were at Oxford together. Dr Charlotte Albury, whom I met on our first day at St Peter's College, Oxford, and whose friendship I continue to cherish.

To my family, in particular my aunts and cousins, and those sadly no longer with us and missed dearly, you have always taken an active interest and equal pride in my work over the years - thank you.

My brother Mahyar, the time discussing and comparing our theses has been invaluable, you have shown me the true meaning of perseverance. It is a privilege of my life that we are completing this path together.

My parents, Maman, Pedar, thank you for instilling your love of learning, curiosity of the world and resilience in me. The unwavering backing, in all of life's aspects, goes beyond what the word love can express. This is for you.

Abstract

The use of technological solutions within the healthcare environment is becoming widespread. The implementation of the Falsified Medicines Directive (FMD) is a large-scale regulatory mandated example of this innovation to impact pharmacy practice in modern times. At the core of the innovation lies the practice of visual and digital authentication and verification by clinicians supported by the digital systems. Few implementation studies for policy-driven digital health system changes of this magnitude have taken place previously in the area of pharmacy practice.

A preliminary literature review found that existing digital solutions focusing on prevention and detection of falsified medicines were limited, with little evidence of integrated national and international policy supported initiatives. In the empirical component of this study, I sought to i) explore the implementation process within community pharmacy; ii) understand the challenges and opportunities pertaining to adoption, scale-up and sustainability of FMD technologies at the local level; iii) place findings within a wider national and international policy context; and vi) inform clinicians' and policy makers' practice for future policy-driven driven innovations.

Fieldwork consisted of a three phased approach including 10 elite and expert participant semi-structured interviews, semi-structured interviews with 17 clinicians at each study site, and 112 hours of ethnographic observations in participating community pharmacies. Analysis was informed by a multi-level theoretical lens known as the Non-adoption or Abandonment of technology by individuals and difficulties achieving Scale-up, Spread and Sustainability (NASSS) framework alongside Shiffman's Political Priority Framework (PPF).

My approach has generated a rich qualitative dataset comprising of interviews, ethnographic fieldnotes, video and digital imagery, and extracts from documents.

My findings support a number of provisional conclusions. Primarily that my chosen framework, NASSS, is a suitable model in explaining the complexities with large-scale system implementation within pharmacy, becoming the first ever study to utilise this framework within this context. Secondly, for a digital solution of high complexity to be adopted, embedded, maintained, and interacted with by clinicians, the digital infrastructure must have capabilities to provide added value for clinical work. Thirdly, policy-driven reform is only an instigator for change, which also requires expert and clinician input to shape and develop policy at the front line of implementation.

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List of abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AMRH	African Medicines Regulatory Harmonization
API	Active Pharmaceutical Ingredient
ARVs	Antiretrovirals
B2B	Business to Business
BN	Batch Number
CAQDAS	Computer-assisted Qualitative Data Analysis Software
CD3	Counterfeit Detection Device
COVID-19	Coronavirus disease 2019
CPCF	Community Pharmacy Contractual Framework
CPD	Continuing Professional Development
CT	Clinical Trials Oversight
CUREC	Central University Research Ethics Committee
DH	Department of Health
DHSC	Department for Health and Social Care
DRC	Democratic Republic of the Congo
DSCSA	Drug Supply Chain Security Act
DQSA	The Drug Quality and Security Act
EC	European Commission
EMA	European Medicine Authority
EMVO	European Medicines Verification Organisation
EMVS	European Medicines Verifications System
EPS	Electronic Prescription System
EU	European Union
EXP	Expiry date
FDA	Food and Drug Administration (U.S.)
FMD	Falsified Medicines Directive
GBT	Global Benchmarking Tool
GC	Gas Chromatography

GDP	Gross Domestic Product
GNI	Gross National Income
GP	General practice
GPhC	General Pharmaceutical Council
GPHF	Global Pharma Health Fund
GSMS	Global Surveillance and Monitoring System for substandard and falsified medical products
HBM	Health Belief Model
HCA	Healthcare Assistant
HCP	Healthcare Professionals
HIC	High Income Country
HIV	Human Immunodeficiency Virus
HPLC	High-Performance Liquid Chromatography
IA	Impact Assessment
INTERPOL	International Criminal Police Organization
ISO	International Organization for Standardization
IT	Information Technology
LASUTH	Lagos State University Teaching Hospital
LE	Licensing Establishments
LI	Low income
LIC	Low-income country
LMIC	Low middle-income country
LR	NRA Lot Release
LT	Laboratory Testing
MA	Marketing Authorization
MC	Market Surveillance and Control
MHRA	Medicines and Healthcare products Regulatory Agency
MQDB	The Medicines Quality Database
NASSS	The Non-adoption or Abandonment of technology by individuals and difficulties achieving Scale-up, Spread and Sustainability framework
NHS	National Health Service

NI	Northern Ireland
NIP	Northern Ireland Protocol
NMR	National Medicines Regulatory
NMRA	National Medicines Regulatory Authority
NMVS	National Medicines Verification System
NRAs	National Regulatory Authorities
NRLS	National Reporting and Learning System
NRS	National Regulatory System
OECD	Economic Cooperation and Development
OVI	Operation Vigilant Interdiction
PDA	Pharmacists' Defence Association
PIDM	Programme for International Drug Monitoring
PMS	Post-marketing surveillance
PPF	Political Priority Framework
PrEP	Pre-exposure Prophylaxis
PSI	Pharmaceutical Security Institute
PV	Pharmacovigilance
PSNC	Pharmaceutical Services Negotiating Committee
QALY	Quality-adjusted life years
RFID	Radio frequency identification device
RI	Regulatory Inspection
RPC	Regulatory Policy Committee
RPS	Royal Pharmaceutical Society
SAFARI	Substandard and Falsified Antimalarial Research Impact
SFM	Substandard Falsified Medicine
SSA	Sub-Saharan Africa
SSFFC	Substandard/Spurious/Falsely labelled/Falsified/Counterfeit medical products
SN	Serial Number
SOP	Standard Operating Procedure
TFDA	Tanzania Food and Drugs Authority

TLC	Thin layer chromatography
UMIC	Upper middle-income country
UK	United Kingdom
UN	United Nations
UNODC	United Nations Office on Development and Crime
VL	Vigilance
WHO	World Health Organisation
WMR	The World Malaria Report

Chapter 1 Introduction

In this chapter, I provide a background of how I came to select the field of research, and outline the overarching aims and objectives. This chapter sets the scene and guides the reader through the many ebbs and flows in constructing and conducting fieldwork in a changing healthcare, political and global landscape.

The primary objective of this research was to understand the interacting influences that explain the fortunes of a technology-supported initiative mandated through regulatory change. This includes delving into the challenges and opportunities afforded of such implementation strategies, contributing to the development of future such policy, and academic outputs.

1.1 The path less taken

I began my career knowing that I wanted to combine professional pharmacy practice with a more strategic perspective on how pharmacies work and how to improve them at system level. With this somewhat unconventional career in mind, I was fortunate that a former tutor provided an opportunity that propelled me into a high-level corporate position that I would hold for over six years.

My role required for me to bridge the gap between primary and secondary care for the National Health Service (NHS) and private sectors to bring about benefits to patient care through outsourcing pharmacy projects and interpreting grey areas in legislation. A large part of my national role was ensuring compliance with regulatory frameworks, creating audits to meet national and regulatory body standards, ethical assessment of business strategy, trend analysis of audits and patient safety incidents to develop tactical action in

addressing these issues and gaining senior engagement to fund the remedial actions. I created the first inpatient, outpatient and mental health training programmes for the organisation's outsourced NHS and private pharmacies, in addition to the clinical standards training platform, recognising the need to upskill management functions to better support frontline colleagues as well as the pharmacy teams themselves.

I gained extensive, often self-taught knowledge of process mapping, in addition to design and implementation of Standard Operating Procedures (SOPs) utilising my own experience and practice to create meaningful services. The outsourced service sector was in its infancy when I first joined as clinical standards pharmacist with legislation and the regulatory frameworks not affording clarity on practice. By the end of my tenure, I was managing a team and a portfolio of over 300 business to business (B2B) contracts.

As the portfolio progressed, so did ways of working. In the absence of designated personnel for IT consideration, I acquired this work stream, becoming the governance lead for B2B electronic prescribing and prescription systems. This involved working with NHS and private partners to develop IT programme capabilities to meet the needs of the UK healthcare landscape and ensure patient safety and process measures were built into the system to assist healthcare professionals in their roles, with a focus on error reduction. Unfamiliar with the territory and faced with a variety of systems, needs and expectations, I became aware that system requirements by health service providers were increasingly unclear, conflicting and often characterised by a model-reality gap, leading to either complete failure of system adoption or failure to adopt in the way originally conceived.

I was part of the teams that designed and implemented the first pharmacy outpatient electronic prescribing system and full end-to-end hospital solution. This was the first step in my interest in digital system use within healthcare and influenced the path that I now pursue. Many months later, I became aware of the Falsified Medicines Directive (FMD), a new proposed legislation that was at the beginning of the implementation period within the manufacturing and wholesaling arena of the organisation I was employed with at the time. In 2016-2017, I began to look into the potential changes required for the contracts under my management, leading to the straw poll data gathering exercise described here in brief and in more detail within chapter 3. Considering pharmacy professionals' practice and perceptions of FMD, with a view to understanding if the topic warranted exploration, I carried out an initial scoping survey via social media platforms in 2017. From the 100 pharmacists invited to participate, 56 completed the survey. Of the respondents, only 20% could confidently state that there were planned changes to their working practices within their sector of work from 2019. More concerning perhaps, 72% believed the legislation change would only impact stock taking procedures. This highlighted a very interesting question: for FMD to be successful in protecting public health, does decommissioning of the medicinal product at the point of stock take rather than the point of supply/administration reduce the effectiveness of the safeguard the legislation is attempting to bring about? As further research for my proposal, I created possible workflow mapping for likely solutions which highlighted, the additional tasks the latter solution would pose for pharmacy professionals. A larger study than my own, conducted across 29 EU countries, showed that 10% of the healthcare professionals included within the study did not know what FMD was and concluded that further education regarding the implications of FMD on working practices was required (1); this study did present

methodological weaknesses, with the greatest criticism being the response rate of 17% and inclusion of countries with differing healthcare systems and practices.

The results of this rough initial study convinced me that there was a potential gap in knowledge about the directive itself, the impact on pharmacy practice and the effectiveness of a mandated legislation to enforce change. This formed the basis for my initial project proposal and DPhil application and the subsequent change in career direction from industry to academia.

1.2 The Falsified Medicines Directive

In a bid to ensure the highest level of medicines authentication, with the main aims of protection of public health and sustainability of the European pharmaceutical market, changes to EU law were introduced by the Falsified Medicines Directive 2011 (FMD 201162/EC). This DPhil has sought to focus on the impact of this legislation change on community pharmacy practice within the UK through the mandatory adoption of new technology as a result of this policy becoming enforceable from February 2019. The primary focus throughout has been on the policy-driven regulation reform impact on pharmacy professionals' working practices; with a secondary aim to establish whether the proposed and implemented digital system provided the means of enabling healthcare professionals to safeguard patient health more effectively than existing solutions, whilst also evaluating the challenges of scale-up and sustainability.

1.3 Falsified medicines: the scale of the problem

Counterfeit and falsified medicines have attracted an increased focus and attention in the last decade by government agencies globally, owing primarily to increased documentation of the effect of falsified medicines on the global health economy (Figure 1.1). Falsified medicines contribute to 1% of the total medicines market within the EU (2). The World Health Organisation (WHO) reports that this figure is up to 10% in Africa, Asia and Latin America (3, 4).

The global strategies for protection of patient health against infiltration of counterfeit and falsified medicines into the legitimate supply chain varies across each continent with a wide variety of approaches being pursued at country level (5, 6).

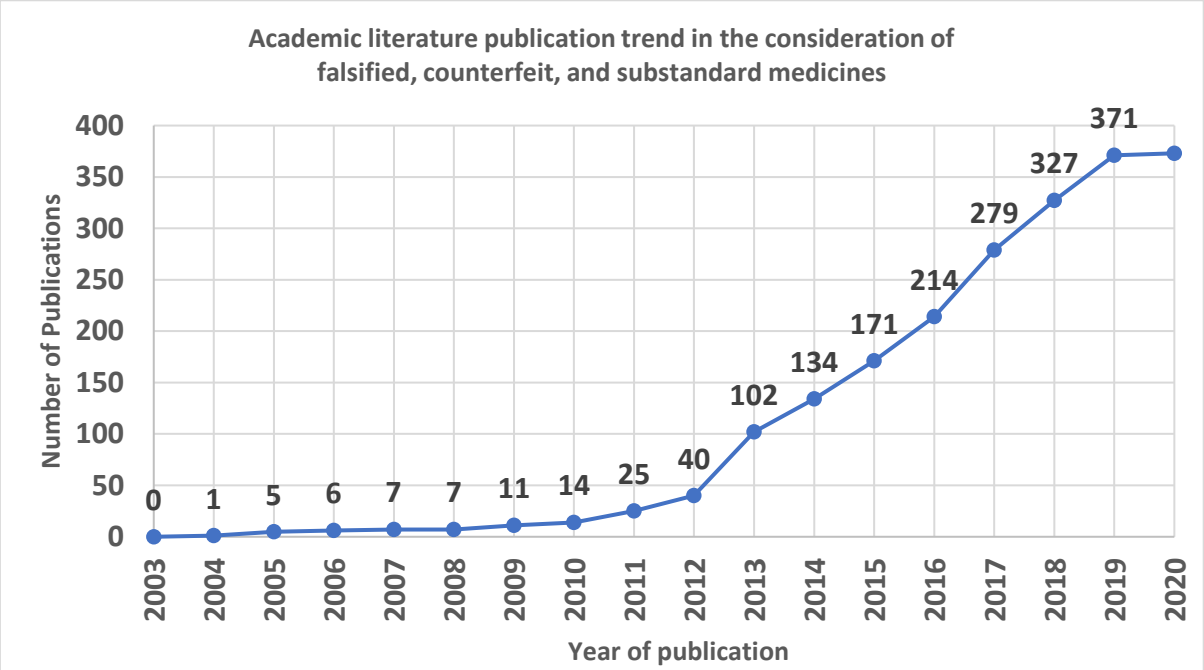


Figure 1.1: ***Academic literature publication trend in the consideration of falsified, counterfeit, and substandard medicines.*** *The PubMed online database was searched for articles on falsified, counterfeit, substandard medicines and drugs up to February 2020 in all contexts. A total of 371 articles were identified. There were no article matches for these search terms pre-1990. 75% of publications identified from this search were published 2010-2017.*

An explanation for this disparity is the level of economic impact on low and lower middle-income countries being higher, with the impact increasing in recent times for high-income countries (7-10). Studies have considered the technological solutions for detection of falsified and substandard medicines in a narrow index of therapeutic agents – predominately, antibiotics, antimalarials and antiretroviral (ARVs) – but very few have proposed high level strategies to prevent the infiltration of such products into the legitimate supply chain. It should be noted that only the legitimate supply chain has been considered in these policies and there is no account for medicine supply through unauthorised markets. However, there is also a recognition that the availability of affordable high-quality medicines coupled with robust policies for domestic market utilisation within private healthcare systems should be considered as a strategy in protection of public health in low- to middle-income countries as a preventative action in patients seeking medicines from unauthorised markets.

Hamilton et al (11) have included pharmacovigilance (PV) reporting systems as a method of collation and communication of actionable intelligence to policy makers and legal authorities. These authors have proposed that to tackle falsified medicines, national PV reporting must be collated into a global reporting system. In the absence of mandatory global reporting system(s) this solution only exists in an effective format at a national level such as the UK's National Reporting and Learning System (NRLS) and Pharmaceutical Security Institute Counterfeit Incident System. National Medicines Regulatory Authorities (NMRAs) may escalate submitted reports to the WHO Medical Product Alert (Rapid Alert) system for further dissemination to countries with Medicines Regulatory Authorities. The uptake and use of this system seems to be somewhat limited with only four reports

submitted to the WHO in 2015. The greatest limitation of this approach is not the lack of legal obligation for reporting at national and international level but the reliance that a patient safety incident must first occur to result in the detection of the falsified medicine. It is thus a reactive rather than proactive measure. Far better would be the identification of falsified medicines before they reached the patient.

1.4 How will FMD address the safety concerns relating to the supply chain?

With increasing sophistication of counterfeiting capabilities, FMD aims to address this issue with the implementation of two obligatory safety features:

i. a unique identifier

ii. an anti-tampering device (12, 13).

The introduction of FMD can be considered as one of the largest strategic policy changes to impact the pharmaceutical industry across several countries in recent times. To date there have been few studies to assess the operational and clinical impact on professionals' working practice and health outcomes. Technological innovations are considered to have significant contributions to health. However, literature on the sustainability of the proposed technological revolution within the pharmacy supply chain is sparse, and developments of this scale across multiple countries are yet to be explored (14, 15).

Whilst authors such as Naughton et al (16, 17), have considered operational implications within the secondary care environment with an analysis of the pros and cons for each, they have failed to consider the implications on the professionals undertaking this activity and the consequences of digitalisation of practices; whilst a solid overview of possible practices have been identified there is no link to the benefits this will bring to practice other than mandatory compliance with legislation.

The complex nature of organisational routine change, scalability, and sustainability should be a key focus on learning from the FMD case study. This study has sought to understand the factors that define the fortunes of a legally mandated, technology-assisted organisational change in pharmacy practice. The postulated FMD compliant model(s) have

been utilised to demonstrate how medication safety and professionals practice will be affected to support the anticipated improved public health outcomes in addition to highlighting the safety effects of decommissioning at the point of supply regardless of the supply chain end point e.g., hospital or community pharmacy.

A single-site case study conducted at Newcastle upon Tyne University Hospitals in 2017 as part of commissioned consultancy work (i.e., not part of the main empirical work for this DPhil) revealed large multisite legal entities, the practice of opting for decommissioning at the point of medication receipt is one that is less labour intensive, requires minimum investment and disruption to existing working practices at pharmacy and ward level. It can thus be argued that the end-to-end supply chain can be verified from manufacturer to pharmacy but not in real time after the point of receipt, and traceability is not then translated into individual patient benefit.

It will therefore be of particular interest to identify practical solutions to overcome this challenge such that patients' digital records accurately reflect down to the batch number what has been supplied. In this way, my research has endeavoured to understand the impact on individual patient safety that can be realised, rather than a legislative change that drives the financial protection of supply chain actors (18).

1.5 Aim and research questions

As a pharmacist with a background in governance, law and ethics, my main aim has been to contribute to the knowledge base on effective implementation of technology solutions in healthcare more widely and pharmacy practice in particular, through both theoretical analysis and empirical research. I have sought to improve the scoping process of legislation, enhance the tools available to policy makers when making decisions that will have an effect on clinicians and clinical practice and highlight the need for unified global strategies to tackle the problem of falsified medicines. My DPhil therefore sought to address the overarching question of:

- What factors explain the fortunes of a technology-supported initiative to implement the EU Falsified Medicines Directive in community pharmacies over the period of April 2018 – October 2023, and what wider lessons can we learn from this case study?

This would be achieved through consideration of the following sub-set of research questions:

- In what way did the introduction of the EU FMD regulation reform impact on community pharmacy professionals' working practices in the UK?
- On the basis of this empirical example, to what extent does digitalisation of the pharmaceutical supply chain provide effective and sustainable means of enabling healthcare professionals to safeguard patient health from falsified medicines?
- Is there an optimal community pharmacy operating model to provide enhanced operational and clinical effectiveness under EU FMD, and if so, what is it?

- What are the challenges to implementation and sustainability of the national digital system/solution for compliance with the EU FMD?

1.6 Brief outline of theoretical approach adopted

The Non-adoption or Abandonment of technology by individuals and difficulties achieving Scale-up, Spread and Sustainability (NASSS) framework developed by Greenhalgh et al offers seven key domains through which to explore efforts to develop and implement technology-supported programmes in health and social care (19). The full theoretical approach is described in chapters 3 and 5. In brief, each of the seven domains comprises of questions about aspects of the programme that can be classified as either simple, complicated or complex; the framework allows the analysis of the technology solution under consideration and the likelihood that the technology will be adopted, spread, and sustained, with this being most achievable where all domains are classed as 'simple' and least likely to be adopted and sustained if multiple sub-domains are 'complex'.

The NASSS framework has been utilised as a guide to create a rich, qualitative (and, where appropriate, quantitative) narrative of the introduction, scale-up and sustainability of traceability technology to be implemented as part of compliance with FMD in the UK. Initial review of the likely success of this, utilising this framework demonstrated that several of the domains appear to be 'complex' and others were unknown at the time of commencing this study, indicative that the programme is likely to be difficult, expensive and slow to implement and sustain but not an impossibility. The framework has not previously been used within a pharmacy practice context and is the first such application as part of this research.

Alongside NASSS, I will be drawing upon Shiffman's Political Priority Framework (PPF) to explain this global political priority, that is 'the degree to which international and national

political leaders actively give attention to an issue, and back up that attention with the provision of financial, technical, and human resources that are commensurate with the severity of the issues'(20).

1.7 Overview of thesis

The remainder of this thesis is structured as follows:

Chapter 2 consists of a literature review focusing on existing research into global strategies to combat falsified, substandard and counterfeit medicines. In addressing this literature, the impact on public health and confidence, wider societal and economic implications are also realised. Specific focus is given to strategies in mid- to high- income countries, their relative success with comparisons drawn to FMD in the UK.

In chapter 3, I address the ontological and epistemological approach adopted. The methodology and choice of methods is discussed as well as changes to the original plans as a result of Brexit, the COVID-19 pandemic and other notable delays. The ethical consideration, research site and participant recruitment, interview structure, data collation and analysis are discussed as part of the research process. My study design is a national case study using Stake's interpretive (hermeneutic) methodology. This is because the central question guiding my case study has been "what is going on here?" (i.e., achieving a rich understanding of the particularities of the case) rather than "what is this a case of?" (i.e., using a case or sample of cases to produce theoretical generalisations). Thus, my focus on producing understanding of FMD in the UK will lend itself to what is called an N = 1 case.

Ethnographic vignettes and case reflections are presented in chapter 4. In this chapter, I provide narrative summaries of each of the individual pharmacies and participants. These summaries are a way to introduce each of the three pharmacies and twenty-eight participants to readers, presenting each as a case within the overall case of FMD.

Chapter 5 is the first of three chapters of empirical findings. I focus on the organisational context and introduce the pharmacy sites from the perspective of the organisational levels that build their operational foundations and the people that interact and shape the actions at an individual level. I draw upon the NASSS framework and situational analysis to structure my findings.

Chapter 6 presents the governance, systems and policy. The overall policy approach, from conceptualisation stage, through to impact assessments and guidance for implementation practices in primary care are considered alongside digital imagery and other documents. This chapter also considers how healthcare professionals are required to change their working practices to adapt to fixed systems selected by hierarchical structures. Analysis of expert and elite participants show a marked difference in perceptions of the adaptability and ease of use of these systems to those participants working on the frontline of clinical practice.

In chapter 7, a brief presentation of policy adaptation post-Brexit and the events leading up to the event are considered. The discontinuation of FMD in the UK has created a need to consider other means for a national solution, devolved from the EU. The solution to be selected is open for deliberation and with no clear indication of such timelines, the questions for how and if existing policy and systems could be recycled require

consideration. I have used the overall narrative of my case, which is seeking to capture a rich in-depth description of FMD implementation, while also placing these organisational-level descriptions in the context of a national policy to implement a technology-supported initiative in community pharmacy practice and considering changes to pharmacy professionals' identity and their interactions with patients. In other words, I have sought to tell an over-arching story of what is happening at a national level (macro level) and then zooming in to include depth and detail about local organisations (meso level) and individual professional actors (micro level) to provide outputs for possible such future cases.

Finally, the discussion and conclusions are presented in chapter 8. This chapter brings together all of the findings from the preceding chapters to make sense of the collected data and methods upon the presented results. The limitations of the research are also considered. The contribution of these results to digital system implementation in pharmacy practice, primary care and wider healthcare field is discussed alongside the implications of these findings for future development of policy and clinical practice. Future research directions and approaches are also presented.

Chapter 2 Literature review

Chapter 1 provided an introduction to FMD in combination with a brief overview of the scale of the problem and the reasons for increased focus on this topic on a global scale in the last two decades. This chapter reviews existing research into global strategies to combat falsified, substandard, and counterfeit medicines, and the reasons for needing such strategies at national and international levels. In addressing this literature, the impact on public health and confidence, wider societal and economic implications are also realised. Specific focus is given to strategies in mid- to high- income countries, their relative success, to allow for an accurate comparison to be drawn with the situation of FMD implementation and strategies in the UK.

My research strategy was a two-step process, beginning with an initial narrative review (section 2.1) to describe and define what substandard, falsified and counterfeit medicines are (section 2.1.1) and why they occur (section 2.1.2). Once I had completed this overview, it became clear that there was wide-ranging, existing literature to answer my sub-question of "What are the existing global strategies to combat falsified, substandard and counterfeit medicines?". This led to a change in my approach to the search strategy, opting to carry out a simple, systematic, protocol-based search of electronic databases to identify this literature. The methodology for this is described in section 2.2.

2.1 Narrative review

2.1.1 What are substandard, falsified, and counterfeit medicines?

In order to fully appreciate the scale of the problem related to substandard, falsified, and counterfeit medicines and begin to accurately quantify the scale in which this impacts healthcare systems, it is wise to dissect the definition of this terminology to better understand the subtle differences between each and how they may then relate to each employed strategy. The term falsified medicines are those applied to medical products that deliberately or fraudulently misrepresent their identity, composition or source. Substandard medicines, or more commonly referred to as out of specification medicines, are those that are licenced for production and distribution within a defined region that fail to meet either their quality standards or specifications, or both. Finally, counterfeit medicines are medicines that do not comply with intellectual-property rights or that infringe trademark law (21, 22). Whilst these terms are often used interchangeably, the difference in their definition does present a distinction in the potential harm to patient and public health, regulatory and licensing concerns and reputational damage for manufacturers. Nevertheless, to avoid confusion and encompass all eventualities the World Health Organization (WHO) refers to these products as Substandard/Spurious/Falsely Labelled/Falsified/Counterfeit (SSFFC) medical products.

2.1.2 Why do substandard, falsified, and counterfeit medicines occur?

Through standardisation of the terminology used to refer to Substandard, Falsified and Counterfeit Medicines, the WHO has created an encompassing platform of inclusion of all

such cases that have the potential to result in patient and public harm, thereby ensuring a unified definition for the WHO's executive board to vote on in their 134th session in January 2014 to formalise the steering committee's proposal for implementation of the work plan to tackle the actions, activities and behaviours that result in SSFFCs.

The principles established by the steering committee are done so as to prevent and reduce the risk to public health through prohibiting the following: manufacturing medical products in establishments that are not authorized by the national and/or regional regulatory authority, manufacturing medical products or their packaging or their labelling without registration or approval by the national and/or regional regulatory authority, modifying accompanying information of the medical products and changing their packaging and extending the use-before date or expiration date of the products that misleads the public and/or purchasing entities, substituting the contents of the medical product using the authorized packaging, importing, exporting, distributing, including transporting, supplying, selling, including through the internet, as appropriate, and storing medical products without compliance to applicable national and/or regional regulations and requirements, manufacturing, importing, distributing, supplying or selling medical products: (a) without registration or approval or authorization by the national regulatory authority; or (b) using an authorization that does not exist; or (c) using without permission an authorization already granted to another by a national and/or regional regulatory authority; – manufacturing medical products which replicate registered medical products or their packaging without authorization of the national and/or regional regulatory authority; – failing to comply with good practices of manufacturing, distribution, transportation and storage of medical products, as set out by the national and/or regional regulatory

authority; – importing, exporting, distributing, including transporting, storing, supplying or selling medical products obtained from an unauthorized or unknown origin; – manufacturing medical products that violate the formula or the data contained in the registration file as approved or accepted by the national and/or regional regulatory authority; – modifying the packaging and/or the labelling, without complying with national and/or regional regulations and without authorization from the national and/or regional regulatory authority (23).

This list is not exhaustive and other eventualities are a possibility given that medical, scientific and technological advancements are likely to have occurred since this list was produced. This body of work from the WHO was financed through voluntary contributions from the governments of Argentina, Brazil, the Netherlands, Switzerland, and the United States of America, it is not clear from the published literature why specifically these governments volunteered to contribute to this agenda. It is known that the United States of America has had The Drug Quality and Security Act (DQSA) passed on the 27th November 2013 to allow for the electronic tracing of defined prescription medicines, through a phased implementation process (24).

Existing literature widely documents the rise in SSFFC medical products to five key areas: real-term and relative poverty, healthcare privatisation leading to medical poverty, medical tourism, online purchasing of medicines and more recently, the COVID-19 pandemic (2, 25, 26). There does exist a difference to the extent on which these factors affect the healthcare system in each country. The UK has the National Health Service (NHS) which is free to all at the point of access and prescription charges are at a fixed rate per item, payment only takes place where the individual does not satisfy the prescription charge exemption

criteria. Other countries operate on an insurance or fee-contribution system, resulting in the patient contributing to the cost of their medication needs at the point of access. The economic wealth of a country also has a bearing on the healthcare provisions in place for the population.

The established economic system to distinguish this is divided into four income groups by the World Bank of low-, lower-middle-, upper middle- and high- income countries (Table 2.3) (27). The effect is that, in what is considered as developing countries, medicines account for 30-50% of the total healthcare expenditure in comparison to 15% in developed economies (25).

Privatisation of healthcare is thought to improve the efficiency, availability and choice of healthcare afforded to patients whilst also controlling access or preventing overuse to develop appreciation of health services (28, 29). This type of privatisation creates a divide between those that can afford to pay for their healthcare and further pushes those in the middle and bottom of the income scale into medical poverty as the costs of treatment falls directly on the individual. As an example, Mullings and Paul have reported that 14-20% of people did not seek medical care due to an inability to pay for the treatment and/or transport in the Caribbean (30). Whilst this region can be considered as a developing country, the situation in developed nations is not too dissimilar with medical costs accounting for 40% of personal bankruptcies in the year 1999-2000 (31).

Medical tourism is not a new phenomenon, in fact it can be commonplace for clinicians, especially those renowned for their specialty, to travel to deliver healthcare to a number of patients either nationally in different regions or internationally, more commonly for

privately paying patients. The other type of medical tourism that has become more prevalent in the last two decades is for patients to travel to seek access to healthcare. This is driven by a desire either to obtain access to a specific clinician, treatment, reduced treatment costs, and bypass or reduce treatment waiting times, or a combination of these factors (32). This is particularly true for patients in the UK and European Union countries (EU)(33, 34). Whist this may provide good benefits for those going from developed and high-income countries to seek treatment, it can result in scarce resources and medicines being utilised by these so-called medical tourists, potentially removing medicine availability for the local population.

Medicine unavailability can be in itself a leading cause of falsified medicines, where demand and access drive the supply requirements for specific classes of medicines. Falsified medicines are arguably more of a visible and documented problem now than it was when this study first began. I return to this topic in chapter 8 as part of my discussions, when I consider falsified medicines emerging during the COVID-19 pandemic.

Pharmacies are an integral part of any healthcare system. In low- and mid- income countries this is particularly the case, patients whom cannot afford the costs associated with diagnostic tests often seek the treatment directly from pharmacists (25). However, even in high income countries the emergence of online pharmacies and other online platforms for the acquisition of medicines has created a channel for falsified medicines to be acquired directly by patients. The accessibility of the internet through a variety of devices such as mobile phones and smart devices and the ease with which websites and online outlets can be created, presents a regulatory challenge for law enforcement to ensure the legitimacy of these outlets for consumers. The fourth pillar of the EU FMD seeks

to address this through introduction of the EU common/obligatory logo (22), further details of this are discussed in sections 2.4 and 8.2.

2.2 Narrative systematic review

2.2.1 Methods

I approached this element of the review with a straightforward view to answer the question of "What are the existing global strategies to combat falsified, substandard and counterfeit medicines?"; as I progressed with my thoughts on how to approach this, I conducted a number of pilot searches which provided thousands of results to review. This led me to revisit my strategy in approaching this narrative systematic review and devising the search protocol using an adaptation of the PRISMA checklist to accommodate my chosen methodology of a narrative systemic review. The full protocol is published under PROSPERO registration number: CRD42021226858(35). The initial PROSPERO registration was submitted on 14th December 2020 and after some revisions accepted on the 20th April 2021. The review includes publications up to April 2021.

I aimed to identify papers across four key categories: health impact, economic impact, governance strategies and policies, methods of detection. I drew on recognised terminology identified from my initial narrative review to build up a bank of key words to develop the search terms. This eventually led to the development of six categories for keywords to be included (Table 2.1). I searched the following academic databases for potentially relevant literature: PubMed, ScienceDirect and Google Scholar, alongside searches on the websites of the following organisations: World Health Organization (WHO), Medicines and Healthcare Products Regulatory Agency (MHRA), Food and Drug Administration (FDA), The Organisation for Economic Co-operation and Development (OECD), alongside adding in existing policy documents that were known to me such as UK government impact assessments on FMD.

To assist with the screening of the papers, I created a data capture form to document a summary of each article that I read, and this became useful in checking the decisions that were made about the inclusion or exclusion of each, especially as the screening was conducted by three people. This is described later in this section.

The criteria for inclusion were distinguished as publications that documented the following: 1- Systematic and narrative reviews, 2- Detail of policy change strategies, 3- Original text in English or Persian (the languages I speak fluently), 4-Stipulates the origin of medication discussed/presented, 5- Defines the population(s) involved, 6- Randomized studies, 7- Practice guidance, 8- Policy papers. The following publications were excluded: animal studies, undergraduate dissertations, conference abstracts, and opinion pieces.

To allow for an even more condensed and concise overview of each article, I developed a scorecard to capture the details of each article with the pertinent elements alongside the documented outcomes of each article for review. An extract of the scorecard is shown in Figure 2.2.

To assist with the volume of literature to screen against the inclusion and exclusion criteria, two final year pharmacy students were brought on board, a subsection of the obtained datasets was then used as part of their respective individual Masters' dissertations, split as strategies within the African continent and a comparator of low- and high- income country strategies under my supervision.

Screening of the publications took place in four phases (Figure 2.1). In the first round, I reviewed the papers and removed duplicates and those in the excluded languages. The pharmacy students conducted the second round to establish and eliminate those papers

where full text was unavailable. The third phase was conducted by all three researchers, with the papers evenly distributed for screening of each article against the inclusion and exclusion criteria and for completion of the data capture form, alongside this the data extraction scorecard was completed and any borderline publications discussed. In the final phase, I reviewed all of the included and excluded literature.

The twenty-four papers found from the formal search of the electronic databases were then further analysed and the presence of each of the following themes documented: health consequences, economic consequences, systems and policies and detection technologies. Only two papers cited all four themes, fifteen cited three and seven included two of the themes.

Category classification	Search terms
Category 1 – Falsification terminology	Falsified/ Fabricated/ Fake/ Forged/ Bogus/ Phony Substandard/ Poor/ Low-level Counterfeit/ False Active ingredient/Ingredients
Category 2 –Medicine and healthcare terminology	Medication / Drug/ Medicine/ Antimicrobial / Antibiotics Health care/ Pharmacist/ Doctor GP/ Pharmacy/ Hospital Pharmaceutical Manufacturer Companies
Category 3 – Population	Global/ Worldwide/ High-income countries/ Low-income countries Africa/ Nigeria/ Zimbabwe/ Ghana/ Sub-Sahara Asia/ India China Europe/ United Kingdom/ Germany/ France
Category 4 – Policy and organisations	Regulatory/ Agencies/ Authorities/ Directives/ Agencies/ Charities Falsified Medicine Directives/ FMD/ Government/ Interpol/ Police/ Crime World Health Organisation/ WHO
Category 5 –Technology	USP's program/ Global Benchmarking Tool/ GBT "End-to-End" program/ Track and Trace system Support/ Governance/ Help Smartphone/ Internet/ Online Pharmacy
Category 6 – Laboratory and tracing mechanisms	Barcoding/ 2D matrix/ Batch number/ Hologram/ RFID tags TLC/ HPLC/ GC/ NMR GPHF Minilab/ Counterfeit Detection device Training/ Education/ Practice

*Table 2.1: **Key categories of search terms.** The search terms used within this narrative systematic review have been placed within 6 key categories to cover the key criteria of keywords required to find*
publications to answer the question "What are the existing global strategies to combat falsified, substandard and counterfeit medicines?"



Figure 2.1: ***Narrative systematic review screening process for PROSPERO registration number: CRD42021226858*** *The full four phase screening process is demonstrated with an overview of the publications included and excluded at each phase.*

	1				2				3				4				5			
General Information																				
Author	H. Rebiere				European Commission				M.Rahman								T Sanada .N yoshida. K Kimura			
Publication Year	13-May-17				01/03/2020				22/10/2018				Oct-20				02/12/2020			
Title	Fighting falsified medicines: The analytical approach				Substandard and Falsified Medicines in Myanmar				The health consequences of falsified medicines- A study of the published literature				Substandard, falsified and unregistered medicines in Latin America				Discrimination of Falsified Erectile Dysfunction Medicines by Use of an Ultra-Compact Raman Scattering Spectrometer			
Country	N/A				Myanmar				N/A				USA				Japan			
Study Eligibility																				
Inclusion criteria met? 1- Systematic reviews 2- Policy change strategies 3- English or Farsi langauge 4-Origin of medication 5- Origin of population 6- Randomized studies 7- Practice guidance 8- Policy papers	Yes				Yes				Yes				NO				Yes			
Include / exclude	Include				Incuded				Incuded				Exclude				Incuded			
													Spanish							
***** INCLUDED MANUSCRIPTS *****																				
Aim	Range of techniques to be used to obtain individual information on the organic and inorganic composition, the presence of an active sub- stance or impurities, or the crystalline arrangement of the formulation's compound.				The aim of this study is to examine the extent of SFMs for sale in Myanmar.				To analyse and present the literature describing the health consequences of falsified medicines, focusing on mortality and morbidity, as well as the scale of the issue, the geographic extent, the medicines affected, and the harm caused at both the individual and population levels.				To assess all the incidents of substandard, falsified and unregistered medicines in 2017 and 2018 in Latin America, determining the types of products affected, stages of the supply chain in which incidents were detected, quality deviations.				This study analyzed tadalafil (Cialis), vardenafil (Levitra), and sildenafil (Viagra) tablets. tested the standard product and products purchased from the internet			
Secondary scorecard																				
	Poor	Fair	Very Good	Excellent	Poor	Fair	Very Good	Excellent	Poor	Fair	Very Good	Excellecnt	Poor	Fair	Very Good	Excellent	Poor	Fair	Very Good	Excellent
																			X	
different strategies to detect e.g technology				X	X															
falsified medicines directives			X			X				X										
Policies						X						X								
Health impact																				
Economical impact																				
Digital elements		X				X					X							X		
Overal score	3				4				3								2			
Link	https://reader.elsevier.com/reader/sd/pii/S0731708517306192				https://www.mdpi.com/2226-4787/8/1/45/htm				https://onlinelibrary.wiley.com/doi/full/10.1111/tmi.13161				https://pubmed.ncbi.nlm.nih.gov/33033498/				https://www.mdpi.com/2226-4787/9/1/3/htm			

*Figure 2.2: **Data extraction scorecard excerpt** A data extraction scorecard was created with the key categories for consideration. Publications were assessed and documented against these domains with the outcome of include or excluded clearly documented against each.*

2.3 What is the impact of falsified medicines?

2.3.1 Background

The presence of falsified medicines can result in numerous profound adverse outcomes with enduring implications. Primarily, and as has been mentioned in previous chapters falsified medicines can imperil public health by elevating the incidence of both immediate and prolonged illnesses, amplifying mortality rates through adverse reactions and/or the absence of active treatments. Simultaneously, the presence of falsified medicines within the legitimate supply chain has the potential to erode trust in the healthcare system. In combination, these factors can give rise to substantial economic setbacks and the squandering of healthcare and other public resources, thereby exacerbating intricate challenges at a national level, specifically within low-income countries where resources can be finite (2). The remainder of this section explores these key areas and other contributing factors in more detail.

2.3.2 The reasons for occurrence of falsified medicines

To find suitable strategies to counteract the existence of falsified medicines, we need to understand the reasons for their occurrence. Several factors have already been addressed in the narrative review in section 2.1.2. The majority of reasons in the ensuing literature can be attributed to two fundamental topics: poor governance and regulation, alongside, inadequate detection capabilities from a technology and capacity angle. In summary, substandard and counterfeit medical products tend to be prevalent in situations where there is: limited access to medical products that are both affordable and of high quality, ensuring safety and effectiveness; and/or where there is weak governance standards, encompassing unethical practices within healthcare facilities and medicine outlets, as well

as corruption within both public and private sectors; and/or there is a lack of adequate tools and technical capabilities to enforce proper practices in manufacturing, quality control, and distribution (36).

2.3.3 Health impact on populations

In the reviewed material, 26 papers referenced health consequences of falsified medicines in some way, with 18 of these focusing on low-income countries, documenting that approximately one in ten medicines in low- and middle- income countries is falsified (2, 37).

The most targeted medicines for falsification are covered in 4 papers, with the most prevalent reported as antimalarials within developing nations (38-40) and a further 4 papers determine the health impact that falsified medicines have on the public. There were no papers focusing on the health impact on high- income countries.

Two of the papers considered practice-based examples, with one evaluating the access and quality of injectables in Ghana and the other a prescribing audit in Uganda to establish the wide availability of substandard β-lactam antibiotics. In the former study, the authors acquired 55 ergometrine ampoules and 46 oxytocin ampoules from 69 legitimate locations for acquiring medicines lawfully. The analysed samples of oxytocin and ergometrine showed that 2% of the acquired medicines had passed their expiration date with 89% of the tested samples demonstrating an active ingredient below British Pharmacopoeia specifications (37, 41, 42). Furthermore, the authors noted that the most substantially targeted medicines for falsification were those for chronic diseases such as diabetes. In Nigeria, a study evaluated the eight most prescribed brands of metformin tablets from

pharmacies. The evaluation included assessing the uniformity of weight, friability, disintegration and dissolution of the tablets. The study found that 50% of the tablets failed one or more of the bioequivalence pharmacopeia tests (43). Lam et al document that there are 463 million people with clinical diabetes requiring medicated treatment in 2019 projected to increase to 700 million people by 2045. Of this figure, roughly 80% of the worlds' diabetes sufferers live in low- and middle- income countries (38, 44). Given the high rate of falsified and substandard medicines within the legitimate supply chain coupled with a high percentage of medicine users this can give rise to negative health implications for the patients and consequently the healthcare system in these geographical locations.

Drug resistance was a frequently presenting theme amongst a number of studies and drug groups, in particular antimicrobials, touched upon in the aforementioned study and antimalarials. Ozawa et al have located a meta-analysis demonstrating that 19.1% of antimalarials to be of poor quality (38). The World Malaria Report (WMR) estimates that 31,000 deaths occur as a result of the falsified and substandard malaria treatments in sub-Saharan Africa, this figure increases to 116,000 if considering the Clinton Access Initiative data (45).

Beargie et al conducted a review which established that 11.8% of antimalarials were subject to falsification (39). Other studies have recorded that 12% of all death cases from falsified malaria medicines occur in the Democratic Republic of Congo. It is with this data that Ozawa et al have sought to establish the impact that appropriate quality medicines would have on this population. Through mapping of the healthcare model and incidence of infections within two regions, they simulated a model whereby all medicines prescribed and administered are of guaranteed quality. The simulation demonstrated a marked

improvement in the health outcomes of patients within the simulation, with data showing that having good quality antimalarials resulted in 63% (region 1) and 62% (region 2) fewer hospitalizations. In region 1, the number of deaths purely due to malaria decreased by 33% in comparison to 43% for region 2 (38).

In the reviewed literature, drug resistance was the only factor considered alongside projected mortality and morbidity rates. Mortality is defined here as the years not lived due to a disease state and morbidity as years lived in imperfect health. This has been supported in the examples such as that above with the use of mathematical modelling tools to establish such estimates. None of the studies reviewed discussed conclusive data for Quality-adjusted life years (QALYs). QALYs measure the state of a person's (or group of individuals with the same condition) quality of life in relation to the length of life lived after a particular intervention such that 1 QALY is equal to 1 year of life in perfect health (46).

All of the factors mentioned so far have the potential to affect the confidence levels of the public with medicines and health systems. This creation of doubt may impact an individuals' beliefs on the efficacy and suitability of medicines and the healthcare system. Utilising the Health Belief Model (HBM) is evident to predict this outcome.

The unintended consequence of the loss of public confidence does mean that people not seeking healthcare treatment either preventatively (e.g., vaccination) or actively (e.g., not taking a prescribed course of antimalarials) may result in a decline in their health status. It is also possible for patients to seek treatment from other sources such as unregulated practitioners and medicine's suppliers. This loss of public confidence in health

professionals, health systems and public institutions and governments is widely documented by a number of research and policy authors (47, 48).

Many papers referenced a number of case study examples of the occurrence of falsified medicines. Some of these case studies have been referenced in the WHO GSMS report to demonstrate the incidence and importance of preventing falsified medicines from entering the supply chain (49). A summary is shown in Table 2.2.

Table 2.2: ***A summary of case studies referenced within the WHO 2017 GSMS report affecting high- and middle- income countries.***

Case study	Date and location of incident	Summary of events	Cause
Dextromethorphan (cough syrup) imported from India (49)	September 2013, Paraguay	44 children admitted to hospital with breathing difficulty	The product had the same active pharmaceutical ingredients (API) imported from India (below). The information from Pakistan's authorities allowed for the batch identification of the cough syrup and meant that an antidote was given in time to patients to save their lives. Some of the affected batches were recalled globally but not all were found.
	November 2012, Pakistan	60 adults died after consuming large quantities of cough syrup as part of their drug addiction	Two manufacturers had recently changed their source of API to a cheaper alternative. Indian authorities were notified and suspended production. Testing showed cough syrup contained levomethorphan, which is five times stronger than morphine

Avastin® (bevacizumab) solution for infusion (Breast and other cancers therapy) (35, 36)	November 2011, USA	19 medical practitioners report purchasing falsified Avastin® from an online pharmacy in Canada in 2015	US FDA reviews efficacy data from clinical trials and withdraws the recommendation for use in clinical trials on the basis of cost effectiveness. Insurance companies also withdraw policy to cover this treatment under their health coverage plans. The internet pharmacy sold the medicine under the Turkish brand Altuzan for $500 less than the price of Avastin per dose. Testing of the batches showed no API was present. Investigation of the supply chain showed that the US supplier had acquired them from the UK. The UK dealer from Denmark, they from Switzerland and they subsequently from Egypt and the origin from Syria.
Harvoni (sofosbuvir and ledipasvir) tablets (50, 51) for hepatitis C treatment	January 2017, Japan	A supplier to a pharmacy in Tokyo used legitimate Harvoni bottles and replaced the contents with vitamin tablets. Patients were not seen to have shown any improvement or in some cases worsened where a full recovery had been expected.	In 2013 Sovaldi (Sofosbuvir) was approved for the treatment of hepatitis C and proved an effective treatment when given for 12 weeks in combination with ribavirin and interferon. In the same year another medicine Harvoni (sofosbuvir and ledipasvir) was released by the same manufacturer and shown to have fewer side effects but with the same efficacy. In 2016 studies demonstrated that the treatment price was $10000 more for Harvoni than Sovaldi resulting in falsifiers taking the opportunity to target this medicine. The falsifiers made an extraordinary amount of money from this in the period of activity.

2.3.4 Socioeconomic impact

There are currently 217 countries included in the World Development Indicators, this is greater than the 194 WHO member states, which demonstrates that not all economies are accounted for depending on the study's inclusion criteria. The income groupings are based on each territory's gross national income (GNI) per capita in July of each year from data for the preceding year. The groups are low- (<= $1,135), lower-middle- ($1,136-4,465), upper-middle- ($4,466-13,845) and high- (> $13,845) income (52).

It can be seen from the threshold GNI per capital that there is a wide inclusion criterion for this that fall in the lower- and upper- middle income classifications however, in all of the papers that were reviewed these are grouped together as middle income countries. Table 2.3 provides a summary of each income group alongside the GNI per capita threshold and the number of countries within each banding in 2016, which is the data most often referenced within existing literature and that of July 2022, the most recent published data from The World Bank. The majority of papers utilised this classification for the purpose of categorising countries by financial banding rather than solely on geographical location to demonstrate the prevalence of falsified medicines. One paper explored the affordability of available technologies within each income group (53).

The papers that considered economic impact used the existing established economic modelling tools for high-income countries but not to LMICs, citing that the significant difference in income levels, regulatory frameworks and medicine supply within a healthcare structure amongst other metrics rendered these models obsolete. This difference in

economic modelling and reporting has created an issue with comparison of data on a global scale.

Income group	GNI per capita threshold	Countries	
		July 2016	July 2022
Low income	<= $1,135	31	26
Lower middle income	$1,136 - $4,465	53	54
Upper middle income	$4,466 - $13,845	54	54
High income	> $13,845	78	83
Total		216	217

*Table 2.3: **World bank income level classification.** The number of countries within each banding as at July 2016 and July 2022 are shown within this table. The addition to the total number of countries is a result of Nauru becoming a member of the World Bank in 2016.*

LMIC have an abundance of prevalence data documented against very little economic data and conversely high-income countries have ample economic data against limited data on prevalence. The WHO and other organizations, including national governments, publish a multitude of data on health system spending including a breakdown of medicines prescribed by therapeutic area. There is a lack of published data on patients' out of pocket and/or private healthcare spending, where these are available, they are self-reported data from households for surveys or national censuses (45).

A study by researchers at the London School of Hygiene and Tropical Medicine on the effectiveness of substandard and falsified antimalarials found that the total annual economic impact (base case) due to additional treatment-seeking and further care was estimated at

between $12.1 - 44.7 million (45). It is of course not just patients and healthcare systems (private or universal) who can be economically impacted by falsified medicines, the products' manufacturers also stand to lose either through lost revenue because the legitimate product is not being purchased, the legitimate product is not reaching its intended destination or loss of confidence in their quality-assurance procedures result in fewer healthcare environments purchasing them.

The loss in public confidence in healthcare systems can also place cost-effective health programmes at risk of becoming ineffective, this is seen with vaccination programmes where a lack of confidence in the quality of the vaccine or its efficacy can see patients not taking up the vaccine resulting in increased financial pressures to the healthcare system (universal, private or insurance-based) from additional screening and treatment measures at a later point in time for the wider population. A recent example of this was the Falsified COVID-19 Vaccine AstraZeneca (ChAdOx1-S [recombinant]) identified in Iran and reported to WHO in October 2021(54). In this case the legitimately produced packaging was obtained once empty (used) by falsifiers and refilled for circulation outside of the legitimate supply chain. In this case the method of detection was through visual inspection of the vials and lack of efficacy resulting in diminished public confidence in the efficacy of the AstraZeneca vaccine and uptake of the vaccination programme.

It is still difficult to quantify direct and indirect socioeconomic costs of falsified medicines as quantification would require metrics and data such as gross national income, life expectancy, literacy, levels of employment and social mobility. Additional expenses could arise from the necessity of further medical treatment in such cases. The repercussions of such situations might not only affect individuals and their families but also extend to businesses and the

broader economy if they result in additional work absences. Consequently, this could potentially trap patients in a cycle of declining health and financial hardship (55).

2.4 What are the surveillance and monitoring systems in place?

The Medicines Quality Database (MQDB) is a public database maintained by the United States Pharmacopeia of the medicines samples in the legitimate nation supply chains in Africa, Asia and Latin America where the US funded programme operates (56). In the majority of cases, the samples obtained and tested were acquired through non-probability methods, this is commonly referred to as convenience sampling (57). The rationale given for this strategy is that the allocated resources for testing are targeted at areas where falsified medicines being detected is thought to be greater. This could be as a result of previous evidence or with increased volumes in a given environment (e.g., a warehouse) the statistical probability of finding a falsified batch of medicines will be greater. Conversely, the random sampling technique is documented as providing reliable prevalence data as it is a probability sampling technique employing confidence intervals. The downside of this technique and the reasons for why studies rarely use it, is that it is accompanied by increased testing of large sample sizes making it unviable financially for many economies alongside impractical for researchers (57).

Many of the papers reviewed captured the analytical techniques used for testing of the samples. This included high-performance liquid chromatography (HPLC), spectroscopy, spectronomy, mass spectrometry, chemical testing and Minilab™. In some papers the analytical techniques were classified under the general terminology of 'laboratory methods' making it difficult to understand the appropriateness and reliability of the technique employed. The other variable between the different analytical techniques is the percentage

of active pharmaceutical ingredients (API) considered to be 'in specification'. Some studies considered an API under 95% as substandard, whilst others utilised the national or regional pharmacopeia acceptance levels which ranges from 85%-115% API concentration as acceptable (36). The vast majority of affordable and instant screening technologies provided a pass or fail analysis, the Minilab™ is an example of this type of portable assay testing for 85 APIs (58). The test is able to demonstrate the presence of API but not the percentage presence and therefore whether it meets the requirements of the pharmacopeia followed within that territory. The data from the supplier demonstrates that over a 1000 of these devices have been supplied to 100 countries, of which Tanzania, Uganda and Myanmar actively use the technology/device to check the quality of the antimalarials to be supplied to patients (59). Some authors have discussed the different types of technologies and have attempted to place them into an affordability criterion of low, medium and high cost alongside whether they are portable with and without the need for electricity or lab base. In total there are approximately 42 technologies that are available globally, with 17 of these being usable in the field given they are portable and/or require basic laboratory-based testing (53). The most simple technology that has the lowest cost of all is that of a visual inspection. The WHO has created a four-page checklist to aid the visual inspection of medicines by predominately pharmacists and other healthcare professionals (60). The only costs associated with this is that of training and accessing the checklist either digitally or in a hardcopy.

Taking the position to establish a systematic epidemiological view, the WHO established the Global Surveillance and Monitoring System for substandard and falsified medical products (GSMS) in 2013. The GSMS provides a method for capturing global data on incidence of substandard and falsified medical products, their therapeutic categories and geographical

location of detection. The system itself is useful for not only capturing this data but also for further analysis to establish trends and weaknesses on a global scale as well as at national levels. Where an issue is detected the GSMS has the capability to provide alerts to all system users of particular affected medical products and batches. This is useful in ensuring that those working at different points in the supply chain are aware and more vigilant in identify particular products that may affected and thus intercepting them before they reach healthcare institutions for onward use by patients. GSMS data from 2013-2017 shows that 42% of reports originated from African regions, followed by 21% in European regions, 21% in the Americas, 8% Western Pacific region, 6% Eastern Mediterranean and 2% in South-East Asia. The reported products to the database consists of 19.6% malaria medicines, 16.9% antibiotics and 8.5% jointly for anaesthetics and painkillers and lifestyle products and 6.8% cancer medicines (49). This then makes this system the first technology to tackle falsified and substandard medical products on a global scale.

The national solution to the GSMS are pharmacovigilance systems, where healthcare professionals namely pharmacists, manufacturers and suppliers can report side effects they are made aware of alongside direct reporting by patients who experience these. This type of reporting allows for not only a safety analysis of the medicine or medical product to be analysed but also builds a picture of problems that may be manifesting with a particular batch of a medicine. In the UK the pharmacovigilance system is maintained by the MHRA and is called the Yellow Card scheme (61). There is also a pharmacovigilance database that 110 countries feed into under the WHO collaboration centre based in Sweden.

The WHO estimates within their own reports that two thirds of the worlds' countries do not have an adequate pharmacovigilance system resulting in inaccurate, incomplete and

impeded reporting (49). Almuzaini et al conducted a review of all MHRA drug alerts between 2001 and 2011 to identify the prevalence of substandard and falsified medicines detected within the UK supply chain. Their review found a total of 291 defective medicine recalls, of which 11 were due to falsified medicines and 280 cases of substandard medicines. The affected products were Seretide 250 (Salmeterol 25mcg/fluticasone propionate 250mcg) inhaler indicated for the treatment of asthma (reduced patient dose) in 2009, Sensodyne original and mint toothpaste (contained diethylene glycol) in 2007, Plavix (clopidogrel) 75mg tablets indicated for prevention of atherothrombotic events in a variety of conditions on two separate occasions in 2007 along with seven other medicines in 2004 – 2007 (62).

The collaboration of medicines regulators takes place on an annual basis as part of Operation Pangea, which is coordinated by Interpol. The aim of this cooperation is to collectively target and shut down the illegal sale of medicines and medical devices from the internet. Operation Pangea XIV took place in 2021 resulting in seizures of illicit medical products with an estimated value of around $23,414,483. In addition, 113,020 websites were removed, the highest number since its inception in 2008 (63). Interpol also coordinate a number of other actions that are regional operations. These are: Action against tramadol trafficking in Africa since 2020; Operations Afya and Heera targeting criminal groups manufacturing and distributing illicit medicines in South and West Africa respectively; Operation Qanoon targeting illicit activities in the Middle east and North Africa since 2015; and most recently Operation Vigilant Interdiction (OVI) and Operation Flash the former targeting emerging threat of COVID-19 related crime globally and latter target counterfeit and illicit vaccines, medicines and medical devices and their use across Africa (63).

To evaluate the effectiveness of each National Regulatory Authority (NRA), WHO introduced the Global Benchmarking Tool (GBT) in its original form in 1997 for vaccines programme evaluation, with further updates in 2014 to include medicines and blood products as a means to address these common challenges transparently on a global scale. The GBT encompasses eight primary regulators (Table 2.4) operating within the broader framework of the national regulatory system (NRS) to evaluate the fundamental functions of NRAs. This approach contributes to the establishment of a unified system for ensuring the quality of medicines intended for both national and international markets (64). The GBT also integrates the notion of 'maturity level'. This inclusion enables both the WHO and regulatory authorities to gauge the overall 'maturity' of the regulatory system across a spectrum ranging from one (indicating the presence of certain regulatory elements) to four (indicating advanced performance and ongoing enhancement). Out of the 194 member states across the globe, only 26% are classified as possessing mature regulatory agencies, which means they fall into the highest or second-highest maturity level category. In contrast, 74% of these states have regulatory systems that are less than optimal, with 23% falling into the second-lowest level of maturity, and 51% being categorized as having the lowest level of maturity (65, 66).

With developments in digital technology and the wider availability of camera phones and smart devices more widely, including within LMICs, tools that utilise these more widely have been put in place since 2017. The pilot project by the Tanzania Food and Drugs Authority (TFDA) is the first example of the use of smartphone-based application designed for use by healthcare professionals to actively report substandard and falsified medical products to the TFDA. The response time by the TFDA was set to be within 48 hours for all reported suspicions to assert the importance of reporting and investigations and build trust with the healthcare professions included within the pilot programme. During the 6-month pilot programme

across 59 healthcare facilities (distributed between urban/rural, public/private and hospital/primary care facility) and 180 healthcare professions trained to use the smartphone app, 20 reports of 12 products were submitted (nine medicines and three medical devices).

Regulatory function	**Purpose of the function**
Registration and Marketing Authorization (MA)	The product licensing authorization that approves medicine after reviewing and assessing the safety, efficacy and quality.
Vigilance (VL)	The activities and science relating to detecting and preventing the adverse effects or any other medical product-related problems.
Market Surveillance and Control (MC)	NRAs monitor market and supply chains and advertising activities to prevent and discover low quality medications.
Licensing Establishments (LI)	Establishes the product license by verifying manufacturing, distribution and wholesale activities.
Regulatory Inspection (RI)	To follow the approved standards and guidelines, regular inspections are carried out to ensure operations follow the national medical products legislation and regulations.
Laboratory Testing (LT)	To assess the quality of medical products by performing quality tests when needed.
Clinical Trials Oversight (CT)	This aims to secure the wellbeing and privileges of people taking part in clinical preliminaries. This guarantees that trials meet the scientifically stable targets and misrepresentation of information.
NRA Lot Release (LR)	Regulatory function of releasing batch number.

Table 2.4: ***Summary of the eight core regulatory functions for medicines and their purpose as defined by the WHO*** *((25, 64, 67)*

Of these, one was found to be falsified, four were substandard, two were unregistered, three were genuine, and two could not be determined (68). After the success of this pilot the programme was also tested in Indonesia. This type of technology is reported to be an effective method of detection and response but not for prevention. To expand on the use and availability of mobile phone technology and encourage the prevention strategy for

emergence of falsified medicines, track and trace methodologies have become increasing popular within supply chains on a global scale.

A simplified version of this for authentication of medicines is the application of a scratch-off authentication device by the manufacturer, which when scratched reveals a unique code and telephone number for the user to send a text message, with an instant response of valid or invalid code reply to show if the product is genuine. This technology, offered by a number of different technology suppliers has been in existence since 2006 and widely used within LICs such as Nigeria and within LMIC such as Turkey since 2010 and then India in 2012. The later versions of the mobile app have additional functionality, such as features to enable attachment of a photograph (69) to support further enquiries in one step rather than requiring a patient or a healthcare professional to provide further details after the authentication event. This scratching mechanism is often done by the patients themselves to confirm the authenticity of the medicines they have been supplied but can be done by healthcare professionals in the presence of the patient. This methodology is set up in this way to build patient/public trust in the legitimate supply chain and is now in place within a number of African countries more widely (70).

In a similar thread, the EU FMD has been developed to address many of the shortfalls witnessed globally, these are: strengthening the visual inspection by the presence of a tamper proof seal and a method of authenticating the medicine using the unique identifier. Both of which are described in more detail within chapter 1 and the proceeding chapters. FMD does go further than other track and trace technologies by attempting to strengthen a number of other places within the supply chain whilst developing cooperation across EU

member states. The four key areas have been presented since 2011 with a phased implementation and include:

i. supply chain and good distribution practice
ii. active substances and excipients (from July 2013)
iii. internet sales (entered law July 2014 and in place before July 2015) (Figure 2.3)
iv. safety features of medicines (from February 2019)

In respect of digital systems using 2D barcode verification, EU FMD is not unique and a number of countries from various regions have implemented such systems within their supply chain. Examples of these include New Zealand in 2011 and Turkey which achieved full implementation of a mobile app-based verification system in 2012. Other countries utilising and finalising implementation of an 2D barcode-based verification systems are: Indian (2015), China (2016), Brazil and Canada (2017), Pakistan (2019), USA (2023)(69). In the USA the use of Radio Frequency Identification (RFID) is recommended by the FDA. The RFID tags are incorporated into the medicinal product's packaging, as a thin label or integrated circuit, which is detectable using an RFID reader. This type of technology is often single use microchips and more expensive to include than other methods (69). It is still however, utilised for temperature sensitive products owing to the ability to be programmed with heat detecting mechanism and ability to record temperatures at pre-set intervals thereby ensuring the integrity of the products' storage conditions throughout its shelf life.



Figure 2.3: ***The EU common/obligatory logo*** *(left)* ***and voluntary internet pharmacy logo scheme*** *(right)*

2.5 Discussion and conclusions

In this chapter, I have approached the literature by two methods, an initial literature review and a narrative systematic review. Each of these approaches was selected at various points within this DPhil to understand the bigger picture and wider impact that falsified medicines have on populations, encompassing health outcomes and systems, economic considerations alongside the global political landscape and technological advancements for detection. The two-pronged approach was taken as a result of the impact of the COVID-19 pandemic on planned fieldwork, this is described in detail within chapter 3.

2.5.1 Health impact of falsified medicines

What has been demonstrated in this chapter is that the literature on the impact of falsified and substandard medicines, specifically with a view in capturing and quantifying the scale of the problem is scarce and outdated. What we have are a series of case study examples presenting incidents where such a breach in the health systems have occurred and the subsequent detection methodology employed to do so. The vast majority of incidents with significant health impacts are documented as occurring in low- and middle- income countries and more specifically in sub-Saharan Africa. The examples provided here of Nigeria and the Democratic Republic of Congo alongside other reviewed studies have found this to be a particular problem in low- and middle- income countries or the so-called developing nations. However, this problem can cascade and be presented as a global problem through the transmission or evolution of infections and the impeding drug resistance to these, as a direct result of subtherapeutic doses and incomplete treatment cycles. This is notwithstanding the inappropriate prescribing of such medicines for self-limiting conditions, which is out of the scope of the discussions here. The health systems of these countries are devolved and

removed from our own within high-income countries more broadly and the UK more specifically, the burden and health challenge that this presents in respect of drug resistance for conditions such as malaria and those requiring antimicrobial therapies should not be brushed aside.

2.5.2 Economic impact of falsified medicines

In respect of the economic impact to nations, whilst The World Bank economy classification is a useful benchmarking tool in placing member countries in to one of four categories, researchers often only recognise three opting to group lower-middle and upper-middle income economies together. Given the wide range from the lower ($1,136) to the upper ($13,845) GNI per capita financial threshold for this category it can be difficult to differentiate between what is financially possible and what is a political choice. This is a study limitation in most cases which goes unacknowledged in all of the reviewed papers. It is recognised that those countries in the middle section of the financial spectrum can move between the two categories due to political changes affecting the value of their currency and/or inflation, it does nothing to acknowledge the existing investments and infrastructure that would have been or is already in place within these territories. A transient annual change to a lower category is immaterial where there is existing technological or lab-based infrastructure and policies for verification checks or batch testing to be conducted. What does change however are individuals' ability to access healthcare and medicines from a legitimate supplier as a result of changes in the economy including inflation which often sees an increase in pricing, this being particularly problematic in places that operate on a private or insurance-based healthcare systems.

What is needed, is for this gap to be acknowledge and transparently reported on within studies to provide an accurate picture of capabilities and challenges. As the UK is categorised as a high-income country, and this has not deviated in the last 20 years, the main area of focus can remain comparative measures with other high-income countries against other measures in place within the other three economical categories. This is also true when looking at prevalence studies, where low- and middle-income countries have been studied in more detail but fall short of covering the range of socioeconomic impacts (52).

2.5.3 Technologies and policies involved in prevention, detection, and reporting

Perhaps the most effective current tools are technologies to detect falsified and substandard medicines from the legitimate supply chain. However, as demonstrated, these tools are often financially costly and inefficient and do not provide assurance for every medicinal product throughout its lifetime of manufacture to patient use.

In addition to this, the technology often provides a method for checking that an API is present, and does not provide the details of the quantity present. This is problematic in that substandard medicines cannot be detected and leaves the legitimate supply chain open to falsification where medicine falsifiers are aware of this technology limitation. This is that even a small amount of an API being present may provide a positive test and therefore provide false assurance of the quality of the medicine(s) to be supplied to patients.

In low-income countries, the ease of use and relatively low costs to operate such equipment can still provide some benefits and patient reassurance that steps are being pursued by health and/or government agencies to protect health and the healthcare system more widely. The other issue with this technology is that only those APIs programmed into the

equipment will be detected. In the example of the Minilab™ equipment the device is programmed with 85 APIs, meaning that not all medicines can be tested. This restricts testing to a limited number of medicines, which are often those known to have been previously falsified or the most commonly prescribed medicines; leaving the supply chain exposed to a vast number of other potential medicines as targets. The need is therefore for the development of affordable, high volume, accurate point of care testing within local facilities such as pharmacies.

One other key variable within developing such technology is the difference in the acceptance levels of APIs as demonstrated by pharmacopeias' of different regions. This difference means that one medicine may be acceptable for use in one part of the world but considered to be substandard in another creating a disparity of acceptable standards. Furthermore, this disparity means that global data becomes harder to capture and interrogate. They do provide a means for quantifying the scale of the problem and demonstrating a level of policy to tackle the incidence of falsification more widely. The next stage in the process of reaching harmonisation should therefore be review of pharmacopoeias to achieve a standardised accepted API level for those medicines that are available globally at each strength, whether branded or generic.

Another point of relevance is that whilst tests for APIs can establish a percentage presence or lack of a particular ingredient, they do not routinely test for other ingredients or impurities that may have a negative effect on human health. The impurities may be as a result of contamination during the manufacturing process, improper storage conditions leading to exposure to other harmful ingredients or degradation over time and resulting by-product(s).

The WHO have indicated that in order to identify falsified medicines the emphasis should be on identifying the source of the product and ensuring that the packaging can be readily identified (36). This statement indicates that the WHO believe that falsified medicines in the mainstay are both falsified in both packaging and product. This is primarily misleading as there are sources indicating that medicine's falsifiers are able to penetrate legitimate supply chains by mixing legitimate and non-legitimate packaging with falsified medicines and vice versa. From this example we know that testing technologies need to take account of all of these eventualities and weaknesses in the supply chain.

The cheapest option by far is visual inspection, this is something that all pharmacists and pharmacy technicians conduct as part of their daily work. It is done primarily to ensure that the correct medicine(s) are supplied in the appropriate strength, formulation, quantity and are in date, alongside checking that there are no physical damages that would impair the quality of the medicine to be supplied.

A number of falsified medicines have been detected in the UK supply chain through visual inspection, this is something that I have witnessed first-hand through my work in clinical governance. Often changes in packaging of medicines, either font or colour for example, is sufficient to raise suspicions. I have seen first-hand falsified branded sildenafil, modafinil, carbamazepine and pen needles. This demonstrates the value of human knowledge and familiarity with routine medicines, as any changes are easily detected. This shows that visual inspection alongside other detection methods is a useful tool.

What is striking is that there are no guidelines on what an effective technology to detect falsified medicines should contain. As a minimum each country or region should consider

which medicines are subject to the highest level of falsification and make recommendations from a regulatory perspective as to which technological methods are best suited to detection of these, alongside affordability and use with knowledge of the existing infrastructure in place.

The GSMS is the first global technological attempt to capture the incidence of falsified and substandard medicines, with a view to building a data set to capture occurring trends and provide alert notifications to subscribed countries of issues as they occur in an attempt to prevent the wider spread of falsified and substandard medicines from the point of detection. This data can also be used to identify weaknesses within the supply chain, including pinpoint geographical regions where the incidence is higher in an attempt to formulate an action for each specific location and medicinal product category affected. There are a number of limitations with GSMS, primarily that the data is only as accurate as the data reported. It is therefore reliant on all countries detecting and reporting such cases for transparency, something that is currently lacking when reviewing the WHO report on GSMS (49). What this system demonstrates is that unified action does help to build the picture of what is taking place, which in turn can be helpful in designing a solution to prevent its occurrence.

The biggest obstacle is partnership working on a global scale to encourage use of such pharmacovigilance systems more broadly and transparently. Not all cases are reported by every WHO member globally, resulting in a reduction in the traceability of the falsified medicinal product to the point of origin or insertion into the legitimate supply. Improved trust in the WHO and the intended use of such data is required, with agreements on a no blame culture and liability on specific government or region in order to convince all

governments that the benefits of such a system outweigh the risks and would not adversely impact their political or international landscape.

A number of cancer therapies such as bicalutamide indicated for prostate cancer, trastuzumab (Herceptin) indicated in breast cancer along with 38 other medicines used in the treatment of cancers have been identified in high-income countries since 2007(71). In the case of Herceptin, the legitimate vials were stolen from a hospital in Italy in 2014(72), manipulated and later reintroduced into the supply chain of countries such as Germany and the UK.

The example of falsified Avastin® in the USA's legitimate supply chain demonstrates the complexity of the supply chain and how medicines move between a number of different territories before reaching their final point of use by patients (50, 51). In this case the lack of active ingredient within the medicine, meant that no therapeutic benefit was seen by any of the patients who received these falsified batches and that their cancer continued to progress. The other ingredients contained did not cause any other adverse effects. In this case the original cause of this incident was the FDA removing the medicine from the list of recommended treatments and subsequently insurance schemes not covering the cost of the medicine. This meant that patients and their clinicians sought alternative brands that would be more cost-effective for private purchase, the so called 'out of pocket' expense for patients. The fluctuating pricing between different countries gives rise to a practice called parallel import, where traders import and/or export medicines from one country to another where they can be sold at a higher cost. At the time of the incident this is exactly what had taken place, the falsified stock of Altuzan intended for the UK market was sold at a higher price to the US market where there was an increased demand as a result of the policy change

by the FDA. This supply and demand created by a change in policy, coupled with financial gains resulted in the due diligence checks not being carried out to the point of origin of the supplier or receiver (73).

This case highlights the responsibility that policy makers have when considering changing or restricting access to medicines and what this may mean for patients in obtaining continued therapy, specifically in cases where the medicine has been shown to be effective or where other avenues of therapy have been exhausted. In the UK this has given rise to compassionate treatment schemes for specialist use medicines to assess such patient cases under the universal health scheme to protect patients from seeking medicines from sources they cannot easily verify, reduce out of pocket expenses, and regulate the price of such medicines.

The other point of consideration is the process of parallel imports and reimbursement procedures for pharmacies. In most circumstances the reimbursement price against a prescribed medication to the pharmacy is fixed by the universal healthcare system or insurance company. This means that regardless of the market price, whether higher or lower, the pharmacy will only be reimbursed a fixed amount. This can result in pharmacies paying out of pocket for the supply of some medicines and to balance this and ensure profitability or even to breakeven the pharmacy will seek to purchase the same product for cheaper where possible. This gives rise to the trading of medicines between suppliers in the same and/or different countries to realise this cost saving (as a purchaser) or profit making (as a seller), making it harder to track the origin of the medicinal product and ensure its integrity for its lifetime within the supply chain.

This action can also give rise to the phenomenon of shortages, where medicines are exported to markets where the resale value is higher resulting in shortages in the market they are exited from. This shortage then increases the demand for the medicine and patients then compete to receive the treatment or seek unauthorised outlets to source their medication. A recent example of this shortage is with Ozempic™ (semaglutide) a medicine prescribed for the management of type II diabetes. The off-label prescribing of this medicine for weight loss has resulted in an increase in demand for the medicine, as demand far exceed the supply. In this example the policy regulator has taken measures to ensure that those with type II diabetes are given access to alternative medicines to protect their health (74). What is unclear is the proposed resolution for those patients who are prescribed this for the off-label indication. This is also an area of concern that could see some patients turning to unregulated sources, or not receiving any effective treatment to support their weight loss. I revisit this case in chapter 8, in order to demonstrate the knock-on impact many months after the original event.

The need therefore is not just on health policies that support efficacious prescribing but complete systems that allows access to affordable high-quality care with safeguards to prevent the infiltration of falsified and substandard medicines. The lack of affordable and joined up methods for detection of falsified medicines makes it difficult to accurately quantify the global scale of the problem and therefore the health and financial impact to nations; this is demonstrated in part by the WHO estimates which are from data gathered pre-2017 with no updated figures published after this date and the new cases of falsified medicines detected as recently as during the COVID-19 pandemic. In fact, during the review process there were no studies highlighting the impact or prevalence of proposed COVID-19 treatments subject to falsification as reported by some media outlets during the pandemic.

This shows a lag time between occurrence, detection, reporting, and review of such incidents.

Operation Pangea demonstrates that the unified action between several regulatory authorities is possible and provides an effective method to target criminal organisations to protect public health against the ever-changing digital platform of the internet medicine's sales. The limitation to this activity is that it occurs for a limit period of time each year and is not an ongoing participation. As internet outlets are easy to create, any number of these can be created daily making this an ongoing threat to public health which requires regular review by regulatory authorities. The added complexity is that investigating and regulating online medicines can be difficult as they involve several countries, creating jurisdiction as well as liability issues. For such actions to have impact in the digital age, they should occur more frequently to ensure that as soon as one illicit online site is created it is blocked by the appropriate regulatory authorities in each country and action taken to prosecute those responsible.

One of the main arguments for the lack of unified actions between nations was considered to be the difference in terminology when considering falsified medicines and their occurrence with words such as 'fake', 'counterfeit', 'false' used interchangeably alongside 'falsified' making it difficult to differentiate between those medicines that were deliberately produced to not meet the required specification (by criminal organisations for example) and those that fell short of required standards through non-malicious routes (for example by legitimately registered manufacturers with an unforeseen deviation in the manufacturing process). A method of correction and to ensure that all member states of the WHO recognised the same definitions the World Health Assembly (WHA) in May 2017 adopted the

new definitions for substandard, unregistered/unlicensed and falsified medicines and medical products (36). These definitions for the first time focusing on public-health elements and not intellectual property concerns. This is in regulatory terms a recent development and demonstrates a slow progression in tackling the regulatory and legal challenges of falsified medicines where it has only been in the last six years that WHO member states have agreed to wholly focus on the public health impact of falsified medicines and devolved themselves from intellectual property concerns, which do impact manufacturers, but that ultimately does not cause direct health harm to patient populations. It can be argued that intellectual property is of importance as this protects the manufacturer, their product and ensures a return on their investment. This is a pertinent argument that should not be forgotten as medicine research and development requires significant financial investment over many years. The patent process and protection of the intellectual property for the defined period of time, is a legally supported route that ensures a return on these costs is realised in addition to added funds which can be used for further medicine development or a return to shareholders for the initial investment. The medicine development process is not a nonprofit sector, but one needed to serve the health needs of populations all the same. It is an imperfect system with an idealistic and human centred approach at its core, to find ways to treat illness and improve health.

The advancement of digital technology has seen national regulatory bodies and manufacturers use innovative ways such as smartphone applications to harness an existing and widely available hardware device to support mechanisms for prevention, detection and reporting of falsified medicines. The use of the simplified and fairly inexpensive scratch-off authentication device printed on to the packaging of medicines and medical devices is one such example. Studies have shown that this has helped equip healthcare professionals with

an added layer of assurance alongside visual analysis, whilst building patient confidence in the legitimate supply chain. The limitation with such technologies is the limited global cooperation for their use. As mentioned earlier in this chapter, the import and export of medicines occurs on a wide scale and ensuring that the authentication technology is available within each region that the medicine ultimately reaches the final point of use is paramount to the success of this technology. The technology is also reliant on mobile phone signals being available which may be problematic in some rural areas and countries where mobile phones may still be expensive to obtain and maintain although it is expected that healthcare professionals or healthcare centres would have access to these.

2.5.4 Review limitations

There are a number of limitations with the primary studies included and my own review which are expanded on in more detail within the paragraphs that follow. In summary, a key limitation of the studies reviewed is that primary studies are heterogenous, disparate and sometimes incomplete, flawed and sparse. This has meant that from the outset there has been very few studies to review.

The other limitations that have been identified with the reviewed studies, papers and policy documents, is chiefly the method of categorisation of countries into different groups and various metrics utilised, this was predominately done by economic evaluation, but the metrics involved differed. For example, one study used data from Nigeria, Ghana, Ethiopia, UK, Germany, and France, countries which fall into different world bank economic classifications, have different healthcare systems and financing structures rendering them directly incomparable. Furthermore, each country used different testing facilities for sample analysis, and the results were partially based on random sampling. This variability could lead to varying levels of detection, potentially resulting in the reporting of false negative results. Authors also provided economic impact figures in the absence of detailing how such figures were obtained making it difficult to verify the calculations or the source of the figures provided.

Additionally, the global diversity in definitions of terms like "falsified," "substandard," and "counterfeit" can introduce ambiguity into the findings. Moreover, due to limited primary data availability in some developing countries, the studies in the mainstay relied upon reviews from additional resources, often unverifiable beyond the published paper. Some

countries also inadequately reported the incidence of falsification, further affecting data reliability.

Some papers presented studies based on simulation design to test the operator's compliance in using the verification technology by inserting falsely programmed 2D barcodes into a simulated environment (75). Whilst presenting an interesting concept for testing adherence to policy, they did not in themselves present detail of the verification technology nor conduct further testing in a live environment and their results have therefore not been included herein. Other authors discussed the process of implementation of verification technologies within a secondary care hospital environment utilising an audit toolkit (76). Important in considering the implementation process itself, these studies were also excluded as the findings could not be extrapolate or transferred to other settings or the medicines verification system sufficiently interrogated. Some studies presented alternative solutions tested within the lab, such as UV laser coating on solid formulations with a view of causing the least degradation on polymer film coatings, with a potential individuality marking on each dosage form that could be detectable by uploading a picture of the tablet to a pre-programmed mobile application (72). As this technology was in development phase and only applicable to one type of dosage formulation the study data itself has not been included but has been mentioned to demonstrate the continuous advancements that are in progress within trials.

A number of authors focused on strategies within low-income countries and the illegal/black market or cosmetic products. Whilst acknowledging the economic and health impact of this on the populations discussed, the control of this from legislative perspective requires a number of legislative and law enforcement actors that go beyond the scope of my review,

which is to focus on protecting the legitimate supply chain and consider countries that parallel the UK infrastructure in some way alongside products that fall within the classification of medicine or medical devices.

The limitations with my own review can be considered to be studies missed through the developed search strategy as there may be other terminology used globally, authors publishing such work which can be classified as grey literature reports, opinion pieces or within non-peer reviewed journals. Given the incidence of falsified medicines being higher in mid- and low-income countries on a global scale the language limitation, that being my own native ability of English and Persian, can be considered a key limitation as some studies and data published in the spoken and written language of these countries have not been considered.

All of the factors mentioned above can introduce bias into the results, potentially undermining the research's validity and the strength of the evidence and conclusions provided. Nevertheless, the studies help to develop the narrative on falsified medicines, the magnitude of the issue and underscores how evidence-based strategies can address this global health impacting phenomenon.

2.6 Final thoughts

My review of the global strategies for detection and thus prevention of falsified medicines on a global scale has demonstrated the complexity of the issues involved when discussing the emergence of falsified medicines. Notwithstanding the differences in healthcare infrastructure, governance structures and the national economies as just some factors contributing to the difficulties in establishing a unified global action on prevention and

detection. Whilst action is being taken, this is slow to take form, has inconsistent reporting and adherence to policies, coupled with limited regulatory consequences for those not participating, and, most critically is predominately concerned with detection rather than prevention. In order for the problem of falsified medicines to be tackled, policy makers, regulators and ensuing frameworks need to have an increased focus on actions to prevent the emergence and infiltration of falsified medicines into the legitimate supply chain to supplement the existing detection techniques.

Chapter 3 Methodology

In this chapter, I present the methodology I have adopted and its theoretical underpinnings. This includes discussion of the approach and limitations with the factors that constrained my selection of methods. I have experienced some unanticipated challenges throughout this DPhil (such as the pandemic), which have significantly impacted on planned work. In this chapter, I first describe the design as originally planned, and then the external influences and the resulting changes made over time.

3.1 Brief outline of theoretical approach

Here, I provide a brief outline of the proposed theoretical framework to set the scene for my methods; the full detail is presented in chapter 5. In short, my choice of a national case study of a policy directive, along with a deep dive into the implementation of this policy in two main community pharmacies, applies complexity-based social science theories to study a multi-level phenomenon occurring at a time when the external context was particularly turbulent. I have used case study methodology as explained in the next section.

To begin exploration of this topic, I began by considering one of the key questions in any case study research: 'what is the case?' (77). I have explored two contrasting approaches to case study, based on the work of Robert Yin and Robert Stake. Taking account of the features of the case, I believe the more appropriate approach is that of Stake. This is because the central question guiding my case study was *"what is going on here?"* (i.e., achieving a rich understanding of the particularities of the case) rather than *"what is this a case of?"* (i.e., using a case or sample of cases to produce theoretical generalisations). I expand on this decision below.

I chose to take as my main case the introduction of FMD in the UK, as an example of the introduction of a new policy and associated technology across a country.

The Non-adoption or Abandonment of technology by individuals and difficulties achieving Scale-up, Spread and Sustainability (NASSS) framework developed by Greenhalgh et al is a way of constructing and following a complex case study. NASSS offers seven key domains, as shown in Figure 5.1, through which to explore efforts to develop and implement technology-supported programmes in health and social care (19). Each of the seven domains comprises questions about aspects of the programme that can be classified as either simple, complicated or complex; the framework allows the analysis of the technology solution under consideration and the likelihood that the technology will be adopted, spread and sustained. Sustained adoption is most achievable in situations where all aspects of the case (each domain and, within it, different sub-domains) are classed as 'simple'. Technologies are least likely to be adopted, spread and sustained if multiple sub-domains are 'complex'.

The NASSS framework is, first and foremost, an aide memoire of the different domains that may be relevant to a rich case narrative of technology adoption and routinization. These comprise: the illness or condition, the technology, the value proposition, the individual adopters, the organisation, the wider context and emergence over time. NASSS is not strictly speaking a theory, in that it is designed to accommodate other theories as relevant (for example, psychological theories when explaining individual non-adoption; organisational theories when explaining routinization in organisations). The other contribution of the NASSS framework, and the reason I think it is highly relevant to my chosen case study, is the focus given on complexity. All sub-domains in the framework can be assessed as simple,

complicated or complex, and the interactions and interdependencies within and between domains can be highlighted through the use of narrative as the case study is constructed.

I have used the NASSS framework to guide data collection and organise my data into a rich narrative. I have also drawn on elements of Scott's neo-institutional theory. Scott explained that social institutions do not operate purely by market logic. Rather, they rest on three 'institutional pillars': regulative (laws and contracts), normative (assumptions and expectations, especially in relation to professional codes of practice) and cultural-cognitive (shared mental models and schemas)(78). I have used this theory eclectically to interrogate my interview data and ask, for example, whether a pharmacist is acting in a particular way because they must (e.g., legal requirement), because they think they should (professional expectations) or because they are just doing what they think generally happens (mental model). This approach sits comfortably as the neo-institutional theory is compatible with the NASSS framework since it is designed to analyse individual behaviours and actions in their organisational and social context, thus drawing out complex interactions between different levels of analysis.

In summary, I have utilised the NASSS framework, informed by neo-institutional theory as interpreted by Scott, as a guide to creating a rich, qualitative and quantitative narrative of the introduction, scale-up and sustainability of traceability technology introduced as part of compliance with FMD in the UK. The framework has previously not been used within a pharmacy practice context and in doing so, this study will also provide methodological innovation in the context of pharmacy practice.

3.2 Methodology

3.2.1 A brief introduction to case study method

My chosen methodology is case study. Case study research can be defined in a number of ways, taking Flyvberg's common sense approach (79) from the Merriam-Webster's dictionary (80, 81): a case study is an intensive analysis of an individual unit (considered as a person, organisation, community or other unit of analysis), and focusing on rich description of the case for its own sake rather than for developing theory (though Stake acknowledges that theory development can be a secondary aim). In contrast, Yin's emphasis on case study as a research method emphasises 'the case' as primarily of theoretical interest, specifically for testing particular theories within a real-world context (82).

My focus on producing understanding of FMD in the UK lends itself to what is called an N = 1 case. I have been impressed with Stake's defence of such an approach to produce what he calls 'naturalistic generalization' through thick description and interpretative analysis of a single case (77, 83), an approach which strongly aligns with Flyvberg's definition above. In contrast, what Yin calls 'analytical generalization' or 'theoretical generalization' is achievable with small-N (that is, multiple) samples. In this technique, different aspects of the case are compared across multiple cases that have been theoretically sampled, and insights are drawn by cross-case comparisons (84, 85). Greenhalgh, Russell and colleagues' description of N = 1 case study is as follows: "Case study offers an alternative to linear ways of thinking about rationality in evaluation: a celebration of the particular and the personal narrative, a concern to explore not simply 'what works' but 'how things work' and 'what is going on' ….."(86). This fits with how I have approached the case of FMD in the UK and explains why I chose Stake's approach over Yin's.

Case studies use a range of qualitative methods, including interviews, non-participant observation, document analysis and ethnography, as well as quantitative data to enrich and illustrate the analysis (87). Case studies may be constructed in such a way as to allow for comparisons to be drawn across different examples of the case (82); which in this case is implementation of the FMD directive within different community pharmacy settings within the UK.

Cases can be studied at the micro (individual and interpersonal), meso (organisation), and macro (societal) level – and most especially via the interaction between these levels (88). This multilevel approach aligns with the layers within my chosen method of study. In the overall narrative, my case has sought to capture a rich in-depth description of FMD implementation in a sample of pharmacies, while also placing these organisational-level descriptions in the context of a national policy to implement a technology-supported initiative in community pharmacy practice alongside considering changes to pharmacy professionals' identity and their interactions with patients. In other words, I am seeking to tell an over-arching story of what is happening at a national level (macro level – including prevailing regulatory factors and professional norms and expectations) and then zooming in to include depth and detail about local organisations (meso level – including work routines and local material infrastructures) and individual professional actors (micro level – including attitudes, beliefs and learning styles, and how individual pharmacists interpret and act on prevailing national policies and professional guidance). Describing a case in this way, we can see how the case of FMD lends itself to Stake's description of "the case is a specific, a complex, functioning thing"(89).

Another challenging aspect confronting case study researchers involves determining the parameters of their selected case (90). Succinctly put, this involves a reflexive and progressive approach, ideally engaging in dialogue with the involved actors. Certain cases, such as a school, possess clear material or spatial boundaries, while others, like a neighbourhood, might be defined using more subjective or conventional methods by considering how social actors, both participants and observers, perceive them. Additionally, cases can be theoretically bounded by examining how specific analytical themes can be best represented. Furthermore, methodological boundaries may be established based on practical considerations like resource limitations or access constraints. Regardless of the approach, these boundaries can often be ambiguous, adaptable, subject to dispute, and thus require careful management.

3.2.2 Strengths and limitations of the case study approach

A major strength of the case study approach is to close in on real practice directly as it unfolds (91), capturing a rich narrative with depth and detail (81) and providing detailed analysis in the individual case to understand why interventions succeed or fail (or explain partial success). The real-world context in a multilevel study means that the number of variables and sources of data in the case are very high (indeed, potentially infinite)(82). Whilst for practical reasons not all these variables and data sources can be fully studied, the technique of progressive focusing allows the researcher to first identify factors that are salient to the case and then systematically explore and follow these influences as the case unfolds leaning towards an inductive research strategy.

In this way the researcher moves between theory and data, at each iteration narrowing the breadth of enquiry and focusing efforts on the emerging concepts (92, 93). Stake has

expanded on this view by describing the multiple stages within this concept as “observation of the, then *further enquiry, beginning to focus on the relevant issues, and then seeking to explain”(94)*. This approach is well suited to my study as it requires the researcher to be well acquainted with the complexities of the problem prior to embarking on fieldwork and fixed to a specific study plan. This means that equal value is placed upon theory and data, and the research direction is in part driven by opportunities and emerging themes that push the scope of the research from that first conceived. This means that the researcher is not constrained by a predefined research question, rather this can evolve over time with emergent themes in studies involving complex organisational structures and changes over a period of time.

A downside to taking an emergent approach is the need to revisit literature and expand the scope to include previously excluded avenues. In itself this revisit of literature can be helpful in drawing upon existing work but can add additional time to the project timelines (92). I did not believe this to be a drawback when considering my case at inception, as implementation of this new innovation, coupled with little or no literature of previous such examples would naturally mean reviewing literature for new publications or drawing upon concepts of other historical projects not previously considered to be in scope. In fact, this constant iterative process provided new avenues for exploration as the external pressures such as the COVID-19 pandemic, mentioned later in this chapter and Brexit within chapter 7, resulted in a significant shift to the landscape of conducting research in general and more specifically on the scope of this research.

In case study research, data collation and synthesis can occur in several stages, with the researcher carrying out analysis after each round of data collation and increasing their

understanding of the field and focus for future visits. This relates closely with my own planned activity where given the participant availability, schedule of implementation, resource, and time constraints there was a period of several weeks to months between each interview and site visit. The progressive focusing approach has allowed for tracking of the longitudinal changes in organisational practice, embedding and adaptation of the technology over time (92).

Knowing when to stop data collection can be a challenge, given there is a desire to continue learning and uncover new avenues for exploration, making knowing how much and what data is enough to end data collation a problem (95). This became less of a consideration for me with the discontinuation of FMD after Brexit as there was no system in place to study. I could have explored people's reactions to the reversion to previous organisational routines, but pandemic restrictions precluded further in-person fieldwork at the time, staff fatigue and burnout also removed the option of contacting participants remotely. Many months after the discontinuation of the EU FMD system, the opportunity to contribute to the development of a UK based FMD solution was presented to me. I discuss this in more detail in chapters 7 and 8.

There are some limitations to the case study approach, primarily associated with generalization and transferability from a few case studies within this study to contribute to wider learnings. Flyvbjerg (91) groups these into five key categories, theoretical knowledge is more valuable than the practical, generalization from a single case is not viable, case study is useful for generating hypotheses and other methods for testing and theory building, there is verification bias, and finally, it can be difficult to summarise specific case studies. I summarise Flyvbjerg rebuttal of each of these points in turn.

The first misunderstanding stems from the view point that case studies produce practical knowledge. As an example, in medical courses, we often use practice-based scenarios to support teaching and learning, using our context dependent knowledge to impart comprehension and our own learned experience to develop future clinicians into experts, through this cycle of building a bank of relevant and detailed concrete cases in the field. The argument for operating in this way is that if these clinicians were trained in context-independent knowledge, such as attending lectures with a theoretical only lens, that is to form the basis of textbook style leaning, they would remain at the beginner's level. Therefore, the first misunderstanding can be rewritten as *"Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predicate theories and universals".*

In addressing the second misunderstanding that, generalization from a single case is not viable, it needs to be dependent upon the case and the context in which it is used and applied. Flyvbjerg considers Galileo's conceptual and practical experiment to disprove Aristotle's law of gravity. In this historically famous experiment, there were not an endless number of objects of differing specifications tested in different conditions but of a single event in time, making it a case study. The second misunderstanding can therefore be surmised as 'generalization is possible from a single case and may support the creation or progress of other ideas and methods. The use of an example is often underestimated in such cases while formal generalization is overvalued.

The third misunderstanding is that case studies can generate hypotheses which is the most useful outcome rather than testing hypotheses, but as in the second misunderstanding this originates from use of an individual case which we now know to be false and therefore the

third misunderstanding can be reviewed as follows: ‘case studies are useful in generating and testing hypotheses and other research outputs’.

In the fourth misunderstanding, as case studies provide more leeway for the researcher to be objective this can be incorrectly interpreted as verification bias. What this ignores however is that case study methodology has its own unique rigorous approaches and that even in the single-case study approach multiple data sources are utilised to draw a conclusion, through triangulation for example and seeking further information and context from subjects as the case unfolds. This then means that the fourth misunderstanding can be corrected to: ‘all methods of enquiry contain similar biases, case study methodology may have biases towards falsification than verification’.

It is often difficult to summarise specific cases, is the fifth misunderstanding to address. There is devalue given to case studies *“focus on the little things”* to build the narrative of the case. The case is therefore helpful in providing the detail and the whole context of the subject and the properties that surround it, enriching its existence. So the fifth misunderstanding should become: ‘case studies are valuable as whole narratives without summarisation or generalization’.

Looking at the role of the clinician, in the context of learning and knowledge acquisition, it can be stated that clinicians such as myself have been through a rigorous teaching and learning process over many years of study and examinations, culminating in university final exams followed by foundation year training, more exams to test our competence before the stabiliser wheels are taken off and we are allowed to navigate the clinical decision-making path unsupervised. Now, if text book reading and exams were sufficient on their own then

why go to the trouble of creating placements, practicals and enlisting educators with x-number of years training? In answer to this, Flyvbjerg argues that *"case knowledge is central to human learning"*, that is all experts build up knowledge through practical experience and that context dependent knowledge lends itself to creating the experts (81).

Critics might argue that case studies have limited use and are suited to the preliminary phases of research (96) and not a suitable basis for generalization (97). This is a common criticism of case study research, whereby the studies produce very specific context dependent outcomes, thereby creating an impossibility in the application of these to other scenarios (84). Merriam and Miles (98, 99) debate the labour, time and monetary intensive nature of case research, arguing that perhaps the investment of these resources is either traumatic or not feasible for the researcher. Miles further argues that participants may not be forthcoming in disclosing the reality and instead provide a false account or at best a version of the truth (99). Yin (82) presents the case that researcher freedom creates the risk of presenting a biased view or lack of adherence to or absence of detailed research procedures, all contributing to a lack of rigour.

Taking the strength and limitations of case study as a research method, for many research questions the strengths outweigh the limitations and, the merits in employing a single case study or critical cases are well documented (91). Returning to the perspective of creating experts and taking Flyvbjerg's approach on this, *"The highest levels in the learning process, that is, virtuosity and true expertise, are reached only via a person's own experiences as practitioner of the relevant skills."* (81). It is through becoming immersed in my case that I have allowed for sufficient depth in community pharmacy practice changes to be examined in detail.

3.2.3 Individual interviews

Semi-structured interviews are a particularly useful method of evidence collection when a list of issues are to be explored and freedom is needed to engage deeper into specific points raised (100). This brings the benefit of a topic guide to support the interviewer and creates a more formal structure. There is a risk that the formal interview can make the interviewee uneasy and a more suitable option in such circumstances would be an unstructured interview to create conversation. My choice of this interview technique over other methods such as focus groups or structured interviews was to provide each participant with an opportunity to expand upon their views and ideas without the obligation to censor or adapt their viewpoints for fear of repercussions and/or social influence. This was of particular consideration for elite/expert participants and also if there were to be a mix of varying job roles at different hierarchical structures within the same session. Social influences can alter behaviour to correcting behaviour to what the person believes is expected or correct (accuracy), become accepted within the group of their workplace and profession (affiliation) and/or provide an outward positive approach to the topic (self-concept)(101). Considering this, the participants' motivations in answering a question may be altered, for example, in a way to reflect what is expected of them and their job role, enforcing influence in acceptance or the rejection of an idea or policy. To minimise the possibility of this, individual interviews were conducted.

In the field, impromptu and brief interviews with clinicians and the wider pharmacy team took place with a view to clarify activities, understand the 'how' and 'why' of what is being observed.

3.2.4 Naturalistic interviews of people doing work

"The interview is a conversation-the art of asking questions and listening." write Denzin and Lincoln (102). The interview cannot be viewed simply as a neutral tool but an exchange of information where the interviewer gains an understanding from a specific interactional event from the interviewee. Positivistic research requires objectivity and detachment, but feminist-based interviewing where the openness, emotional engagement and development of a lasting trusting relationship between both parties (102) is more akin with my interviewing approach. Barley and Kunda (103), observe that *"work practices are highly situated"* and depend upon the environment and context in which they occur. The majority of people need to be actively doing the work, in order to then be able to describe and infer what that doing actually is (104, 105). In being situated in the working environment alongside the participants, the process of work and work patterns can become more apparent to the researcher. This also creates an opportunity for conversation to take place (as mentioned above) where the probing researcher can gain an appreciation for the participants concerns and sense making of their work. The real-time conversation, coupled with observation is ideal for studying work practices (103).

3.2.5 Material analysis of technology

Technology comprises of software and hardware, whilst much emphasis is placed on the operability and ease of use of the software interface, the part of the hardware can be overlooked in organisational practice (106). Atkinson and Delamont (102) argue that the physical objects that are used in everyday practice are themselves social actors, where *"practical utility and aesthetic value intersect"*. The documentation of the placement of these

objects within each of the pharmacy locations, their size and attractiveness to use are all a part of this *"ethnoarchaeology"* capture of the past (107).

Fenwick argues that object and human interaction has the capacity for one to affect the activity and the characteristics of the other in a mutual way (108). The physical objects are often missing from produced reports and as reasons for failure of implementation of technologies and processes. The objects are not seen as consequential or are dismissed consciously as tools required for 'the work' and yet they influence clinical practice, sitting within the microdynamics of daily practice. The murky water of this interface is deepened by the meaning and priorities of different clinicians within the multidisciplinary team. This shows that even material objects are interacted with depending upon the clinical speciality, the expertise of the clinician and how they navigate their work environment with different methods.

Within clinical practice, over the decades, there has been a shift to evidence-based medicine/practice. The rationale being the standardisation of practice and procedures to provide the best possible outcome for patients with a uniform approach, such that the outcome for a given patient would be the same regardless of which clinician(s) their treatment was provided. This ideal control of standardisation is a method that is not subject to the uniformity suggested by the protocols that underpin them. When the patterns of practice are analysed, these protocols are shown to not drive efficiency in all settings, have been shown to stifle critical and flexible thinking (108).

I provide details of the material objects captured within ethnographic vignettes in chapter 4. In doing so, I examine and interpret the meaning given to the object, gain understanding of

their use and develop empirical knowledge in this under researched area including the advantages and limitations of the technology and this method.

3.2.6 Thematic analysis of documents

A large portion of my research is centred around the policy approach to implementation of FMD and so it would stand to reason that interrogation of the policies and their development over time are critical to understanding of the background, requirements and limitations of FMD. Bowen defines document analysis as a *"systematic procedure for reviewing or evaluating documents, which can provide context, generate questions …"* and recommends a three-step approach comprising of, a quick overview glance, reading the full text, followed by interpretation (109). This three-step approach provides the basis in forming familiarity with the topic and aiding understanding prior to analysis of the document for specific concepts before drawing conclusions.

Document analysis is considered to be one of the primary methods used within health policy even though very little exists specifically for this genre. In recent times, authors have attempted to bolster the knowledge and guidance for use of this method within health policy research. The method also has the same critique requirements as any other such as reliability, validity, alongside the motives of the author. These are mitigated through triangulation as with other qualitative techniques to bolster research rigour (110). In order to provide a systematic approach, the other technique offered as an enhancement to Bowen's three step approach is the four step READ method: ready your materials (establish parameters for the type and volume of documents), extract data (using a pre-defined thematic coding method), analyse data (e.g. through case study methodology) and distil your

findings (completeness, saturation or time limit reached and findings can be reviewed, grouped and conclusions drawn)(111).

Within the context of FMD there are few policy documents available and so the READ method in my case would not be the best suited. I have however, drawn upon the four-step principle to improve on Bowen's three step process as a way of increasing rigour within my document analysis process. A number of types of documents can be included in this analysis and I provide details of the documents included within my research under the data sources section in the latter part of this chapter. These included documents have been analysed thematically to provide themes for reporting and further inquiry. This simple form of analysis has been used to describe the identified themes or progressed further to establish the existence of a possible relationship between them (112).

3.2.7 Ethical issues in case study research and qualitative interviews

Ethical issues will occur in any case study research, some of the key considerations relate to the research participants, ensuring their safety, wellbeing and crucially providing the right information from the outset to allow for informed decision making and consent to be obtained (113). When thinking about participants it is important to consider the impact that participation will have for the individual, for example does the person fear ramifications for participation in research not sanctioned by their employer or conversely not engaging with research promoted by their employer? There are many more questions that can be asked specifically if vulnerable persons are to be included and their ability to provide informed consent (100). Maintaining confidentiality and anonymity can be an important factor in participation and this can be as simplified as use of pseudonyms or codes but can be more complex and involve not sharing certain details publicly. It can be difficult for a researcher to

establish what comments, opinions or facts obtained would be acceptable for publication to a participant and if in doing so would compromise the relationship with the participant or more severely their wellbeing and safety. In these uncertain cases and with readily identifiable participants, sharing of the transcript can be an important step in confirming the accuracy and also consent to publish the content (114).

I discuss the anticipated and unexpected ethical considerations I encountered in section 3.3.

3.2.8 Survey of clinicians' knowledge of FMD

In order to gather a starting point on wider views at the micro level of practice and to understand wider views of clinicians' knowledge of FMD, short surveys have been used as a medium to capture qualitative and quantitative data. I introduced this form of data capture, in part to ensure sufficient breadth of data capture and ultimately as it became a good way to cross reference my findings from wider fieldwork. This is because of two key factors, the COVID-19 pandemic interrupting fieldwork prematurely and Brexit resulting in the termination of FMD systems within pharmacies. I expand on this further in section 3.3.7.

3.3 Empirical methods

3.3.1 Study design

The study design is a national case study of FMD implementation. Initially, I had planned sub-cases of four individual community pharmacies within that overall case. Delays with obtaining ethical approval and amendments resulted in the loss of a potential site. The three pharmacy sub-cases faced further severe disruption as a result of the COVID-19 pandemic and eventually resulted in the suspension of fieldwork in March 2020 in the two pharmacy sites fieldwork had commenced. It was not possible to start in-person data collation at the third site. When it became clear that the time period of fieldwork suspension would be extended, the third pharmacy site suggested a virtual visit with further meetings to discuss progress with the implementation.

I had initially planned for the case study and component sub-cases to be built through a combination of methods, including:

- qualitative semi-structured interviews with a sample of elite and expert participants,
- quantitative survey of community pharmacy professional's views of practice impact post FMD implementation,
- ethnographic observation in community pharmacies,
- document analysis.

I conducted my field research in three phases: semi-structured interviews with elite and expert participants, national survey, and ethnographic site visits (including material analysis of technologies). The aim of conducting semi-structured interviews as the first phase of data collation was to gain a broader understanding and context from policy and decision makers

in creation, development, and implementation of FMD. In the study design, this appeared to be a logical step in following the hierarchal chain of policymaking and consequent implementation. I expand on each of the phases further in this section.

As I describe below, these planned approaches were modified to comply with pandemic restrictions, other practical constraints, and the implications of Brexit.

3.3.2 Ethics approval and information governance

The ethics application for this study was submitted to the Central University Research Ethics Committee (CUREC) on the 8th February 2019. Following the CUREC procedures the application was submitted under the higher-risk research involving human participants and/or their data (CUREC 2) pathway. This application was reviewed by the CUREC 2 panel and classed as a 'low risk' study. Therefore, a new application was submitted under minimal-risk review (CUREC 1) with updates and amendments on 19th August 2019. Ethics approval was granted on 1st October 2019 from the University of Oxford (Ref: R62266/RE001) and subsequent amendments approved on 7th February 2020 (Ref: R62266/RE002). The full study protocol and ethics approval documents are included in appendices I and II respectively. A separate ethics application had been submitted for the preparatory and sampling work (survey, questionnaire, workflow mapping) carried out in 2017-2018 where ethics approval was deemed not required (confirmed by CUREC on 7th October 2016).

Throughout the study, participants are identified only by a participant ID number or pseudonyms on all study documents and any electronic database, with the exception of the participant consent form, where the participant's full name is added. All documents are stored securely and only accessible by the research team and authorised personnel. The study complies with the Data Protection Act, which requires data to be anonymised as soon

as it is practical to do so. Personal/sensitive data is stored on Oxford University password protected computers for the study duration and for a minimum of three years after the study end date. Other research data (including consent forms) will continue to be stored for at least five years after publication or public release of the work. The researcher and/or supervisors, collaborators, transcribers, and other authorised personnel have or have had access to the research data. Responsible members of the University of Oxford may be given access to data for monitoring and/or audit of the research.

3.3.3 Ethical considerations

Every effort was made at the design and planning stage to consider the impact on participants and prevent any direct or indirect consequence of participating in this research. An example of this is where elite/expert participants were made aware from the outset that whilst every effort will be made to protect their identity it may not be possible to do so by virtue of their position/job title. All interviewed participants were therefore provided with the opportunity to review transcribed interviews for the purpose of ensuring an accurate reflection of their comments. The participant consent form also captures consent to use direct quotes in research outputs.

A potential limitation, specifically prior to engaging in the site visits was managing the tension between, my already embedded and second nature, identity as a pharmacist and that as a researcher. As this is a profession I am familiar with, it is not quite akin to 'going native'(87, 115). I thought that perhaps, and, in practice was a realisation of an inability to detach myself from my professional role as a pharmacist. I found it difficult to not step in, this sometimes as a direct consequence of expectation by the research site for professional support/practice during busy times. Whilst I was comfortable with the duty-bound nature of taking action if I

believed that patient safety was at risk, not possessing independent indemnity insurance (nor being covered by organisational indemnity by the participating pharmacies) significantly limited the activities that I was willing to undertake and also the professional advice that I could impart to other healthcare professionals (HCPs) and patients as a registered pharmacist.

During the course of fieldwork, I encountered some unexpected concerns for my own safety. The majority of my fieldwork was planned as day visits to the study locations using public transport, for site 1 this included a 4 am train to allow for a 9 am arrival. I had not travelled on my own at this time previously and found that during the darker winter months being a lone female at an unattended train station unnerving. I was able to enlist the support of family in waiting with me at the station for future journeys and when this was not possible, I took a taxi to manned stations which added to the journey time. An eight hour round commute in addition to a full working day was also tiring, this combined with late night finishes that sometimes saw me return home at midnight created an unsustainable fieldwork structure. When I disclosed this to my supervisor, she quickly proposed a solution that aligned with the University's Lone Researcher Policy and suggested that I stay locally to the research site. The rural affluent area and the normal budgetary cap for hotels initially meant that the accommodation within budget was located either as a remote cabin in the woods or the red-light district of the town. I really did want to cut down on the commuting and found the prospect of staying in these locations a less desirable exchange. Speaking with my supervisor of my concern, she did not hesitate to approve an increase to the accommodation budget which enabled stays in more central city locations.

One uncomfortable situation that occurred was a participant expressing the desire for becoming acquainted on a more personal level. I politely declined but the encounter initially made me question my presence, professionalism and actions when interacting with participants. On reflection, I subconsciously adapted my behaviour towards this participant for the remainder of the day and on the follow up visit by attempting to be less visible, asking fewer questions and standing on the outskirts of activity zones. Increasing the time period to my next visit was helpful in disconnecting from this experience and the possible embarrassment caused. On consecutive visits interaction with the participant returned to that prior to the mentioned event. This incident was escalated and discussed with my primary supervisor in the context of the University's student and lone researcher policies, and we ensured that at no point would I be in a situation alone with that individual.

I was also acutely aware of opt-in and implied consent during fieldwork. Whilst individual organisations had consented to participation in research, I wanted to ensure that each participant at the research site had the opportunity to actively opt-in. I achieved this by explaining the research, the purpose for my presence and then asking if they wished to speak with me, I supplemented this by providing a printed participant information sheet and consent form. Every person I interacted with provided verbal consent. Some participants did not feel that providing written consent was necessary, when this was the case, I asked for them to keep the participant information sheet for reference, to contact me with any questions or queries or if they changed their mind about participating. I made a note of this in my fieldnotes as an audit trail.

3.3.4 Some reflections on study design

I began the case study with thematic analysis of key policy documents, namely the applicable EU regulations, MHRA impact assessment and the operational model proposed for the UK mobilisation against existing industry practices. The analysis demonstrated and presented an opportunity for identification of changes to pharmacy practice as a starting point for the minimum changes to be expected commencing 9th February 2019. This was followed by survey and semi-structured interviews for more detailed descriptive analysis of the activity underway to assess compliance with the directive and to understand how the different actors within the chain view the impact of the directive on UK pharmacy workforce and the operation of community pharmacy.

Another key methodology in my study design was material examination of the functionality and capabilities of the digital system or systems used by community pharmacies to achieve compliance with FMD. The material properties of technologies (for example, optical scanning of bar codes) both enable and constrain primary work practices (for example, logging new stock when it arrives at the pharmacy) and also secondary work (for example, audit or stock taking)(116). The aim of the material analysis was to contribute to a rich understanding of whether, in a particular local setting, the new working practices were likely to successfully identify falsified medicines and thus improve patient safety.

This methodology was selected so as to generate rich narratives of how the top-down policy of FMD actually played out in a range of front-line settings. The data collection methods are described in more detail in the sections that follow.

3.3.5 Elite and expert interviews

To build a representative picture of the national context, purposive, and snowball sampling was utilised to identify a maximum variety sample of ten from potential stakeholders ranging from professional organisations (e.g., General Pharmaceutical Council (GPhC), Royal Pharmaceutical Society (RPS), Pharmacists' Defence Association (PDA)), government (e.g., NHS Digital, The Medicines and Healthcare products Regulatory Agency (MHRA)) and industry (e.g., National pharmacy chains (Lloyds Pharmacy, Boots), suppliers (AAH, Alliance), Manufacturers (e.g., Actavis, Pfizer)) for recruitment of elite and expert participants. Elite participants in high-ranking regulatory roles such as the UK's Chief Scientific and Pharmaceutical Officers were approached directly for participation.

Participants were asked to attend a minimum of two interviews. The first round of interviews occurred prior to FMD implementation (pre-February 2019) and the second post-FMD implementation or within 12 months of first interview. Where possible, I carried out the interview with the participants in a private meeting room at their workplace or if preferred, at the university. Due to participants working schedules and changing geographical locations some meetings were arranged by telephone or video link. Interviews ranged between 1 to 3 hours and were audio recorded for verbatim transcribing. I used a list of predefined questions to guide the semi-structured interviews but deviated from these where appropriate as the interviews unfolded (Figure 3.1). I anticipated recruiting ten participants, and initially overrecruited but some of these did not materialise in to first interviews due to changing job roles or difficulty in arranging a suitable meeting time. There were also participant

withdrawals after the first interview, so recruitment was left open to increase diversity in experiences with the technology and implementation processes within this cohort.

Size of the problem

1- What do you believe to be the scale of the problem with falsified medicines in the UK or EU?
2- What do you believe has contributed to this?
3- Has there been any notable action against falsified medicines prior to FMD?

The directive

1- What are your thoughts on the traceability capabilities of the proposed solution?
2- Does the decommissioning activity result in tighter governance? In what way?
3- Will FMD impact pharmacy operations and in what way? Prompt: stock, workflow etc.
4- How does FMD compare to similar legislation? E.g., US DSCSA (drug supply chain security act)

Implementation plans

1- What are the organisation's plans?
2- Are there any specified workflows?
3- Are there any testing or dry runs planned?

Challenges

1- Have you encountered any challenges so far? Do you anticipate any challenges?
2- What support do you foresee being required? Organisation/professional body/national/EU

Figure 3.1: ***Sample semi-structured interview questions for first interview with participants.***

3.3.6 Study scoping and professional engagement

I came to be interested in digital system implementation through my professional day to day role as a governance manager for a large international company. As the UK's national governance lead for primary- and secondary- care based hospital and specialist services, I was involved with implementation of prescribing systems from concept to rollout. I was struck by the lack of policy and guidelines for inclusion of such systems in healthcare settings and found that system functionalities varied site by site creating complex issues for the organisations in respect of usability and future proofing developments in this area. I set about creating a functionality requirements framework to assist with working on such projects and ensuring a uniformity in governance features, taking account of the guidance and regulatory parameters in place at the time. It was through this work that I became familiar with FMD and the national project that was in progress at the time. Knowing that at some point pharmacy would be required to implement changes to demonstrate compliance, I set about in exploring what the challenges could be and whether this would translate into a suitable research topic for my DPhil.

To do this I decided that a simple, easy and quick way to capture an initial snapshot was to use my own professional network. I created a preliminary 'straw poll' survey on SurveyMonkey® in 2017 comprising of ten questions and advertised this on the social media platform Facebook through a pharmacist's group that I was a member of, mostly comprising of pharmacists who had graduated/qualified at the same time as me. From 100 members within the group, 56 responded. These results were sufficient to demonstrate a gap in the knowledge base of what FMD was and why and how it would impact pharmacy practice. I used this as a basis to draft my research proposal which has ultimately brought me to

conducting the research discussed in this thesis. Later on, the results obtained from this professional engagement exercise, contributed to the study design overall and more specifically in identifying areas of professionals' concern to develop the national survey discussed below.

3.3.7 Survey on pharmacists' views of FMD on pharmacy practice

To gain an understanding of individual pharmacists' views more broadly and on a national level, I used the findings from the preliminary survey as a guide to drafting questions for this survey. Initially, I had 21 questions, and this was whittled down to 15 by discussion with peers on the usefulness and relative gain of asking the drafted questions. Review of literature indicated that a survey length of 10 minutes and less than 20 minutes would provide the best positioning in improving engagement and thus the response rate (117). For this reason, the survey questions were reduced after discussion with my supervisors and a mixture of free text and multiple-choice response options were created giving a total of 12 questions for participants to answer. The survey was tested by colleagues, and all were able to complete the survey in under 10 minutes. In the next stage, the survey was advertised via the social media platforms LinkedIn, Twitter and professional online networks in December 2019. To support this activity, two final year pharmacy students were recruited to help in identifying professional network groups. The survey was closed to responses in July 2020, one month after promoting the survey ended.

The recruitment goal was 100 participants, and 87 completed surveys were achieved. With the survey being made available to a larger proportion of pharmacists through a large number of advertisements on social media platforms and professional journals, a larger response rate was anticipated but not achieved, perhaps because there was a feeling that

FMD would not impact pharmacy practice or that there were more pressing work demands and so completion of a survey was considered low priority and even survey fatigue is a possible reason given the number of surveys that professionals receive both internally from their organisations and externally is increasing as method of opinion seeking and data collation.

3.3.8 Sampling frame for community pharmacy selection

The initial sample size of four community pharmacies was selected to balance depth and breadth as detailed ethnography is needed to elucidate the complexity of organisational practices (77) and afford a broad representation of pharmacy practice across the country. The pharmacy sites were chosen to provide maximum variation in the operational and implementation practices, working structures, geography, and patient demographic.

The first recruited pharmacy was identified through conversation and collaboration with NHS Digital. This pharmacy is the NHS Digital exemplar site for FMD in primary care and is a testbed for digital innovation within the pharmacy sector. The independent pharmacy is set in an affluent and rural part of Yorkshire with a predominantly elderly population and NHS workstream. The FMD system is fully integrated within the pharmacy dispensing system.

The second recruited pharmacy was identified through my own professional network. This pharmacy is set in the heart of London and has a diverse international clientele with arguably the most affluent patients. The vast majority of services are private, with only a small percentage of NHS patients. Although linked with a larger parent company, the pharmacy has independence on governance but utilises the same IT infrastructure as the parent

company. The FMD system here, is a standalone device designed to accommodate use of the device for other purposes.

The third recruited pharmacy is a large independent pharmacy set over several floors within a purpose-built standalone building. The pharmacy has robotic dispensing. There is not an FMD system implemented as none of the available solutions interface with the existing robot.

The fourth planned pharmacy site was to be a pharmacy in the West Midlands linked with one of the largest pharmacy chains in the UK. The proposed FMD system was to be a standalone solution. Given the delays with obtaining ethics approval this site implemented FMD and were then no longer interested in participating in the study.

In reality, this is the part of the project most affected by the COVID-19 pandemic initially, resulting in a reworking and extension of timelines for fieldwork. This was further disrupted as a consequence of Brexit, when it was announced that the UK FMD system would be switched off on the 31st December 2020(118). It was originally communicated by the MHRA that a no-deal Brexit would lead to discontinuation of FMD in the UK, but all signals indicated that a deal would be made and some version of FMD could stay, except for Northern Ireland where FMD would continue to be operational in the current form under the EU withdrawal agreement. A debate on the Medicines and Medical Devices Bill in the House of Lords, to introduce delegated powers to allow regulatory frameworks to be updated post Brexit, raised concerns that the proposal for the UK-only scheme included a wider data collection strategy than currently in place (118). The MHRA is currently tasked with creating a UK FMD system post-Brexit but as yet there are no dates on when this may be. This is discussed further in chapter 7.

Both of these external factors resulted in a substantial delay amounting to 12 months, where plans had to be revised and then reworked to complete fieldwork. It became impossible to recruit a new fourth site. Revised timelines for completing data collation at the three recruited sites also became redundant.

To supplement and fill the gap in my data created by COVID-19 pandemic and Brexit, I made plans to amend my research design to include one remote interview with a lead person from each pharmacy to understand the implications of switching off the systems that have taken years to plan and implement and in one of the pharmacy cases, the benefits and disadvantages of abandonment and/or non-adoption. This however was not possible for a number of reasons, the first being that in one of the pharmacies the research champion had reached retirement age and moved abroad, the remaining team members although supportive were not able to commit time citing fatigue and stretched working hours. The second pharmacy faced the same work pressures and had shifted their focus in implementing an electronic record system and linking their pharmacy system with that of the local General Practice. The third pharmacy, that had not implemented FMD, the catch up was done by WhatsApp and was very brief as overall it was felt that the very little time and expense invested and waiting for the right solution was an effective decision and there were no other points to discuss. In sum, the unprecedented pressure of the pandemic made it unethical to continue to try to obtain data from professionals who were working flat out on the pandemic response and later the subsequent recovery of services to pre-pandemic arrangements.

3.3.9 Ethnographic observation in community pharmacies

The participants (pharmacy personnel, managers, procurement leads, IT personnel etc.) at the three research sites were observed during their daily occupation to gain an

understanding of work practices and routines, and identify tacit dimensions of practice. Fieldnotes were used to record observations to enable issues and concerns to be discussed in a naturalistic and open manner.

To further supplement data, ethnographic observation of strategy meetings took place in the preliminary stages of the study. As an example, a national RPS professional guidance meeting on FMD was attended in addition to three corporate strategy meetings for a large UK multiple pharmacy chain.

Ethnographic observations of the 28 participants practicing at the two main research sites took place over seven visits for site 1, nine visits for site 2 and two virtual visits for site 3 (see section 3.3.12). The Hawthorne effect (119, 120) specifically in relation to participation of personnel at the research sites was a factor of consideration prior to starting this fieldwork. I had anticipated the possibility that my presence as an observer or indeed my professional qualification as a pharmacist may result in modification of behaviour; or that I may be recognised professionally from previous roles I have held over the course of my career and given that I practiced primarily within a governance function, it would not be unreasonable for participants to perceive that I may be auditing or reviewing their competency for practice. I addressed this possibility early on through explanation of the research objectives and clarity of conflicting interests should any exist. Over time, I found that this was not an issue, nor familiarity a hinderance in building relationships. It was often helpful for the participants to know my background and that I would understand the terminology they were accustomed to using in their day-to-day work.

The COVID-19 pandemic disrupted the data collation process at the research sites and thus comprehensive data was only gathered from sites 1 and 2. The third research site visits scheduled to commence in March 2020 did not take place due to UK wide lockdown measures and was instead done virtually as two visits. A fourth planned research site also never materialised to full recruitment and further recruitment could not take place due to the challenges faced by the primary care sector in continuity of services during the pandemic and became redundant after Brexit for the reasons explained above.

As part of the ethnography, I carried out interviews of professionals within community pharmacy. This included pharmacy teams, including managers, healthcare assistants, technician and pharmacists who were observed and interviewed (audio recording) as they conducted their daily tasks, for clarification. This took the form of naturalistic, non-structured and sporadic interviews and each interaction lasted no more than a few minutes. These impromptu and brief interviews were utilised as a means of informal enquiry into the daily tasks as they unfolded. These were recorded where possible and transcribed verbatim for content and narrative analysis (121, 122). Accompanying photographs and video recording of activity have been taken to supplement the details of the activity and as part of the case presentation.

3.3.10 Dispensing and timing data

The time taken for items on a prescription to be prepared by the pharmacy team is captured automatically by the dispensing systems in place or manually by staff. This is quantitative data that creates one of the data sources that pharmacy teams' performance is measured from on a commercial perspective. This timing data is used to understand how long pharmacy teams take to prepare a prescription for a patient and there are often pre-set time targets.

The time target varies between each corporate entity and sector of practice, with each employing varying methodology to calculate this, in one leading UK multiple the waiting time regardless of the number of items on a prescription is eight minutes, in other community pharmacy multiples it is calculated as five minutes per item. In the secondary care outpatient environment, the waiting time is set between 15-30 minutes as an acknowledgement of the increased number of pathology and clinical checks required prior to dispensing a prescription.

This data as well as being a measure of the team's performance can provide valuable insight into busy periods, support rota scheduling and highlight training needs. In the case of FMD, these work timings could provide data on whether the addition of the verification and decommissioning under FMD increased or decreased the time to process the prescription and therefore aid the demonstration of workflow impact, if any, as a result of FMD system implementation.

I had planned for this data to be extracted from the dispensing and FMD systems or paper logs (where used). Three points made this task unviable. The first was the unavailability of data prior to FMD implementation in one site as timing data was only available for the preceding three months and then archived. Accessing the archived data required specific permissions and requests from the software provider. The second being that for the standalone FMD system, the timing for preparing the prescription and FMD activity would not be recorded on the dispensing system and would require reconciliation of paper logs against the electronic database. This would be resource intensive and additional time was not planned in the fieldwork duration to account for this activity. Thirdly, the abrupt termination of fieldwork due to the pandemic, resulted in the partial download of this

information creating an incomplete data set that could not retrospectively be captured given that the FMD systems had been switched off. I provide further details on this and indicate timings from the available data captured in chapter 8.

3.3.11 Documentary sources

	Pre-pandemic activities	In-pandemic progress	Total
Time period of data collection	July 2018 (scoping) – February 2020	March 2020 – March 2021	32 months
National context	• Longitudinal qualitative (semi-structured) interviews • 9 policymakers/elite/expert participants - first interview • 7 policymakers/elite/expert participants - second interview (12-24 months after first interview)	3 participants declined second interview	24 months 15 hours 20 minutes of audio recordings 16 pages of post interview reflective notes
	National-level policy and implementation documents: • EU Impact assessment, • MHRA Impact assessment, • FMD Medicine Safety Features – Article 23 Flexibilities, • European Commission impact assessment guidelines.	Documents: • Brexit and FMD – government/professional and regulatory body publications	6 major documents + many articles, journals, and opinion pieces
	National Medicines Verification Service community pharmacy monthly registration trend collation	National Medicines Verification Service community pharmacy registration discontinued due to Brexit	12 months
	Observation of national strategy meetings: • 2 NHS Digital strategy/progress meetings • 1 RPS progress meeting	No activity due to Brexit and pandemic	7 hours

	Pre-pandemic activities	In-pandemic progress	Total
Community Pharmacy	Ethnographic observation: • Pharmacy 1 – Rural location, independent pharmacy - 7 visits • Pharmacy 2 – City centre location, flagship multiple pharmacy – 8 visits • Pharmacy 3 – City centre location, independent pharmacy – 0 visits • Pharmacy 4 – City location, multiple pharmacy – 0 visits Staff involved: • 3 Superintendent pharmacists • 6 Pharmacists • 1 Technician • 3 Dispensers • 2 Healthcare Assistants • 2 Foundation year pharmacists	Ethnographic observation: • Pharmacy 1 – Rural location, independent pharmacy – 3 visits cancelled due to pandemic • Pharmacy 2 – City centre location, flagship multiple pharmacy – 1 visit • Pharmacy 3 – City centre location, independent pharmacy – 2 virtual/video visits • Pharmacy 4 – declined continuation in study	162 hours of observations plus fieldnotes
	Staff workload survey planned for final visit	Staff workload survey – not possible as final visits cancelled	
	Semi-structured interviews: • 5 staff in total • Individual interview with other staff not possible due to rota constraints. Spontaneous interviews conducted with 12 staff	Not possible due to pandemic	2 hours
	• Videorecording and photography of FMD process flow and related activities, in addition to specific medicinal packs	Not possible due to pandemic	30 minutes video-recording 78 photographs
	Documents: • FMD Standard Operating Procedures from pharmacy 1 and 2	Further document collation not possible due to suspension of fieldwork during the pandemic	
Individual pharmacists	Survey: • Straw poll survey (2018) • National survey (2020)	Follow-up survey cancelled due to Brexit	Pilot (N=56) Survey (N=66)

3.3.12 Approach to data analysis and synthesis

The data sources listed above have provided a diverse and complementary dataset from which the national case study and the pharmacy sub-cases have been built. I approached data analysis in three sequential stages. In the first stage, my thematic analysis of interview transcripts, ethnographic field notes, and document extracts took place. I began this analysis initially by listening to the audio recordings and noting down points that struck me as interesting on to post-it notes. I put these post-its on to a wall and moved them around into possible groups as I progressed through each interview. Following this, I began to transcribe the interviews. This task often took a number of days per interview, as my typing speed was much slower than conversational speed, and I found myself moving back and forth on the audio recording to clarify the wording and pauses in speech. Given the time impact of this, my supervisor very kindly provided a grant to employ the services of a professional transcriber who transcribed 12 of the interview recordings.

Once the transcriptions were received from the professional transcriber, I would then review the transcript against the recording to ensure accuracy of the transcript and more specifically with the technical terminology. Whilst the university approved transcribers are accustomed to medical research, none had previous experience of pharmacy specific related work, and this created problems in documenting acronyms. So, it was imperative that I reviewed every transcript which were often over fifty pages long given the length of the interviews.

Once I was confident that the transcripts were accurate, I reviewed each line by line, identifying and highlighting segments that I found of interest and surprising about the working practices, the technology, policy, organisational structure and routines and created new categories for segments that did not fit under these overarching concepts. Each category

was assigned a ‘code’ and colour grouping to identify these concepts with ease, drawing upon coding and theme-making in interpretive inquiry in the context of grounded theory (123).

Strauss and Corbin describe the coding process as open, axial and selective coding (100). I used the concept of open coding in the first stage, going through the transcripts, highlighting the sections I wanted to look at for further analysis, identifying what Thomas describes as ‘temporary constructs’ (100). My supervisor and I both coded one interview separately and then discussed our various approaches. This was helpful in identifying what I had potentially overlooked in my role as a pharmacist by accepting that certain procedures are embedded practice. Axial coding was the next step taken, where I looked at the data identified and began to interrogate the comments and ideas to piece together those that could be connected together, in this way the label for each code was developed. An example of my coded interview is shown in Figure 3.2. To help me with this stage of analysis, I used the computer-assisted qualitative data analysis software (CAQDAS), NVivo. The codes are known as ‘nodes’ in NVivo. An example of how data files appear in NVivo is shown in Figure 3.3.

MK: But I think perhaps maybe it's better to start from the very beginning, in terms of what you think actually is the size of the problem, and whether it warranted a directive coming in?

AB: Yeah. Yeah. [um] I'm not sure it, it does, on the basis of the current incidence in this country. But recognise that prevention is often important, and so the prevention issue. And the concern has always been expressed by European governments about particularly organised crime, and particularly in Eastern Europe. So, the kind of risks around that.

MK: Mmm.

AB: So, I can see all of that. But yeah, I think it is probably a - There's an awful lot of [um] extra workload and expense to solve what doesn't appear to be a massively significant problem at this point, so. Yeah.

MK: Yeah.

AB: But, and we'll no doubt come onto it - there are potentially silver linings. So, in other ways, so. Yeah.

[0:01:29]

Figure 3.2: ***Example extract of interview coding***

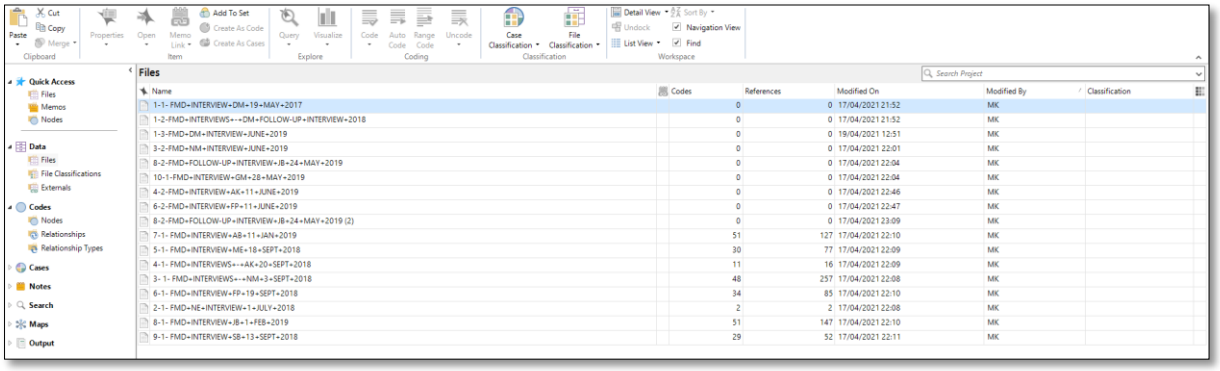


Figure 3.3: ***Example of transcript categorisation in NVivo***

Use of the software simplified the process of keeping track of the multiple codes and merging or grouping codes that I identified as related together (Figure 3.4). I went through all of the interviews identifying the relevant concepts to code them. As I did this, I began to see that I could group certain codes together to create a hierarchical tree, that would then

demonstrate the higher-level concepts for consideration. Initially, I organised and presented these codes using the Denis et al (124) concept of hard core and soft periphery (explained in chapter 5) and then by mapping them to the NASSS domains.

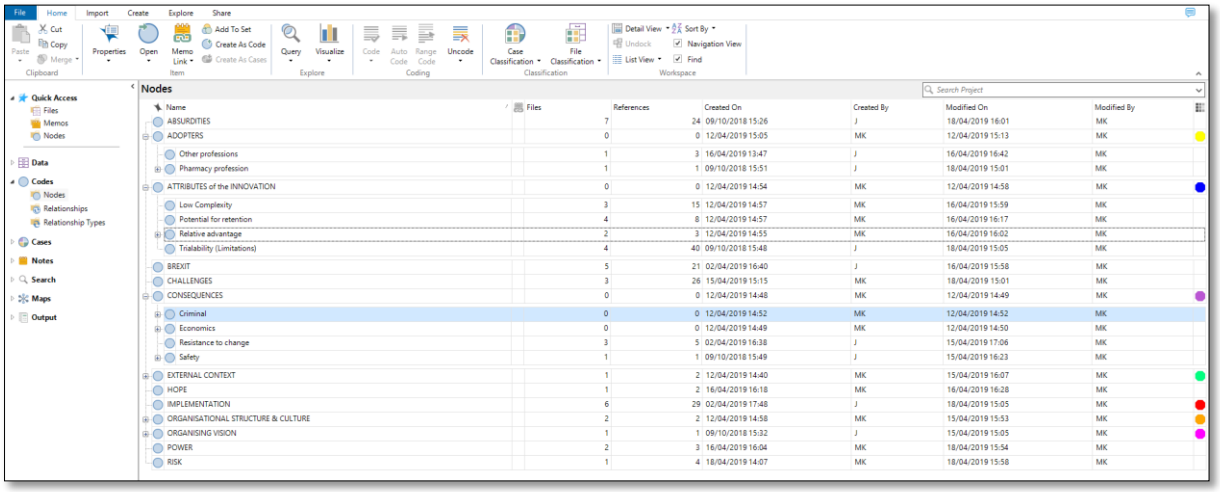


Figure 3.4: ***Overview of nodes in NVivo***

As I coded the interviews, I found that there were overlaps in the concepts and sometimes code labels became redundant, requiring changes to the labelling and their organisation, following an iterative process of reviewing previously coded interviews. To illustrate this, I present the interview extract in Figure 3.2 from a first interview with an elite participant.

The participant is providing their view to the question of, what the scale of the problem is with falsified medicines in the UK. A number of concepts are covered here, relative risk, policy drivers, workload, financial cost. Upon review, I also coded this under 'resistance to change', interpreting the participant highlighting the focus on eastern Europe as a possible irrelevance of the directive to the UK and thus with no perceived issue. This was a theme that I had not considered when I started and became a running thread with those within senior positions and their vision of the level implementation and technological innovation needed to tackle

what they considered a ‘small-scale’ issue. I discuss the findings from the elite and expert participant interviews further in chapter 6.

In the second stage of analysis, I combined different data sources to create individual case studies to inform and feed into the over-arching case study of FMD. This again is achieved via the constant comparative method – that is, using narrative synthesis to construct an early version of the case from a few data items, and then progressively enriching this by adding each additional data item. In this stage, I have developed rich case studies of the individual pharmacies and also of the over-arching case. The results of which are presented in chapters 4,5 and 6.

In the third stage, which partly overlaps with stage two, I have applied the NASSS framework systematically to consider the multiple interacting influences on FMD implementation in each of the pharmacy sites and more widely across the country. Comparing and contrasting the experiences of the individual pharmacy and pharmacy teams, drawing on the differences between them as potentially fruitful areas for further theorisation in chapter 5.

3.4 Conclusion

This empirical phase required adaptation, flexibility, and continuous reworking. In the initial stages, I drew upon my personal contacts for an introduction with senior personnel to secure elite and expert interviews. Later on, when pharmacy site recruitment became difficult the recruited participants were helpful in obtaining possible leads for research sites. The COVID-19 pandemic and Brexit resulted in substantial delays in progression. My methodology, specifically relating to research sites required several iterations with the changing climate.

I believe that whilst I encountered a number of challenges, the adaptations were appropriate for the global and national situation while still allowing me to address my research questions.

Chapter 4 Results 1: Ethnographic vignettes and case reflections

4.1 Introduction

In this chapter, I present ethnographic vignettes and narrative summaries of each of the pharmacy sites and interview participants. These summaries serve as an introduction to readers of the locations and participants in my research, provide thick description and demonstrate the richness of the empirical data gathered (125). All site names and participants are presented here under pseudonyms. Some participant characteristics have been altered to protect the identity of those involved. See Table 4.1, for a summary of each participant. Given the extensive nature of fieldnotes captured, only a selection that provide noteworthy interactions or are a reflection of the status quo have been included. In capturing this narrative, I am presenting the 'case within a case' introduced in chapter 3, this is explored through a theoretical lens in the proceeding results chapters.

Table 4.1: ***Fieldwork participants***

	Participant name	Gender	Ethnicity	Years' practice in field	Job title at time of interview	Number of meetings
Elite and Expert Participants	Ewan	M	White British	12	Head of Operations	3
	Orla	F	White Irish-British	10	Head of Regulatory and Responsible Person/Pharmacist	2
	Nick	M	White British	10	Regulatory Coordinator	1
	Christian	M	Afro-Caribbean	10	Regulatory Quality Assurance Manager/Pharmacy Technician	2
	Omarjeet	M	Indian	20	IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim)	2
	Thomas	M	White British	13	National Commercial and Technology Manager NHS GS1 and PEPPOL Lead	1
	Beth	F	White Irish-British	25	National Healthcare Development Manager/ Nurse	2
	Benjamin	M	White British	24	NHS Services Director	2
	Marco	M	White European	14	Chief Pharmaceutical Scientist	1
	Kristoffer	M	White British	30	International Pharmacy and Policy Manager	2
	Tamsi	F	Indian British	6	Service Delivery Manager	Withdrawn
	Tessa	F	White British	11	Project Manager	Withdrawn

Site 1 – Evergreen Pharmacy	Kate Cooke	F	White British	29	Independent pharmacy co-owner/Pharmacist	7 visits
	Elijah Cooke	M	White British	29	Independent pharmacy co-owner/Superintendent Pharmacist	
	Ibrahim	M	Asian British - Pakistani	1	Preregistration pharmacy student on placement	
	Darcey	F	White British	6	Healthcare assistant	
	Helena	F	White British	9.5	Pharmacist	
	Talah	F	Pakistani British	NK	Pharmacist (locum)	
	Theresa	F	White British	NK	Healthcare assistant	
	Osma	F	Asian British - Pakistani	0	Preregistration pharmacy student on placement	

Site 2 – Goldengate Pharmacy	D'Angelo	M	Italian	NK	Superintendent pharmacist	9 visits
	Tanisha	F	Indian British	NK	Pharmacist	
	Tobias	M	Pakistani British	NK	Pharmacist	
	Tohi	M	Pakistani British	NK	Dispenser	
	Kenneth	M	White British	NK	Healthcare assistant	
	Noah	M	Black British	NK	Pharmacist	
	Henrieta	F	Polish	NK	Technician	
	Tushar	M	Indian British	NK	Dispenser	
	Babak	M	NK	NK	Dispenser	
	Mark*	M	NK	NK	Technician	
Site 3 – Glass ceiling Pharmacy	Gareth	M	White British	NK	Superintendent pharmacist	2 virtual

NK – Not Known

* Not regular team member only present for 10-minute break cover

4.2 The research sites

4.2.1 Research site 1 – Evergreen Pharmacy

> *Elijah is speaking with a medical rep as I enter the pharmacy and join the queue. He notices and nods in my direction. I reach the front and say hello to the healthcare assistant as Elijah tells her, that "She's here to see me, don't worry". This action brings the conversation with the rep to a close. Elijah tells me there is an issue with a tamperproof seal on a medicine pack that happened in the delivery this morning and he is busy trying to find out if it was damaged in transit or possibly tampered with. The supplier won't take back the stock as the MHRA have said batch number is okay. Elijah says it is not FMD compliant and returns the stock to the supplier for recredit. This invites a demonstration of the FMD system so that I can see how it all works. "Everything has a digital footprint (in this pharmacy)."*
>
> [Excerpt from fieldnotes 18th October 2019]

This pharmacy is located in a leafy Yorkshire village. It is a family business run by Elijah and Kate Cooke, a husband-and-wife pharmacist team. Elijah and Kate purchased full ownership of the pharmacy in 2002 from the previous pharmacist upon his retirement. On one of our pub lunch trips, Kate tells me the story of how Elijah had worked in the pharmacy for many years, even during summer breaks from university. He completed his practice a year prior to full registration in this pharmacy and then subsequently continued to work alongside his then tutor until his retirement where he agreed to sell the pharmacy to Elijah and Kate.

The team comprises of Elijah and Kate who also practice as pharmacists, taking it in turns to work so that there is always someone at home to care for their family. There is also one pharmacist who works alongside them. This is either Helena or Talah. Both undertook their training placements in this pharmacy under Elijah and Kate's supervision. Helena works part time as she has a young family and revolves her work pattern around childcare availability. Talah locums and works at a number of other pharmacies in the city. There is also a placement/pre-registration pharmacist Ibrahim and when his placement finishes, Osma will

also join the team. Darcy and Theresa are the healthcare assistants (HCA) and work on a job-share arrangement.

I made several visits to this pharmacy and my seventh visit on the 11th March 2020 would be the final visit. The remaining three visits having to be cancelled due to the COVID-19 pandemic some weeks later. This visit was a little strange, unlike the atmosphere of any other visit I had experienced in my previous visits, the team's anxiety was entirely palpable. Concerns about the COVID-19 virus was growing amongst the healthcare population. With little advice and precautionary measures in place, it remained the responsibility of individuals and employers to decide upon necessary steps. This was evident upon greetings with the team — no hugs, no handshakes but a distant enthusiastic wave to convey the sentiments. The team were putting together safety kits for themselves, comprising of the much sought-after products: alcohol hand gel and paracetamol tablets. One of these kits was for me. "We take care of our own" Kate tells me. I acquire a supply of surgical masks and gloves from a similar kit put aside for me on my visit to Pharmacy 2 during a similar period. It very much felt that the teams had accepted me as part of their work family, reflected in the generosity and inclusion of me in their COVID-19 pandemic planning.

The routine to getting to the rural location is a commute of epic proportions. I normally make my visits as a day trip, primarily to keep project costs low. The beginning of the day for me is the first train at 04:00 after a ten-minute taxi journey from my home. I reach the final destination station and take a taxi to the pharmacy. On the turning into the road where the pharmacy is, there is a bakery on the corner, with hanging baskets hung neatly from the posts on either side of the window and window baskets running along the bottom. Next to this is a news agency with an exceedingly small wooden door. Then driveways to a handful of

houses. Beyond this is my destination. A parade of five shops, creating a break in the procession of long winding driveways. The pharmacy sits in the centre, between two hairdressing salons. There is unmarked bay parking to the front, shared by all of the retail units. Delivery and staff parking is to the rear via a private road.

The pharmacy has a bright façade. There are fainted edges of where lettering previously stood above the doorway but are now so faded it is hard to decipher what it was previously named. The small print underneath this reads “pharmacy” and is visible upon approach to the doorway.

The pharmacy’s large glass windows are covered with medical posters and notices for patients and local charities and events.

Inside, the floor is carpeted and there is a retail space measuring approximately 30m^2. The walls to the left and right have cream shelving. On the left, there is a doorway leading to the consultation room then shelves of vitamin, cold, flu, and related products. On the right, toiletries and cosmetics. In the centre, there are two islands with baby and childcare and other seasonal items such as heat packs and hot water bottles. Directly in front is a light mahogany pharmacy counter. Beyond that are the dispensary and the prescription bags awaiting collection.

There is one workbench that overlooks the front entrance and has the main and only dispensing computer terminal in the dispensary. Next to this there is a fax and copy machine. Above are shelves for ‘fast track’ medicine items and then on the far-left wall are liquids, and powders above the sink. The kettle and mugs sit either side of the sink area. There is one glass fronted fridge under the work counter and a printer. The staff facilities sit in an

outbuilding directly outside and is reached through the white backdoor. In winter, this door can creep open if not locked, letting in cold air. The building is heated with electric heaters built into the skirting around the perimeter of the workspaces.

What I find most intriguing is that the IT and security systems are all very modern and most likely the latest versions available; the other fixtures and fittings are most likely the aged originals. The hardware is very obviously new, with some of the equipment still having the protective plastic attached. On my third visit I ask the pharmacy owners why this is. They are incredibly open about their decision to direct invests in certain areas. They tell me that their investment decisions are based on what will help make their team's work easier and provide a platform for them to provide additional clinical services. There is one additional point which to me seems to outweigh the two primary points, this is, the owner's own interest in integrated technology systems and the clinical and operational benefits that these will provide to pharmacy practice. As the pharmacists in this pharmacy are all teacher practitioners or previous students, it appears that research and indeed testing of new concepts are readily accepted within their practice.

There are obvious parallels that can be drawn between the utilisation of modern or new technology, both hardware and software, within this pharmacy and the wider healthcare landscape, this is that technology automates process that were previously done manually by people. The infusion pump for example has seen the need for a clinician or the patient to administer physical periodic injections removed. This has led to significant financial savings, including clinician time to prescribe and train a patient to self-inject, reduction in the use of disposable single use equipment and dosing errors (126). As the pharmacy owners have 100% control over their business, the restrictions to invest in the digital infrastructure (127)

that appear to be more prominent for larger multiples does not seem to be in place here. In fact, the two joint owners make investment decisions and execute them within their own defined timelines.

The computer systems are all touch screen and pristine white. The team are at ease in interacting with the system, I observe how well they flick between the various screens and navigate the available on-screen options in this way regardless of their age, level of qualification, or number of year's practice. I help put the medicine orders away into the wooden fama drawers (the technical name for the medicines carousels) and soon learn that the system for stocking medicines is different to any other pharmacy I have worked in or process I have devised. Medicines are stocked in alphabetical order including brand names. This means that generic and brand names are mixed on the shelves. It became an initial challenge for me as I try to recall the brand names of products for which I knew the generic, and vice versa. With the team and me, the dispensary soon reaches capacity, and we all engage in a version of what can only be described as a square dance around each other to create space and allow movement. The team all work exceptionally well together, aside from the uniform of those who are healthcare/dispensary assistants, and the certificates of qualification and registration hanging on the wall there is nothing much else that displays a distinct hierarchy. There are momentary pauses when patient queries arise and when it cannot be resolved, the referral to the duty pharmacist shows essentially the chain of seniority within the team. I have not in any of visits, observed anyone requiring to be instructed as to what work to do next, the team know each other so well that they seem to take non-verbal cues in helping each other. I have not observed the team encounter any difficulties in navigating the computer system, this may either be because the system itself

is intuitive, the team have had good training, are used to the system setup or a combination of all of these.

The majority of patients collecting medicines here are elderly, highly educated, and have resided in the area for many years. I speak with retired dermatologists, cardiologists, anaesthetists, headteachers, and professors. All very skilled, knowledgeable individuals, all eager to speak and not just about their condition and treatments. The younger residents have family links with the area. Some have infants and toddlers. Elijah knows them all by their first names. There is no mistaking that this quiet village pharmacy is located in an affluent area. This also reflected in the services that are not commissioned for this area, for example smoking cessation.

The other notable point is that the pharmacy closes for lunch from 12:30 to 14:00 every afternoon. Most of the team go home for lunch, occasionally someone may stay to catchup with work or have their lunch in the consultation room. On the days that I visit, this routine is abandoned, and a special lunch activity is planned. This is something that Elijah had planned for my very first visit and continued for all but one of my visits. A trip to the local pub for lunch. I am moved at how warm and friendly Elijah and Kate are, having not met me previously and knowing very little about me. I find out a lot about each of them, their life history, how they came upon a career in pharmacy. They share mostly happy moments in their lives but occasionally sad ones too.

The community spirit is striking. I am taken with how friendly and personable Elijah is with their patients. He knows the full medical family history alongside other life events of almost everyone that presents into the pharmacy. Elijah enquires about how someone's

grandchildren, the renovation of their home, or an aunt that has moved away is doing, all whilst clinically assessing the electronic prescription on the very glossy touchscreen dispensary monitor. Every now and then interjecting the patient's story of how family members are progressing, to enquire why their insulin had been changed, or that he's going to get a prescribed antibiotic switched as he knows a particular type didn't 'agree' with them last time. The trust that patients have in him is immediately evident. Patients are happy to wait or return while Elijah resolves a problem with their prescription, not one person kicks up a fuss about the pharmacy process taking too much time. Instead, I hear a lot from the patients on the disasters of their local GP practice, from missing prescriptions, to ever changing GPs. "I took the appointment with a doctor I had never heard of and probably won't see again". What becomes evident to me with every passing visit is that this pharmacy is a part of the fabric of the community, a constant in an ever-changing healthcare structure for the pharmacy's mostly elderly and aging population.

4.2.2 Research site 2 – Goldengate Pharmacy

> *I greet D'Angelo. He is very warm and is delighted to see me. Taking off his delicate gold framed reading glasses to greet and shake my hand. Tanisha, recognising me from when I carried out what would be my last clinical service training some 18 months ago, pulls me in to a hug. Very awkwardly, I step into her open arms. This is lovely indeed but unwelcome on my part, I think back to my previous visits and how warm, yet formal greetings were, a world where I initiated the handshakes. In one swift move the balance had shifted, yet it seems and feels as though everyone has very fond memories that means they are comfortable to be so personal after all this time.*
>
> [Excerpt from fieldnotes 14th January 2020]

Goldengate Pharmacy dates back to 1798. The team here is vast. Made of people in different departments and subdepartments. I will focus on the immediate pharmacy team, the 'upstairs team' as they are referred to internally that I will be working with and introduce other participants as the interactions with them occurs. The team is led by D'Angelo, superintendent pharmacist, his deputies are Tanisha and Tobias. There is a second permanent pharmacist, Noah, who works alongside Tobias in the dispensary. Tanisha works part time and comes 'upstairs' for some shifts and to help cover lunch breaks, whilst her main focus is management and activities that take place downstairs. The upstairs and downstairs use of terminology appear to reflect the physical separation of the teams by location and the type of clinical service that is offered. The downstairs team focus on homecare and care-home services, they appear more relaxed. I believe this to be in part due to the absence of physically present patients to distract them and the radio set in the corner that plays mellow music, in stark contrast to the muzak played upstairs.

The team I will be observing includes Henrietta, the lead technician, whom is supported by the lead dispenser, Tohi. Some weeks after my initial visits the recruitment process is completed, and the team gains three new additions: Kenneth as trainee healthcare assistant,

alongside trainee dispensers Tushar and Babak. This becomes the first male dominated pharmacy team that I have worked in during my career.

On my first visit, I use the main 'grander' entrance. The spotless vast glass doors slide smoothly at the pace of a slow-motion video as I approach and are fully open to allow me to step on to the polished Italian marble floor interior. The pharmacy is six meters directly in front of me, with the gold of the metal trim around the open front glistening under the spotlights and suspended designer ceiling lights.

Products are displayed on the white marble tables in front of me. Everything from Himalayan turmeric in Manuka honey capsules to VSL3 supplements. I smile as I draw closer to the pharmacy in response to the team recognising and waving me into the pharmacy. I walk past the queue that has formed and can feel the silent wrath of the people that are in the queue, each shifting in an uncomfortable jerky movement, pursing of the lips, their disapproving glares evident.

D'Angelo introduces the team that are currently present.

As I stand in the back of the dispensary, to my left there is the dispensary sink and above that the products requiring reconstitution. In front of me are the full height glass fridges, one packed full of refrigerated medicines and the other with overstock of non-fridge items which also appears to be switched off. There are three separate monitors on the bench next to this. One is to access patient details from the private hospital housed in the attached building, the other is for the pharmacy dispensing system, and the third is the FMD scanning software. There is also a keyboard, mouse, and a label printer. Next to these items is a three-draw metal filing cabinet. There are a variety of medicines on the shelf across the back wall and

appear to have no correlation. Underneath the workbench there are two metal safes holding controlled drugs. The wall furthest away has special order and frequently requested general sale items, on the worktop there is a long Perspex box encasing categorised prescriptions. Below the worktop, there are brown glass bottles and jars reflecting the chemists of a bygone age, and alongside those are green plastic bottles which have taken their place as a cheaper disposable alternative for packaging, assembly, and decanting.

The front dispensing bench sits behind the traditional pharmacy counter, acting as a physical barrier between the healthcare environment and the hidden factory of pharmacy processes and procedures, separating the dispensary from the commercial activities.

Every member of the team, I note, is smiling. Movement is purposeful and measured, with eye contact maintained at all times when speaking. Conversations with patients is calm and voices of neither party seem to carry beyond those privy to it. Most patient facing team members speak two, three or more languages. Access to someone who can translate does not seem to be very far and I witness consultations in Russian, Arabic, and Italian. The wealth and/or status of the patients seems to be displayed with the accompanying entourage. The pharmacy team are unphased by the status of their patients. This approach is surmised perfectly by D'Angelo, *"They expect us to provide them with the best care possible (pause) because they are paying for it. But at the end of the day, they are people who are ill and need care."*

Having a clarification, error or issue acquiring the medicine(s) seems to have major implications and often the patients call the prescribers' personal mobile numbers to resolve the matter directly. It is common for the pharmacy team to be speaking with the prescriber at the same time as the patient. I observe as one Arabic speaking lady requiring a prescription

for her son is advised of a manufacturing issue with the requested brand. The situation quickly escalates, the lady unhappy that the pharmacy does not have a supply ringfenced for the patients of the world-renowned physician that prescribed it. The pharmacy team are at the same time speaking with the clinic, to understand if an alternative strength or brand can be substituted for off-label use. The duty prescriber at the clinic, does not believe it would be a problem but believes the patients of his colleague are 'particular' and unlikely to accept his decision as it overrules what they have been told on their consultations. The receptionist is equally unhelpful in this scenario, refusing to provide the direct contact number of the prescribing physician. The lady has spoken with their physician, who is I am told on a flight at Heathrow awaiting take-off. She appears more relaxed and hands her mobile to me, instructing me to 'speak'. I look around and everyone in the pharmacy is busy with a task and avoids looking up to meet by gaze. I take the phone and speak with the prescriber, he conveys what he has said to his patient and then ends it with 'I've told her you're the best [pharmacy] in the world, she's in good hands' and then ends the call.

It is obvious that Goldengate pharmacy is prestigious brand built on years of quality service to those with high status and authority. Their patients expect this level of quality and the team endeavour to do this with every interaction. What is poignant however is the significance given to the physical surrounding that is externally visible in comparison to that of where the clinicians carry out the 'hidden work' of pharmacy practice.

4.2.3 Research site 3 – Glass Ceiling Pharmacy

I have never physically visited Glass ceiling Pharmacy, instead I have relied on pictures from search engines and interactive maps to provide a feel for the surrounding area and physical presence within the community. From these images and map location I can see that the pharmacy is set in the main heart of the high street. The physical size of the structure came as a surprise to me. This pharmacy was introduced to me as potential site by one of the existing research participants. They highlighted that the pharmacy owner here was also keen on use of technology and advancing pharmacy research. I had incorrectly assumed that this pharmacy would be of a smaller size than the large chain flagship pharmacies of the multiples given that it is independently and outrightly owned by one pharmacist.

The COVID-19 pandemic prevented any physical visits from taking place. Gareth, the pharmacist owner suggested a virtual call as a starting point. We attempted to do this on Microsoft Teams, but as we spoke, Gareth was not happy that he could not lift the camera to show me what he was describing. This resulted in the meeting taking place on Teams on his tablet device, where Gareth provided a virtual tour of the three levels of the pharmacy, the basement- used as a storage location, the ground floor-housing the main dispensary, five treatment rooms, retail environment, two separate patient waiting areas (one for vaccinations and the other for the pharmacy and other treatments), the viewing gallery and then the first-floor, with the second-dispensary, offices, staff area and the dispensing robot.

The viewing gallery is a glass floor taking what I could see was a substantial area of the ground floor where people could stand and look up at the robot dispensing prescriptions. Gareth describes how the robot is a ‘firm favourite’ with children, and sometimes they have people, both adults, and children, who come to just look at the robot work. I can hear a lot of

background noise and the pharmacy appears to be full with patients waiting to be seen by a variety of healthcare professionals. Gareth greets the staff and patients alike, stopping every now and again to answer a question or straighten a leaflet as he continues the tour with his mobile held high so that I can see what is going on. When we reach the viewing gallery, Gareth sets his mobile on the floor so that the camera pans out to capture the full-scale view of the size of the robot. The robot has three functioning arms, each gliding at pace, backwards and forwards between the glass shelves retrieving medicines for dispensing. We return to the ground-floor dispensary where Gareth shows me the swirling tunnel that the medicines are flowing down as they are released by the robot and then dispatched to one of six terminals. Each terminal I can see is equipped with a computer monitor, keyboard, mouse, and robot dispensing tunnel. The screens are touchscreen capable, but Gareth explains, the team prefer to use the mouse and keyboard and so they are all setup in this way.

Gareth then returns to his first-floor office. We discuss how everything is digitalised in so far as possible. The staff rota, so that the team can view their work patterns and request leave. This system also flags when other people of the same staff grading are away to indicate the safe minimum staff levels to help with managing leave. There is also a section of the programme that allows patients to book an appointment with clinicians.

I ask Gareth about why digitalisation and integration have been so important to him as a clinician and pharmacy owner, his response is one that is quite reasonable in my view: “We do everything once, do it right and make our processes as streamlined as possible”.

I have one further meeting with Gareth, and I can sense his disappointment that we are not able to continue with the research at his pharmacy. He does ask that I keep him updated on

my project and let him know if any other similar projects arise. He is keen to show the value of pharmacy in primary care. I can see how proud he is of what he and his team have achieved in expanding the pharmacy and clinical services.

4.3 Elite and expert participants

4.3.1 Ewan (Head of Operations/Senior industry stakeholder)

> *I set the digital recorder on the table and ask the first question, within a minute Ewan has taken ownership and control of the meeting and is expertly providing his narrative of events dissatisfied that I have skipped ahead to the main topic, "….we need to start from earlier, but if I go back a step. So, I come from a background where batch control etc. was a way of life." The granular detail of Ewan's career unfolds and as I watch and listen, I discover that behind the façade of controlled and humorous leadership there exists a wealth of knowledge of not only management, business, operations and pharmacy but also legislation. The breadth of discussion and Ewan's understanding of FMD I find astounding, his use of metaphors supporting his description of what should happen in the new world: "in your car [it] will all have parts that [are] associated that they'll be able to batch track to 'it was Dan Jones in a shed in Coventry making the windscreen wipers.' So, it's already out there it's just bringing it into an industry that hasn't embraced it before."*
>
> [Excerpt from fieldnotes 19th May 2017]

I first interviewed Ewan in May 2017 at his main workplace, the UK head office of the international company, within one of the corporate meeting rooms. The room is immaculately decorated with frosted glass walls separating it from other meeting rooms. A mahogany oval desk fills the centre of the room alongside, sliding fuchsia upholstered chairs, a large flatscreen TV is mounted on the only solid wall of the room. The windows look out to the front and main entrance of the building, on to the circular driveway and executive shiny black cars parked in the ten visitor spaces.

Ewan enters the room full of enthusiasm and provides a brief of the disasters that are in progress but that his team are on the case. He moves with energy on his seat as he describes the emergency meeting that he had just come from; I wonder if the events that are unfolding will detract attention away from the conversation and given how little has been shared at senior level within the company if any specific details around FMD will be extracted from our meeting today. Ewan has 12 years' work experience in this field and is Head of Operations.

He is a tall well-built man with an obvious physical presence. He is direct, polite, and incredibly jovial even when describing difficult situations. The role Ewan holds is critical to the operations of the organisation, as he leads the team looking after logistical delivery methods across warehouses, pharmacies, hospitals, home delivery and other business locations for all of the UK operations.

The imminent digital shakeup and traceability replicating what is already in existence in other sectors is an exciting prospect for Ewan and there is trust that the technology and the technology developers will ensure it is in place to the specification required. In stark contrast, when I interview Ewan again in June 2018, he is less optimistic about the capability of the technology and is dismayed at the available solutions but he assures me the technology chosen by the business stakeholder group best fits the requirements, allows for the verification and decommissioning activity, and critically is now suitable for other app-based technology projects to be implemented and so it is a win-win situation for the business. This seems to indicate that the desirable technology must do more than meet the pending legislation in order to be useful to the business. I probe further and uncover that it is a standalone solution and there will not be any interfacing with any existing systems. I find this to be an opportunity to seek out why, almost a year later, the minimum requirements for compliance have been selected? Reading in-between the lines, the investment capital seemed too high and disproportionate to the gains. It is the view that compliance is critical because it is often the market leaders that are targeted by the regulatory authorities and there is a need to ensure legal compliance and prevent any reputational or brand damage.

It seems helpful that the business's activities in other EU countries are subject to the same legislation and as such the need for compliance is viewed as a critical and 'must happen'

scenario regardless of any Brexit implications. This has however given rise to what is deemed as the 'cost-effective' scenario with the cheapest option selected. Listening to the decisions, I am not certain that a long-term vision that Ewan had envisaged in 2017 has been applied to the application of technology infrastructure that is to be embedded. The hardware that is being purchased is to be utilised for at least two other existing projects and it is these additional uses that sparks enthusiasm in Ewan. The pharmacies will have the 'tech kits' to access a number of different applications to support their daily practice.

Ewan is the only one of the participants that provides regular updates to me over the three years since my first pilot interview with him as part of scoping and development of my DPhil proposal. I receive MHRA bulletins and proposed blueprints for how the process could work in short emails, often with an 'FYI' caption. All documents that Ewan finds relevant and interesting. He is as invested in this project as I am, if not more so. We meet for a further two formal interviews. In the last of our interviews, he has not lost the energy he had at our first meeting, however, having led on and watched the process unfold he seems frustrated and quite openly provides the names of those "lacking a backbone" and "not taking the opportunity" to build something sustainable with a growth platform. This sentiment is shared by Orla, another of the participants in an informal meeting where she tells me "They've chosen the cheapest thing possible" with focus on compliance with the legislation and no added features or ease of use. Three weeks after our final interview, Ewan is made redundant.

4.3.2 Orla (Head of Regulatory and Responsible Person/Pharmacist)

> *As we begin the interview, I am taken aback with every answer, as to how knowledgeable Orla is. I am learning so much about the regulatory environment history from her that I would happily sit and listen for hours, but Orla does look at me for prompts and apologises if she is covering ground that I am already familiar.*
>
> [Excerpt from fieldnotes 25th July 2018]

Orla works for an international healthcare organisation that currently has two women in key head of department positions. She is a pharmacist by background and is the company's head of regulatory affairs, a position she has held for ten years at this point. I have asked Orla to participate as an expert in the field of medicines regulations given that she holds ultimate accountability for medicines within the organisation's wholesale business.

Orla answers each of my questions skilfully, full of detail from beginning to end, and often stops to enquire if what she is saying is what I would want to know. I like Orla, I appreciate the directness of the answers. There is no deviation into other topics and as such these interviews were much shorter.

4.3.3 Nick (Regulatory Coordinator)

> *I stand from the fuchsia office chair, in the glass walled meeting room named after a prominent vaccinologist to greet Nick as he enters the room. Nick is middle aged, with slightly thinning hair and wears rimless glasses that he pushes up his nose nervously before answering questions. Nick sits across the table, and we are in a traditional interview seating arrangement. Nick has his hands clasped under the desk; I think he may be nervous. I ask about his day and we chat a little about the warehouse activities and projects underway. Nick tells me about the FMD training programme that he has created and how he is going to each of the warehouses around the country to run sessions for the team to raise awareness ahead of the directive change. There is an eLearning programme that will be created to test understanding to show knowledge and compliance.*
>
> [Excerpt from fieldnotes 27th January 2019]

I have only one interview with Nick, who has been a regulatory coordinator for ten years. We spend fifty minutes speaking about Nick's work. It becomes evident to me how passionate Nick is about the work that he does. He spends a lot of time travelling around the country not only conducting audits but providing educational sessions on a variety of topics. Most recently this has included FMD. I find out that his awareness of FMD predates the directive becoming mandated and is something he has worked on for many years. Nick recalls the time he had taken two weeks annual leave only to find that upon his return to the office the carefully curated samples of fake and below standard batch samples of products he had intercepted had been thrown out to make way for an office renovation. Thankfully, Nick says, not all of the skips had been collated and he climbed in, managing to salvage a few of the items after looking through bags upon bags of rubble and other waste. He seems terribly upset when recalling this, his eyebrows crossing in a knot across his forehead. "That was years' of work, gone in a matter of minutes".

I ask him why the items were so important. Nick tells me how this is the only contact we have with the counterfeiters, to understand how they work and what they do. An example of how

they [the counterfeiters] work. He used to take the samples with him for training sessions of warehouse teams so that they can have examples of what to look out for when they handle medicines as part of their quality control training. Now that he has limited samples after the 'clearing out' incident, he takes photographs of the counterfeit products. "I can't have any more of them damaged because they were hard to find".

"The Novofine needles", Nick says, was a rare find. There was something about the colour of the packaging that he did not think was correct. "Normally manufacturers tell us if they're going to change the colour or the graphics on such widely used products…. I didn't think I had seen a notice for this". His enquiry led to the whole batch being isolated and although not publicised there was a mass recall as it was thought more than one batch might have been affected.

It is interesting to me to hear how Nick and the teams he trains are able to visually identify such items, often with just a hunch. Nick thinks this is because the teams see and touch these products every day, so when the gloss or the feel of the pack is different, they notice these minute changes. The feel of the packaging on the skin, the sensory and visual senses testing the products.

There is something that drives Nick. He sees the value in documenting, retaining, and sharing the counterfeit products to raise awareness of how the pharmaceutical supply chain can be compromised.

Nick is not convinced that the scanning solution will be fail proof and believes that there is still a place for human intervention, because it is only a matter of time before 'some clever person' works out how to break into these systems too.

4.3.4 Christian (Regulatory Quality Assurance Manager/Pharmacy Technician)

> *Christian is a slender man, wearing a dark tailored suit with a colourful tie. He is a regulatory quality assurance manager and practiced as a pharmacy technician ten years' prior to taking on his current position. Christian explains that he primarily works within the wholesale side of the business and whilst aware of the impact it may have on other pharmacy sectors, his area of expertise is wholesale. He has been working on the regulations around the directive since 2014 but as he says perhaps not every department that should be involved has been aware of it. "From the regs perspective, we've known about it all these years, and we've been working on it, and we've been telling the business 'This is coming, you need to, you need to start making arrangements for it'."*
>
> [Excerpt from fieldnotes 19th September 2018]

I have two meetings with Christian. Christian is a pleasant person. Our meeting is quite short given that by Christian's own admission that his expertise lay in the wholesale sector whilst most of my research questions related to pharmacy practice. This changed at our follow up interview nine months later. We spent an hour discussing the implications of the black- and white- lists, as well as article 23 providers. This topic is covered in more detail within chapters 1 and 2. The devolved nature of wholesale to pharmacy seems to have changed with the clarifications issued from the EU commission and the MHRA as increased businesses had sought to understand the detail.

4.3.5 Omarjeet (IT – Business Relationship Manager (Operations)/Enterprise Architect (Interim))

> *Omarjeet is very talkative, dressed in a suit trousers and tie. There is no use of technical jargon and when there is, it is accompanied by an explanation of what it means. Perhaps because Omarjeet has experience of others not knowing such terms or is thorough. Whichever it may be, the conversation flows.*
>
> [Excerpt from fieldnotes 3rd September 2018]

Omarjeet is an IT business relationship manager for operations/architect. The operations and architect appear on Omarjeet's email signature and signal what I assume is the breadth of his role. He has twenty years' experience working within an IT function. I have two meetings with Omarjeet.

Omarjeet has a good understanding of the background to FMD and the need for taking action. He is not disillusioned by the scale of the task either and sums up why medicines are a target, "Medicines is an easy target, because people just trust it." This is the first time I hear about trust, which includes the process and practices as a whole and not just the trust in the technology. So far trust has only been applied to a specific element, be it the professionals, the manufactures but more so the technology.

I am struck by how open Omarjeet is about the specification of the 'kit' needed. When I probe, Omarjeet clarifies that he does not get involved in defining the features of the technology, i.e., the additional features. That is the job of the pharmacy experts. His main responsibility is making sure that throughout the selection process there is a check to ensure that any system selected has the capabilities promised, supports any developments, interfaces with the existing technology - basically anything that is 'technical IT'.

4.3.6 Thomas (National Commercial and Technology Manager NHS GS1 and PEPPOL Lead)

> *I am introduced to Thomas via another participant by email. We have arranged a telephone call to speak as Thomas's work involves travel and the unpredictability means that it is impractical to arrange a meeting in advance. The best chance to speak is by phone, at a time when Thomas is travelling between meetings by car. The call is patchy as the signal drops in and out with the moving vehicle. Thomas begins by asking for me to provide details of my research and what it is that I really want to know from him. I give an overview of my research and its aims. Thomas says he will start from the beginning by summing up his assessment "We are heading for a tsunami of problems in February." Thomas stops to check my understanding of some of the terminology and ask if I want to know more detail. There is not a pause in the conversation, and I only interject occasionally to ask a question, to which Thomas's response it always positive, 'ah good question' before delving in to the first set of problems, "…they have to release funds. And that could take six to twelve months, to release funds. They don't understand technology, generally. And technology is a massive part of this."*
>
> [Excerpt from fieldnotes 13th September 2018]

I only have the one interview with Thomas who is an NHS national commercial and technology manager with 13 years' experience in the field. In the thirty-minute telephone call, there are very few pauses, save for the signal droppage and Thomas is able to articulate his thoughts in quick succession. The first meeting is easy to arrange, however, the follow up interview proves problematic with Thomas' work schedule and eventually Thomas suggests that I send on my questions so that he can answer them by email when he has the time. I send the questions and follow up with an email two months later but receive no reply. What I gain from Thomas is an uncensored insight into the existing challenges with implementation within a large complex organisation of varying structures, hierarchy, chains of command, approval processes, and decision makers.

4.3.7 Beth (National Healthcare Development Manager/ Nurse)

> *Beth has a warm welcoming smile. Beth is a nurse by background, and I think this is why she is so personable with a distinct ability to be at ease.*
>
> [Excerpt from fieldnotes 11th June 2019]

Beth has a twenty-five-year career history in healthcare and is currently national healthcare development manager of a healthcare organisation. I have two meetings with Beth. The first is by telephone. There is such poor connection that fifteen minutes into the conversation we both almost give up as there is no conversation flow with each only partially hearing what the other is saying. The second meeting we plan to be in person to avoid a repeat of the first meeting. The meeting is planned nine months after our first call at Beth's workplace Like many of the other participants, Beth touches on the possible implications of Brexit. In addition to this there is focus on the end users, "… wanting to know more on a real high level of, what does it do? [um] What impact will it have on their day-to-day operations? What can we do to support it?". This is the first time a participant has referenced end users. Could this perhaps be a symptom of organisations under pressure to show progress with a directive that had become enforceable five months prior or is it a reflection of Beth's awareness of 'real practice' at ground level?

4.3.8 Benjamin (NHS Services Director)

> *Benjamin places great emphasis on the impact Brexit has had on the implementation of FMD, stating that uncertainty has meant that few people have taken action as there are bigger issues for consideration such as medicine shortages.*
>
> [Excerpt from fieldnotes 11th January 2019]

Benjamin has 24 years' experience at varying levels in pharmacy at practice and policy level.

I meet with Benjamin at his workplace in a London based office. We speak for over 100 minutes. I have a further interview with Benjamin, and we also discuss the progress with the study and struggles to recruit pharmacies. It is Benjamin who puts me in touch with Elijah.

4.3.9 Marco (Chief Pharmaceutical Scientist)

> *The meeting is to be informal, and we meet in the cafeteria, but the noise makes it impossible for us to hear and progress the conversation. Marco suggests we move to an office where it will be quieter.*
>
> [Excerpt from fieldnotes 28th May 2019]

The meeting with Marco has taken a few months to organise. Marco himself is keen to support and participate in my study, finding the time in his busy diary is proving problematic. I spend weeks in email and voice message communications with his secretary. I tried early morning, lunchtime, and evenings and on one afternoon call I was successful to speaking with his secretary. A cheerful lady, we were able to find a time where Marco would be in the office all day.

What is interesting in this interview is that Marco touches not only on the UK implementation but also the European picture. "… I believe the uptake across Europe has also been a little bit not that great either. So, there's something else going on that's deterring people to do this. Whether it's the complexity [um], I'm not quite sure." The word 'complexity' arises a number of times throughout our discussion. On reflection and as I have progressed with interrogating the data, I cannot be sure whether this is referring to the system, the organisations, the processes, or the regulation itself.

4.3.10 Kristoffer (International Pharmacy and Policy Manager)

> *Kristoffer provides a brief overview of his career, a career spanning my age. Reminiscing about the old days and acknowledgment of the shift to digital ways of working and to the piece of paper I have thrust in front of him, "… paper is, paper is still…. Still a much more useful medium in many ways…"*
>
> [Excerpt from fieldnotes 28th May 2019]

I have two meetings with Kristoffer, an International Pharmacy and Policy Manager for a global healthcare corporation. The first as a telephone call and the second in person. The telephone call is interesting; this is the first of my participants to refuse answering a question as it may have political implications. Kristoffer has knowledge of the full details of the European operations and upload volumes for both packs in the system and end user registrations. The UK end user registration is something that I am tracking with the hypothesis that number of registrations equates to pharmacy site readiness to comply with the directive. "So [pause] the number of pharmacies connected is very variable across [um]. So, in the UK, most of the smaller people are connected, but some of the bigger companies are not yet connected, because they're rolling out [er] their FMD into their existing system, rather than putting in some sort of temporary fix. And that's going to take some while. [um] Other countries, they're like ninety percent - ninety nine percent done. I think Germany said they had like half a dozen pharmacies that were missing, or something like that." This raises an interesting point and is somewhat contradictory to the larger site I have seen where the system is standalone but afford possibility of other applications to be uploaded to it and the much smaller independent pharmacy with an integrated system. I wonder if this narrative provides better explanation for seeking leniency.

Chapter 5 Results 2: The organisational context and multi-level complexity in policy implementation

The clinician's feelings and interaction with the implemented technology varied considerably between the three pharmacy study sites, as described in chapter 4. In pharmacy 1, the integrated design of the software allowed for a one step process and negated a switching between different computer applications and programmes, creating a streamlined process that was easy to use for every prescription item presented. This can be seen in the video example here. In pharmacy 2, the situation was more complex, with the standalone hardware and software creating an additional workflow parallel to the prescription dispensing resulting in this added step to be bypassed. This can be seen in the video example here. Pharmacy 3 never progressed to the point of FMD implementation though it presented an existing digitally advanced solution with the presence of robotic dispensing arms. Comparison of these three operationally distinct sites allows the demonstration of how a technology with the same intended output can be implemented differently to varying degrees of acceptability and success in adoption. In this chapter, I present the organisational context and introduce the pharmacy sites from the perspective of the organisational levels that build their operational foundations and the people that interact and shape the actions at an individual level. There is a further focus to demonstrate the multi-level complexity in policy implementation, that is the implementation of FMD within UK primary care pharmacy practice.

I draw upon the NASSS framework as discussed in chapter 3 to structure my findings. My findings generally align with the framework and the organisational elements characterised. I

also introduce the dynamic nature of the organisations and the wider system in which they exist, accounting for the change in planned work and uncertainty surrounding sustainability.

5.1 Theoretical framework

As presented in chapter 3, my study design is a national case study using Stake's interpretive (hermeneutic) methodology.

Having confirmed my approach to the type of case study I wanted to produce, I chose the NASSS framework (Figure 5.1) as my main theoretical lens. NASSS stands for Non-adoption or Abandonment of technology by individuals and challenges achieving organisational Scale-up, Spread and Sustainability (19). The NASSS framework is an aide memoire for considering the many different elements of a case study of the introduction of a technology in a health or care setting; it is thus complementary to the case study approach of Stake that I have chosen. NASSS comprises of different elements (depicted as 'domains') that may be relevant to a rich case narrative of technology adoption and routinization. The domains are: the illness or condition, the technology, the value proposition (financial and non-financial), the individual adopters (staff), the organisation (characteristics of each including capacity and readiness to innovate, changing of workflows/routines and planning to implement and embed change), the wider context (including the policy context of how a national directive is interpreted locally and more general issues of connectivity to a national 'hub') and emergence over time (embedding and adaptation).

NASSS is not a theory, though it was developed from a narrative review of theory-informed frameworks for analysing and evaluating technology programmes in health and social care (19), it is designed to accommodate other theories as relevant (for example,

psychological theories when explaining individual non-adoption; organisational theories when explaining routinization in organisations). The other contribution of the NASSS framework, and the reason I think it is highly relevant to my chosen case study, is its focus on complexity. All domains in the framework can be assessed as simple, complicated, or complex, and the interactions and interdependencies within and between domains can be highlighted through the use of narrative.

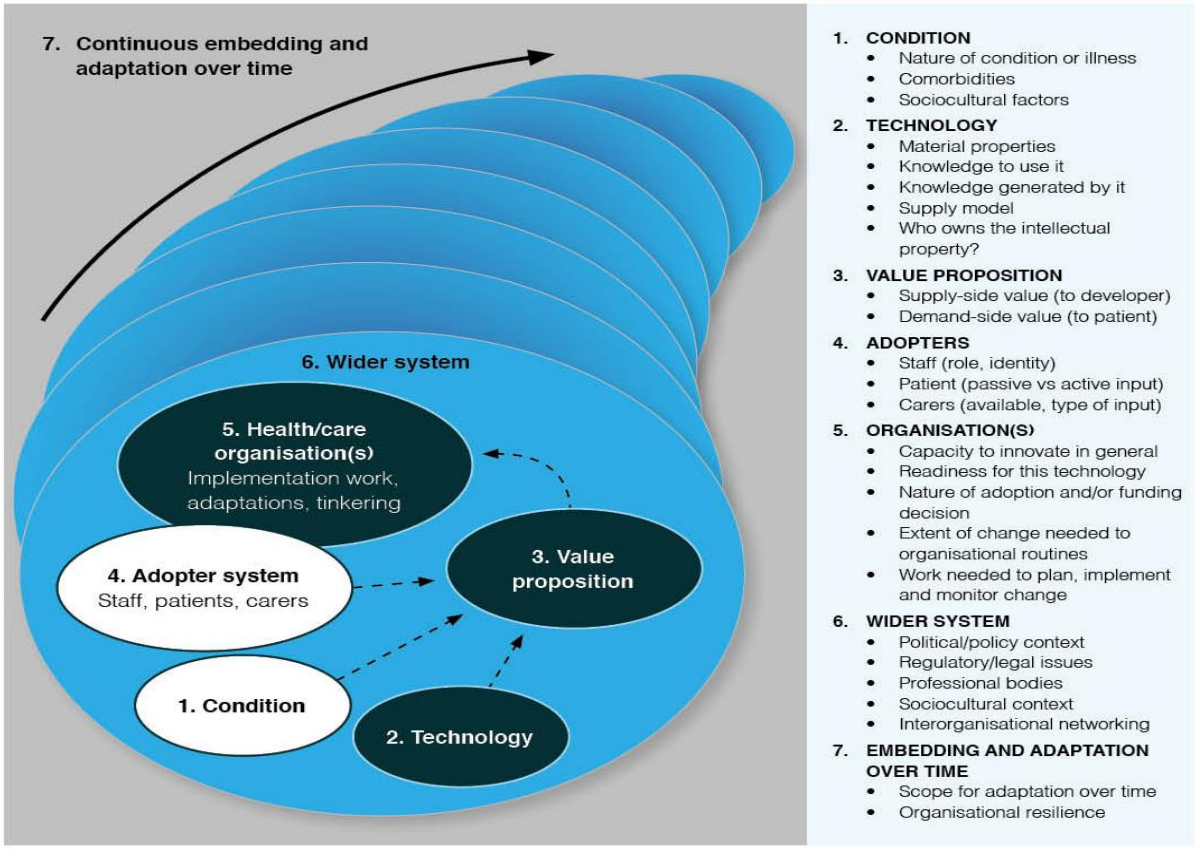


Figure 5.1: ***The Non-adoption or Abandonment of technology by individuals and challenges achieving organisational Scale-up, Spread and Sustainability (NASSS) framework.***

Each domain guides the user through a series of questions to generate conversations and ideas, weaving a narrative to identify uncertainty and complexity in the implementation process. Domain 1, *the condition,* looks at the illness from a clinical, comorbidity and sociocultural aspect. Complexity in this domain occurs when the condition is unstable, poorly

understood or metabolically volatile and/or associated with comorbidities or influenced by sociocultural aspects such as digital or social exclusion or poverty (128, 129).

The *technology* influence is covered in domain 2, in the earlier versions of the framework, which is what I originally used as it was the version available at the time I began this journey, this was addressed by four questions. The first of these questions, considers the nature of the technology, from size, sounds, aesthetics, to their material presence and physical properties in the environment. This question explores the potential sources of complexity associated with technology, emphasizing that complexity can emerge from factors such as the functionality and reliability of the technology. For instance, technology that lacks essential features or is not dependable can introduce complexity, as it necessitates workarounds. This domain also encompasses the knowledge required to operate the technology and the information that the technology presents or emphasizes, as well as what it conceals or fails to generate. It aims to evaluate data accuracy, the trustworthiness of data, and the user-friendliness of the technology for its intended users. An essential aspect within this domain pertains to how the technology interacts with other technologies. For example, whether it is a readily available, "plug-and-play" solution and its compatibility with existing legacy systems and planned upgrades. Moreover, it delves into whether the technology can be easily upgraded or replaced. All of these inquiries address the potential complexities that may arise when considering the impact of "the technology". A later additional consideration has been the intellectual property created, e.g., who owns what in the system and how can this be clearly defined. In this emerging field, case law and precedence may be few but clarity on this factor from the outset prevents issues for collaborators (130, 131).

Domain 3, is the *value proposition*, in short asking whether the innovation is worth it and if so, who benefits, and also how is value distributed across the system? Value here can be non-financial (e.g. prevention of adverse effects) or financial (saving money). The two main areas for consideration here are the potential value to the developer of the technology and to the patient or the healthcare system. In the case of FMD the patient is considered the ultimate end user in a linear supply chain model even though in reality they may not be interreacting with the technology or aware that it exists. This domain can be considered crucial in creating the implementation plan and clarifying what value means to the different actors or stakeholders. Complexity may arise here, if impact assessments and cost-effectiveness evaluations are incomplete (132) or the value element in the hierarchical structures in the system plays out differently at each level. This is interpretating that value means different things to different people and within the hierarchies that exist. At the micro level, the value can be seen as reducing physical workload and supporting the clinician with an accuracy check, at the meso level hitting key performance indicators of waiting times and finances for the organisation, and at the macro level demonstrating improved patient safety, operational efficiencies such as reduced waiting times and financial savings which may be useful for politicians and policy makers to demonstrate the wide reaching impact of their legislative actions.

The intended *adopters* vary between each technology implementation and may comprise of staff, patients or carers. Adopter acceptability, the ability to use the technology, and perceptions around its role (e.g. if it will be intrusive or hindering) can all contribute to hesitancy in adoption and continued use. Domain 4 considers these factors and how complexity can arise when the technology creates concern for the scope and safety of practice (19).

Implementation and the extent of work needed to implement and embed a technology system is often extensive yet continually underestimated by organisations. The five sub-sections in domain 5, explore how complexity could arise when considering the *organisation(s),* including its readiness and general capacity to innovate, the nature of adoption and funding, disruption to existing routines and work needed to implement the change (133). These are all key areas of consideration which cover resources both in terms of people and materials, including leadership and relationships and consider how change can be delivered and evaluated to understand the impact on clinicians' working practices.

The institutional and sociocultural context that organisations exist within are influential factors in not only spreading innovation, but scale-up and sustainability over time. This is further influenced by the organisation's networks and the policy context with regulatory and professional body involvement. Domain 6 considers this *wider system* influence.

In domain 7, *embedding and adaption over time*, is explored. Whilst the earlier domains considered the complexity and challenges of implementing an innovation, domain 7 looks at adaptability in a changing context (e.g., policy or technology development) to assess organisational resilience over time.

5.2 The organisational structure and set-up

Taking the NASSS framework and each site as an adopter existing within the organisation and linked with the wider system and context, I look at each pharmacy site as a multifaceted organisation, proposing that certainly for the large multiples or those linked with a larger corporate entity, the organisation is split into a number of different departments looking after the various operations and 'functions' of each. I propose that within this context, these

departments can be categorised under one of the following three functions: regulatory and governance, pharmacy practice and the organisation as a whole. This is an important distinction and lends itself to explaining the tensions that exist within an organisation and the competing interests within the implementation of a digital health system. The characteristics of the pharmacies included within this study are summarised in Table 5.1. This split-level view of an organisation is evident as one travels between the departments, seemingly taking a vertical slice of the organisational hierarchy layers. Arguably, the pharmacy practice layer sits at the base of this foundation. This distinction is described by a pharmacy dispenser:

> *'…they send us these things (the FMD system) and expect us to just make it work. Well, you can see that it doesn't …. its been off all morning!'*
>
> [Tohi, Dispenser, Pharmacy 2]

The conversation began with a question of how the team are getting on with using the new system. What is striking is that the system is seen as something that has been enforced on to the team by some external powers who appear unaware of the realities of how the technology, and the processes and systems needed for it to 'work', play out locally. Tohi goes on to explain in later encounters that everyone understands the need to scan the 2D barcodes as a patient safety measure, but the system simply does not allow for them to be compliant with the regulation. Similar frustrations are incidentally seen higher up the hierarchical chain, in individuals emersed in the details of the system and implementation:

> *"Is what we've ended up with proportionate to the level of that risk? I think we've - I think we've maybe, we've maybe lost sight of what that original risk was."*
>
> [Orla, Head of Regulatory, Pharmacist, First interview, June 2019]

> *"….he said 'how many have we got', and I went, we're only in on so many, and he went, 'guess what, we are so well ahead, way ahead of the market with who's*

enabled'. I said, 'yeah, there's enabled, but only ten are switched on'. And he went, 'well why'. I said, well I need to pick that up with you. So…"

[Ewan, Head of Operations, Third interview, June 2019]

There is a split view in progress of the implementation and pressure for the team rolling out the deployment to make the system functional. With those in a senior position drawing progress against the competitors and those in the regulatory and governance arm increasing concerned with the regulatory body (GPhC) enforcement and penalties:

"…[the superintended pharmacist] is going 'oh, GPhC are going to start marking us down', and it's kind of 'for god's sake, grow a pair of balls, man'. [um] But, the GPhC, if they want to benchmark everybody, who - who really is complying out there at the moment? Everybody will have some people trying it, but nobody is – are X got every store enabled? No, they haven't. Do you know what I mean? [um]"

[Ewan, Head of Operations, Third interview, June 2019]

I am beginning to scratch at the surface of complexity in the adoption of FMD and through the rich qualitative dataset comprising of many hours of ethnographic observations and pages of fieldnotes, video and photographic material, in combination with hundreds of pages of interview transcripts I can begin to unravel how FMD has been implemented and received in primary care and more specifically community pharmacy. To organise and explain these results more succinctly I present each domain of the NASSS framework in turn within the proceeding text.

	Pharmacy 1	Pharmacy 2	Pharmacy 3
Location	Village – rural	City – central	City – community
Size	Small	Large	Large
Company	Independent	Multiple backed, independent flagship	Independent
IT	Latest hardware and software, FMD integrated systems	Existing hardware and in-house software, FMD standalone system	Latest hardware and software, robotic operations, No FMD system
IT- reliability	Excellent	Unpredictable/ variable	Excellent
Work pace	Constant, steady, measured	Constant, fast, unrelenting	Site visit not possible due to the pandemic
Patient population	Elderly, affluent, loyalty to the pharmacy, white ethnic origin	Mixed aged groups, wealthy, global/multilingual	Mixed aged groups, mixed affluence, mixed ethnicities

*Table 5.1: **Pharmacy site characteristics.** A comparison of each pharmacy against seven distinguishing characteristic of location, size, business type, IT infrastructure and reliability, work pace and patient demographic is made to demonstrate the variance in each case presented.*

5.3 Analysis using the NASSS framework domains

5.3.1 Domain 1: The illness

This domain considers the clinical, comorbidities and sociocultural context of the condition. The illness domain considers the clinician's views of a patient's suitability for the technology within a defined disease state and care pathway alongside the patient experience of it. Indeed, the majority of case studies in the empirical work underpinning the development of NASSS, found that technologies were often developed with a textbook view of the clinical condition, considering it to be 'simple, isolated and easily characterised'(19). In the case of FMD the technology is not condition-specific so domain 1 is redundant for the purpose of evaluating the care pathway, nor is it a patient facing technology so, experiences of patients are not sought in this case (134). Similarly concerns pertaining to inequalities in access or social determinants which affect the poorest in society are not applicable in this case (135-137).

There is an argument to be made however, in seeking patient and public opinion of the proposed technology, especially considering that the routine change may alter waiting times for patients in receiving their medicines whether prescribed or purchased over the counter alongside the broader umbrella of medication safety and whether technology can be viewed as instrument to support on this agenda. An increased waiting time may disproportionately affect those with long-term chronic conditions and those with mobility or specific transportation needs where their transport, either private or ambulance service, would require rescheduling. Such observations are anecdotal and waiting time data from the two pharmacy sites does not provide conclusive evidence to this effect. The overall impact on dispensing practices is seen differently with a focus on the system(s) and how they can be

reasonably be embedded into practice than about the illness/therapy area or how this impacts patient care and experience. In pharmacy 1, it is described as having an overall benefit:

> *'… it has cut down the prep time overall…probably because it is now a streamlined process. Why everywhere else, it's taking them longer…I don't know, probably because they're printing [the prescription].'*
>
> [Elijah, Superintendent Pharmacist, Pharmacy 1]

In pharmacy 2, it is thought to add additional processing time, subsequently increasing waiting times overall:

> *'It is just an extra thing that we have to do.'*
>
> [Tobias, Pharmacist, Pharmacy 2]

Whist the technology is not condition-specific, there is (at the time of data collection) a limitation on which medicines are subject to FMD in accordance with Article 54a(2) of Directive 2001/83/EC for a 'white' list (prescription medicines that shall not bear the safety features) and the 'black' list (non-prescription medicines that shall bear the safety features)(138). Neither of the two pharmacies had in place a process for identifying, verifying, and decommissioning medicines on the blacklist for non-prescription supplies of medicines. Pharmacy 1 did have the functionality with the hardware and software in place to make this happen but no defined process. The teams provided examples of which medicines were not yet functional on the system, but this did not seem to affect a specific condition or patient group.

Whilst the condition domain can be considered redundant in the case of FMD, the defined usage period before the system becoming obsolete has made it difficult to assess the long-term implications, if any, for specific conditions or patient groups.

5.3.2 Domain 2: The technology

The technology, for both pharmacies, at its core is designed to achieve the same ultimate purpose, that is to verify and decommission medicines containing the FMD safety feature (the unique identifier from a 2D barcode) by connection to the National Medicines Verification System (NMVS). The second safety feature, a tamper evident seal requires a physical check and is not reliant on the technology. In order for the technology element to be operational both systems have a 2D barcode scanner where the operator has to manually place the barcode within the visual sight of the sensor. This is though, where the similarities in the hardware and software in place end.

In pharmacy 1, all of the IT equipment is the latest versions equipped with touchscreen technology. The FMD software is integrated within the operations of the main dispensing system (Figure 5.2) and the barcode scanner can be manoeuvred to different positions around the PC terminal for ease of use. The pharmacy team have been involved in the design of the features of the system and were presented with a few screen layout options to establish what they liked and worked well for them. As an original test site for the prototype, they have a direct telephone number to the software developers to feedback or report any issues encountered for either an immediate remedy or feature development for future updates. The team all appear confident in using the system at their designated user profile level and report that the system is ‘intuitive and easy to use’.

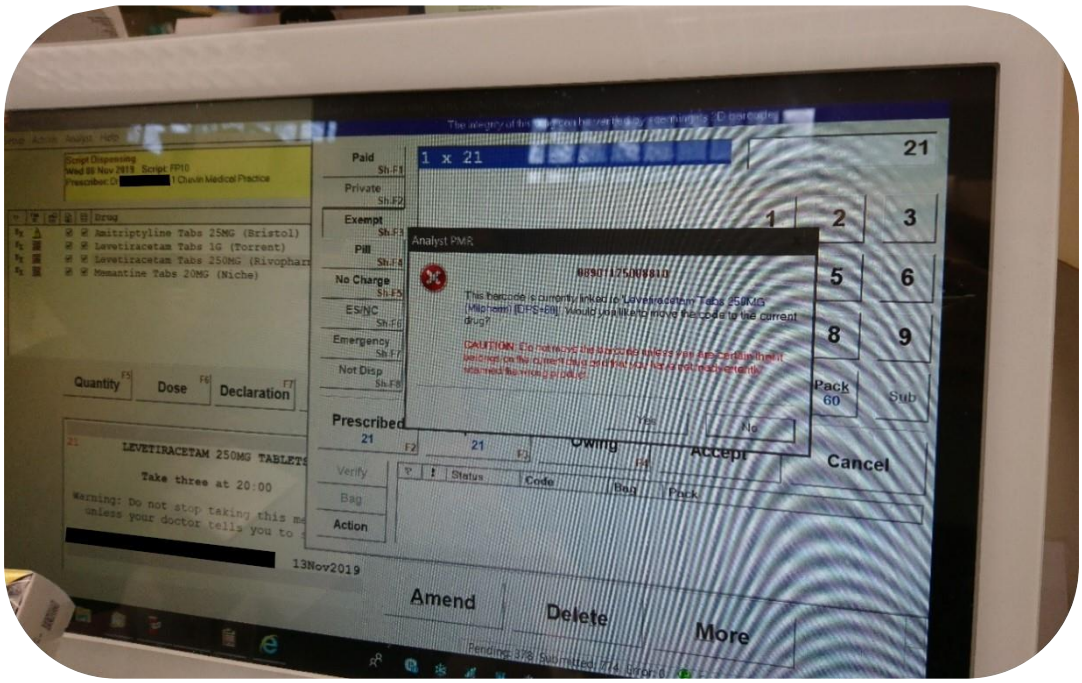


Figure 5.2: ***The FMD software and hardware in Pharmacy 1.***

Once the 2D barcode is scanned, the software is designed to display the serial number (SN), batch number (BN), expiry date (EXP), and 'status'. However, the system does not display the medicine name, strength, and formulation. This seems to be at odds with the narrative that the team have provided of the computer providing a second check to the human eye. I raise this point with Kate as she works on the system and am told that the system does not show this information for a visual check but that there is some back corridor in the system where you can trace it. It seems to me that even within an integrated system the purpose of the created software programme is to primarily achieve compliance with the verification and decommissioning required under FMD and that any value-added segments have developed as a consequence of the design rather than a purposeful endeavour. This is confirmed by Kate:

> *"Elijah will tell you that 'it is not what it was designed to do'."*
>
> [Kate, Pharmacist, Pharmacy 1]

There is a great deal of trust from the team in the system they are using. They believe that the programme is doing the additional checks without them having to visually verify the activity occurring, not even intermittently or as spot-checks. It certainly does appear through my observations that the system is conducting these checks as the sound of error messages ring along with a warning pop up on the physical screen when incorrect items are selected by the operators. I am beginning to believe that their positivity of the system is genuine and in real terms demonstrated by data showing zero picking errors from the human operators.

There are downsides to this integrated approach, where nuanced care pathways are not an inherent feature, the team have to experiment with the functionalities and have altered their working practice in this case:

> *"[Dossett boxes] for the care home take longer to do as patients have to be accessed differently to verify and decommission for FMD. I've found a way around it… if you 'FMD it' at the time of picking then it simplifies this process."*
>
> [Talah, Pharmacist, Pharmacy 1]

This is the only deviation from practice that I observe in all my time at pharmacy 1. The prescriptions are all accessed on the system, even paper prescriptions have their barcode scanned and uploaded. The only paper prescription token that is printed is for the purpose of collating a signature for legal and regulatory requirements, these average to fewer than 10 printed tokens per day. The digital prescriptions appear on the screen in the same format and colour as historical paper versions, this is to create a sense of familiarity and also to allow ease of identification of the type of prescription and prescriber. The medicines are selected from the shelving and drawer locations, the 2D barcode is scanned for verification of the medicines on the NMVS. Once the prescription is fully dispensed and checked, the medicines only undergo decommissioning at the point of supply to the patient at either collection or

prior to home delivery. This last task is undertaken on a different terminal by the healthcare assistant who scans the patients' address label that has an aggregated code consisting of all the items included within the prescription. In this way, one scan decommissions all of the medicinal packs supplied, showing their unique identifier as 'supplied' status. In the integrated system these unique identifiers are linked to the individual patient's records at the local level.

An early learning point, which can be placed under *'what knowledge does the system generate?'* was regarding the notification messages received from the NMVS. This is demonstrated through the case of a pack of Betmiga® (mirabegron), when the 2D barcode is scanned, the system provided a notification of 'pack supplied' and gave the name of the patient it had already been supplied to, which was also the same patient it was intended to be supplied on this occasion. This alert meant that the unique serialisation number had previously been issued. The team upon checking the patient's medication record can identify that the patient did not want this medicine in the previous month but 'the system' had not revalidated the code as an 'active' status when the medicine was undone (returned on the system and to physical stock). This raises the question of movement of stock within the pharmacy or the pharmacy's legal entity. Where medicines are dispensed but not collected or required by the patient, the NMVO allowed 10 days for the code to be reactivated, which in the case of the operation of most pharmacies is too short a period, given that prescriptions are legally valid for 6 months and generally clinically relevant for up to 28 days after prescribing.

The FMD system in place at pharmacy 2 is a standalone hardware and software solution (Figure 5.3). The unit has an inbuilt 2D scanner and webcam, this means that medicinal items

need to be held directly underneath the vertical beam of red light at a distance of 10-15cm. When an FMD compliant barcode is scanned the information that is displayed is product name, strength and formulation, in addition to the product ID, serial number, expiry date, lot number, and 'status'. The information is not linked to an individual patient record at a local level.

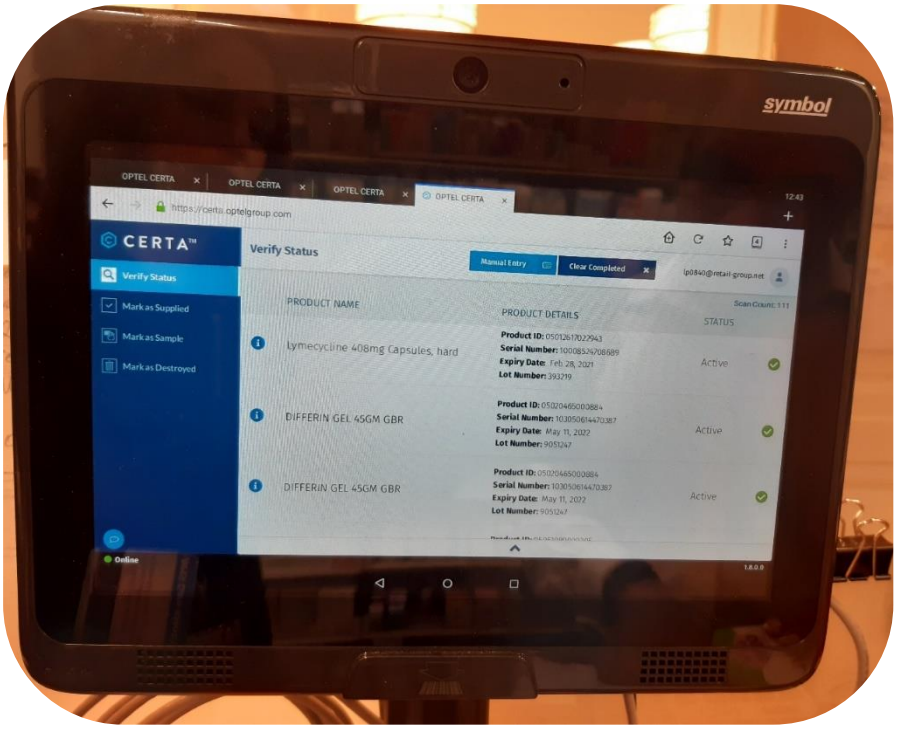


Figure 5.3: ***The FMD software and hardware in Pharmacy 2.***

The team members in pharmacy 2 are keen to point out all of the different types of barcodes printed on medicinal packs and critically that none of them appear to be FMD compliant 2D barcodes, so a lot of time is spent scanning each side of the pack before this is established. This is highlighted by Henrieta:

> *"System is very sensitive and double scans. It takes longer than before in dispensing."*
>
> [Henrieta, Technician, Pharmacy 2]

To overcome this sensitivity, the team have created a window using a piece of paper that they place over the packaging to cover up the additional barcodes in order to prevent the scanner picking up non-FMD compliant barcodes that can cause the system to crash. This though is not unique to their system and is a flaw attributed the manufacturer's design and layout of the information printed on the packaging. In pharmacy, 1 a specific tool has not been created as the team use their hands to strategically hold and cover the extra barcodes:

> *"…with some packs, you have to cover the extra barcode to then scan the 2D barcode; as the system picks this up as an error"*
>
> [Talah, Pharmacist, Pharmacy 1]

The system in pharmacy 2 automatically logs out after a period of inactivity. During busy times when the system is slow, FMD activity is bypassed. The team recognise they should do it but cannot keep patient waiting times down if they were compliant with the requirements. The system response time is quite lengthy, and this is put down to a slow internet connection:

> *"The system goes down a lot and is slow, the messages don't make sense. Can't see any benefit of having it at the moment. The system got installed and we didn't get any explanation about what it was and what we had to do with it."*
>
> [Mark, Technician, Pharmacy 2]

Medicines are scanned for verification and decommissioning at various points in the dispensing process. The number of prescriptions awaiting picking and labelling at the dispensing terminal determine at which point the scanning occurs. If there are more than two prescriptions, the medicines for the prescription are selected, verified and decommissioned, then labelled and assembled. If there is no queue of prescriptions, then the verification and decommissioning occur prior to or after labelling; this is dependent upon the operator's preference. As the medicines are verified and decommissioned during

dispensing, there is no need for an aggregated barcode or additional terminal to scan at the point of supply to patients.

There are a number of deviations to what is considered the normal practice and workflow under the changes with FMD, this has been observed and felt by the pharmacy team, as explained by one of the pharmacists:

> *"The system requires a lot of maintenance. As a two-step process, it's hard to use"*
>
> [Tobias, Pharmacist, Pharmacy 2]

Tobias is describing the added workload of having to continuously login, refresh or reboot the standalone system, which on observation does take over five minutes to achieve. It is therefore easy to understand why the system is viewed negatively by the team in its operability and reliability. One such example, is when a prescription is received for 1565 capsules of cefalexin, the dispensers calculate that this is 74 packs (of 21 capsules), they take a look at the scanner, shrug and say, "Not even going to try to FMD these". This demonstrates the difficulties experienced with the use of a standalone system and inflexible positioning of the 2D scanner.

In pharmacy 3, no FMD solution was implemented as the robotic dispensing software did not have the available upgrade created to install a compatible 2D barcode reader. The robot is regularly serviced and within the manufacturer's warranty period meaning it is still very much new and functioning as intended. The pharmacy layout is designed to showcase the robot and patients and visitors can stand underneath a glass floor to watch the robot at work. I am told in fact that *"parents sometimes bring their children (in) just to see the robot and they can stand there for hours"*.

This pharmacy's technological infrastructure is designed in such a way that everything 'speaks' to each other, meaning that all of the technology either exists in one system or interfaces in such a way that the end user, be it the pharmacy team or patients (e.g., when using the appointment booking or prescription ordering services) only interact with one visual output. Implementation of FMD in this pharmacy would have resulted in the need for disposal of an expensive and functioning piece of technology both as hardware and software.

5.3.3 Domain 3: The value proposition

The value proposition should go beyond purely financial gains and unpack other such intended and unintended benefits, as patient safety, improved pharmacovigilance reporting, ease of generation clinical reports, and so on. However, there is a general consensus that the value of implementation should realise financial gains in the medium to longer term to be of value. Data for this study suggests that affordability and value for money is not something that is discussed at the pharmacy ground level. The focus is on the detail of the operations. In most technology initiatives there is a trade-off between functionality and development costs and system features of 'must-have' or 'nice-to-have'(139). During an interview with a head of regulatory affairs, they allude that whilst patient safety and compliance with the directive are key, the most cost-effective, minimally disruptive system is the one that will be selected:

> *"I think the world has changed beyond every, beyond all recognition, from a - how patients get their healthcare. There weren't all these private hospitals and things back then, to the extent that there are now. To the technology that's available to everybody, to monitor all of this. [um] You know, to, to - in the UK, being brutally honest, the amount of money that's floating around in the system - there is, you know - We're working out how much extra it's going to cost to pick. And that money's not there, and there's no funding for it, so. You know. Impact assessments were done back then, in terms of financial impact - well, they're not worth the paper they're written on now, so. It's probably just taken - from the idea to something landing, I don't think any - I don't think it's anybody's fault, but I don't think anybody could have anticipated how much the world would change."*
>
> [Orla, Head of Regulatory and Responsible Person/Pharmacist]

Within the pharmacy, the financial question underpinning the investment decision appears to be more about cost than cost-effectiveness. This is because the actual work done in making the system work is not factored into the total cost (and indeed is unknown at the

time of purchase), adding to the hidden cost of professionals' working practices, the hidden labour involved:

> *"I don't know why we always go for the cheaper product. Is it actually cheaper? It costs us more in the long run."*
>
> [D'Angelo, Superintendent Pharmacist, Pharmacy 2]

It is worth noting that the cost of FMD systems did not affect the adoption decisions in the independent pharmacies, with pharmacy 1 opting to pay the costs for full package functionality and pharmacy 3 holding out for the right system fit for their operations:

> *"Do everything once, but have everything in one system, [this means you] teach someone how to use it once"*
>
> [Gareth, Superintendent Pharmacist, Pharmacy 3]

Rogers defines this as "relative advantage", that is, each individual has a different measure of each attribute of the innovation and what they believe is useful or better than what is in existence (19, 140).

There are some measurable and perceived benefits seen from both pharmacies. One is around governance and the second around medicine safety. The latter of which is linked directly with the ultimate aim of the directive:

> *"Everything has a digital footprint"*
>
> [Elijah, Superintendent Pharmacist, Pharmacy 1]

> *"I like the system, it's about safety"*
>
> [Tobias, Pharmacist, Pharmacy 2]

There are uncertainties and questions around how these benefits can be demonstrated to patients, signalling that the value of this extra work is not visible to the group that the sector is trying to protect:

> *"How does it benefit the end user- the patient? How can we demonstrate that as pharmacists?"*
>
> [Tanisha, Pharmacist, Pharmacy 2]

In both pharmacies the value of having a system that allows notifications to be received is seen but in a vastly different way. In Pharmacy 1, a potentially falsified batch of medicines is identified during the dispensing process. This, as well as generating excitement, cements the working practices as being effective and the system, the digital system at least, to have been worth the investment. The medicine identified is a pack of Zomorph® (morphine sulphate) 10mg modified-release capsules. Upon scanning for supply to a patient the NMVS returns an alert message of "Pack is locked". The item is immediately photographed for documentation, quarantined and the wholesaler contacted for further action. The wholesaler cannot provide details of why this might be, and the incident is reported to the MHRA. Seven weeks after the notification, the MHRA responds to the pharmacy asking the team to quarantine the packs identified as locked for further investigation. The communications, both by phone and email, with the MHRA continue over several weeks. Unconfirmed reports are received that the packs are falsified but no organisation wishes to take responsibility for how or where this stock may have entered the supply chain. In the meantime, the pharmacy continues to quarantine the medicines and are out of pocket for the cost of these. The monetary cost factor in identifying such a product is one that was unforeseen by the pharmacy team, and it has created anger. It is felt that they are being penalised for doing what everyone should be doing but which in reality most of their competitors are not. This anger further escalates

towards the various regulatory authorities and those that have created a system without thinking of what needs to happen when a falsified medicine is identified or who should ultimately pick up the cost. This is seen by the staff as yet another example of where money is further stripped from independent pharmacies, in addition to year-on-year funding cuts, that is contributing to the difficulties in keeping community pharmacies within the community (141). The team continue to work with the MHRA in resolving this case and I am asked to not share the outcome publicly:

> *"It's bad to be on first name basis with the MHRA"*
>
> [Elijah, Superintendent Pharmacist, Pharmacy 1]

Using the integrated system, the team are able to search for any further patients that may have been supplied this 'locked' batch. The search runs and within a matter of minutes confirms that no patient at this pharmacy has received this specific batch.

In pharmacy 2, which uses a standalone system, this recall process is not as straightforward. The team experience this when a product recall alert for Beconase® (Beclometasone dipropionate 50 microgram/dose) nasal spray is received under an FMD recall due to batches showing as 'destroy' when scanned. The team search the physical shelving for the specified batches and then do a search on the FMD system to identify if any packs matching this batch were recorded as scanned. The team discuss if not scanning every item has meant that this batch could have been missed and not logged on to the FMD system. It was decided that a search of patients that had received this medicine between the time period that this batch had been ordered from the wholesaler should take place using the search function on the dispensing system. The identified patients were contacted by telephone to ask to confirm the batch number on their medicines. It was not possible to contact every person but having

contacted a few patients from the list it seemed unlikely that the pharmacy had ever received this affected batch. In an integrated system that allowed linkage to patient details at a local level, this process could have been carried out with far greater ease, reduced concern on the part of the healthcare staff and time away from conducting scheduled activities.

5.3.4 Domain 4: The intended adopters

The pharmacy teams at both sites raised issues around the design of the packaging (domain 2) and both described the idea behind the directive as necessary. The experiences of the pharmacy teams differed immensely between those using the integrated and those using the standalone systems, with the former providing an enhanced and uniform user experience. The team at pharmacy 1 used the system and the additional functionalities with ease and saw the value added by having all of the needed clinical information for their patients in one place and by including the scanning as part of routine dispensing procedures found the benefit of having a computer system validate their selection. This is seen very much as an added safety check, as with packing and medicines looking and/or sounding alike, this added feature of the system matching the information from the scanned product to what has been prescribed as a reassuring step in a high-pressure, high-stake environment.

> *"I like it. I thought it would hinder workflow initially, I had my reservations about it."*
>
> [Helena, Pharmacist, Pharmacy 1]

The latter team, using the standalone system, describe the additions to their process a hinderance and ineffective solution to a problem. Demonstrated by their expressions of how difficult the system was to use, the speed of the interaction and no added values to the dispensing process other than looking to appear to be compliant with the directive. The time taken in resolving the system issues, slow login process, length of time taken to receive

notifications after scanning and skill in aligning the packaging at specified angles to allow the infrared beam to detect the correct barcode, all contributed to added effort and reduced focus on clinical work. The varying degrees with which each team member interacted with the system was a cause of frustration to those that were actively making an effort to follow process. This often led to conflicts between the weekday team and the locum staff working the weekend shifts. These underlying tensions, contributed to the weekday team reducing engagement with the system over time as a result of a perceived lack of consequence for those not observing SOPs.

One unintended consequence of practicing within an early adopter site, is shared by a clinician who practices at other community pharmacies:

> *"I often get to learn and experience new system features or services in this pharmacy before anyone else and I tell them what's coming!"*
>
> [Talah, Pharmacist, Pharmacy 1]

Talah can be considered a user champion, their pride in advanced knowledge of the system features and sharing of information with others in the profession has created an informal network of influence, whereby the acceptance of the innovation is improved through three key areas identified by Wade et al as enthusiastic promotion, legitimation and relationship building (142). I would propose a fourth area, professional critique. This accepts that clinicians are rarely limited to one system or place of work and the increasing nature of fluidity between locations and systems allows clinicians to compare, contrast and appraise a variety of technology solutions that are all attempting to achieve the same outcome.

5.3.5 Domain 5: The organisation

I have presented an overview of the organisational structures in section 5.2. To further expand on this understanding, it is important to highlight that all the pharmacy sites operate the same core services under The Community Pharmacy Contractual Framework (CPCF)(143). They are however located in geographical settings that provide their own unique set of patients and additional services based on the local area and contractual service requirements (Table 5.2).

The decision makers for selection of an FMD system between an independent and multiple owned pharmacy presented variance in what is value added at the pharmacy level. The multiple owned had IT personnel, regulatory, logistical, operational and financial leads, inputting into the selection where value added is seen as 'what other functionality can this hardware provide for use in other clinical care pathways' and also a plan for the aging of the device and possible usage within the retail environment. These decisions led to a variability in how the intervention was implemented, with the multiples having a rollout plan with dedicated teams to install devices at the time and location of head office management choosing. This decision meant that the local users within pharmacy 2 had no say in what would work for their individual layout and team nuance. This factor was addressed early on by the decision maker in pharmacy 1:

> *"You're not going to get process changes with FMD, unless you trust the system…I've just solved the question of your DPhil"*
>
> [Elijah, Superintendent Pharmacist, Pharmacy 1]

In pharmacy 1, all of the team had an input into the feature designs of the systems in place. Whilst the ultimate decision for purchase lay with the co-owners of the pharmacy, there was

opportunity for system adaptability over time to allow ease of use by the local team and alignment with existing organisational routines. The pharmacy SOPs could be adapted with ease and as direct consequence of feedback. All ideas were discussed, with a trial run of those that the team collectively felt was a good amendment to their practice. By contrast, in pharmacy 2, SOPs took longer to adapt and require involvement from several senior individuals thus creating recognised yet informal small-scale deviation(s) from practices that were adopted at a local level. The safety benefit that the FMD system would bring was widely acknowledged, yet in reality the difficulties experienced in using the system resulted in partial abandonment of the system altogether, with sporadic periods of use often linked with prompts from those tracking scanning activity.

Pharmacy 3 were not FMD compliant as they had robotic dispensing and there was no available software upgrade to allow the robot to read the 2D barcode at the point of picking. The pharmacy superintendent was comfortable with their position as physically scanning at the point of dispensing would add too much time to their processes.

5.3.6 Domain 6: The wider system

Initial analysis of the first interviews with elite and expert participants unpacked key areas for consideration that were initially represented utilising the core and periphery concept (133, 140). The core being the part of the innovation that cannot be changed. In the case of FMD this is the 2D barcode and the tamperproof seals. The periphery comprises of the organisational structures and systems required for the implementation of the innovation. It can be fluid and changing, this adaptability is a key element of the innovation. These concepts when mapped across to the NASSS framework domains are a visual demonstration of the competing factors in the implementation of FMD. Many interview participants

mentioned considerations such as non-FMD compliant packaging, regulatory environment and Brexit, all symbols of the complexity associated with implementing a national solution. What was not factored was the actual costs to be incurred by pharmacy in procuring a solution, how a solution would interface with legacy systems if at all, penalties for non-compliance and if continuation of interfacing with the EMVS upon exit from the EU should be possible.

Pharmacy 1, having experienced the value of their integrated solution were fully prepared to continue with the new routine even in the absence of verification of the authenticity of medicinal items:

> *"If we have Brexit, I've asked [the software provider] to not switch off FMD"*
>
> [Elijah, Superintendent Pharmacist, Pharmacy 1]

The impact of Brexit on FMD implementation in the UK will be explored in more depth in chapter 7. Arguably, the premature demise of the FMD systems can be owed to the impact of the directive not being enforceable after 31st December 2020.

5.3.7 Domain 7: Evolution over time

The uptake of FMD can be mapped by looking at the data trends from community pharmacy registrations with the NMVS (Figure 5.4). This data demonstrates that seven weeks after the directive becoming enforceable 65% of community pharmacies had the capability to verify and decommission, rising to 85% at week 50. This shows a steady uptake by community pharmacy in achieving compliance with the directive. Perhaps the gap can be accounted to pharmacy closures or as in the case of pharmacy 3, the decision to wait for an integrated solution compatible with existing infrastructure or those waiting to fully understand the implications of Brexit.

The single most important factor in the successful adoption of technology within the healthcare environment is widely documented to be the acceptance of the innovation by the individual clinicians who will use it at a local level (19, 144, 145).

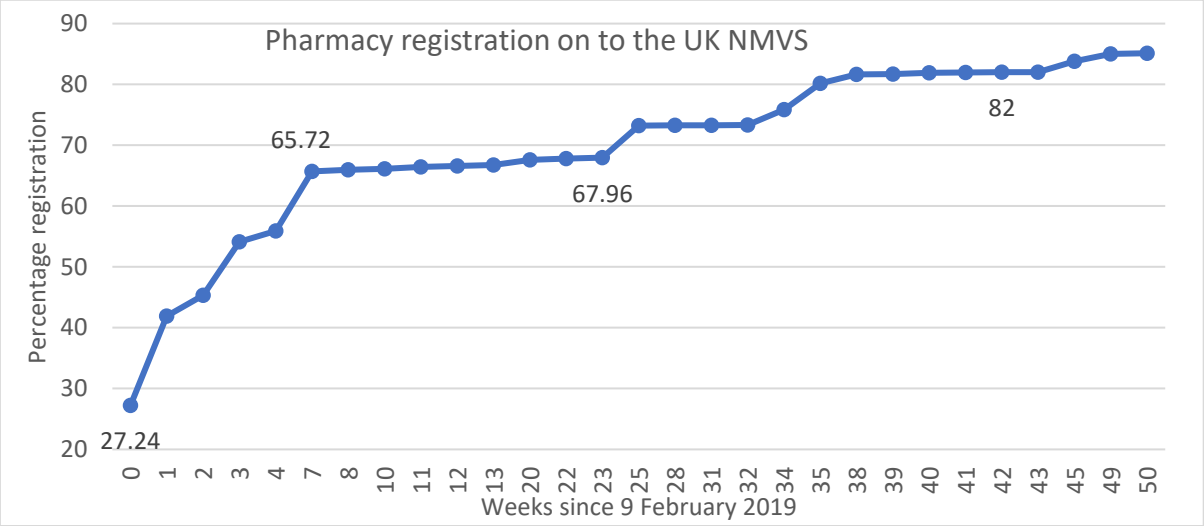


Figure 5.4: ***Community pharmacy registrations with the NMVS****. The number of pharmacy sites registered with the NMVS has been tracked from the commencement of FMD in legislation, with the week of 9th February 2019 shown as week 0.*

This acceptability varied between pharmacy 1 and 2. In pharmacy 1, the trust in the technology increased from that originally seen over time and became fully embedded into daily practice. Helena describes this shift in perception over time: *"I like it. I thought it would hinder workflow initially, I had my reservations about it".* This is observed in how the team carry out the FMD related tasks without added support and confidence in overcoming system related issues independently without drawing on the knowledge of other team members or requesting technical support from the software team. In pharmacy 2, trust in the technology diminishes drastically over time, with the system difficult to use, often adding to work timings and requiring daily maintenance the team often eliminate the FMD system. The irregular use can be seen by the team not being able to account for when the system/device switched off or why. Considering the case studies presented here it appears that the acceptance of the

innovation by the pharmacy teams (the adopters) is critical to the successful adoption of the innovation and that this is also true in the case of policy driven interventions even in the presence of penalties from regulatory authorities.

5.4 Discussion and conclusions

A large volume of data was collected from the study sites to understand the individual adoption processes within independent and multiple owned pharmacies. Whilst I attempted to gain as much variation within the pharmacy sites for inclusion, the COVID-19 pandemic reduced the number of site visits planned and closed off the prospect of recruiting a further, fourth pharmacy site. Difficulties were exacerbated by Brexit and discontinuation of FMD at community pharmacy level. On balance, the three pharmacies recruited all presented their own unique challenges and journey through implementation. This variance allowed comparisons to be drawn between different strategic, operational, management and clinical models.

The limited empirical work that was possible in the circumstances nevertheless generated a rich qualitative dataset comprising of interviews, ethnographic fieldnotes, video and digital imagery and extracts from documents. I have used the NASSS framework domains to explain the implementation of FMD in the three pharmacy sites. To sum up the main findings, the team experience of using the technology varied between the two main study sites that had embarked on implementation, one using an integrated solution and the other standalone (domain 2: the technology). In the integrated solution, there is no bypass option, yet this is seen as an advantageous function, an extended accuracy check contributing to medication safety measures (domain 3: value proposition). However, user trust in the technology for both systems and the process were strong, summarised by one interview participant *"…it's*

(the technology) already out there it's just bringing it into an industry that hasn't embraced it before" (domain 4: intended adopters).

The decision of which system to adopt seemed dependent on the size of the organisation and the relative speed for implementation, with the standalone system preferred for larger organisations (domain 5: the organisation). The standalone intervention was more quickly deployed for integration into the pharmacy workflow but the extent of adoption and use to full potential by the local team was flawed by significant periods of downtime and poor user experience. The integrated solution was overwhelmingly more positively received than the standalone system. In pharmacy 1 and 3, the independently owned nature of the business meant that decisions on system requirements and funding were made with relative ease. In pharmacy 1, the team were more accepting of changes to their working routines, this in part owed to previous changes and adoption of other technology systems and clinical services but also seen as a learning opportunity and knowledge growth. The team commented on how they were never short of case studies to include within their Continuing Professional Development (CPD) portfolios. In pharmacy 2, there was capacity to innovate with the leadership in place at the pharmacy level to support the team. This leader was highly invested in the principles of FMD and what it would be able to achieve. Over time this enthusiastic leadership crumbled as the embedding of a second system into the work routine caused added pressures. In this case the work needed to implement change and adopt the innovation was too great. Looking at the wider system and embedding overtime (domains 6 and 7), 52 weeks following the directive becoming enforceable, 85% of community pharmacies were registered with the UK NMVO.

Regulatory reform is only an instigator for change and is not a guarantee for adoption by healthcare environments. Technology system implementation is complex, and in the case of FMD; with the technology identified as the strength, the socio-political context has been a key factor in hesitancy for acceptance, investment and, ultimately failed sustainability. The same intervention, implemented into similar health settings, will be implemented differently owing to the variance in governance and management structures in addition to individualism of interaction of the team at the local settings because of deviations in standardised workflows. The failure should not be viewed as abandonment, as at a local level effort was placed in to integrating the new procedures in both sites and planned for development in the third site, but rather as a result of forced de-implementation. This significant human effort in embedding the technology is not uncommon to the implementation of FMD and is described in other studies of complex technology-based change utilising the NASSS framework.

The de-implementation of FMD in the UK has created a disparity between strategies to safeguard the legitimate supply chain in the UK and countries in the EU. There are plans therefore to create a UK standalone system. It is not clear whether the new system will mirror the key attributed of FMD exactly, or whether the existing hardware and software infrastructure can be repurposed for this use. The case studies presented in this chapter provide a useful insight into the complexities of implementation of integrated or standalone systems, the importance of acceptability and engagement from adopters and demonstrable value proposition in ensuring engagement with and thus the success of the future system.

Chapter 6 Results 3: Governance, systems, and policy

The previous chapter introduced each of the pharmacy sites as a multifaceted organisation existing within the wider system. The challenges in implementation of the same intervention, implemented into similar but not identical health settings was explored in detail at the micro level of front-line pharmacy practice.

In this chapter, I present the organizational actors at the policy, pharmacy practice and wider system context levels, that is, to convey the overall policy approach, from conceptualisation stage, through to impact assessments and guidance for implementation practices in primary care alongside analysis of other key documents. This chapter also considers how healthcare professionals, chiefly pharmacists, are required to change their working practices to adapt to inflexible systems selected by hierarchical structures. Analysis of expert and elite participant interviews demonstrates that these actors over-estimated the adaptability and ease of use of these systems compared to those working on the frontline of clinical practice as explored in the previous chapters.

6.1 Theoretical framework

The issue of falsified medicines has seen a number of global initiatives over the last decade, in an effort to curtail the impact on the legitimate supply chain and public health. This is explored in depth within chapter 2. No single isolated intervention on a global platform has served to eradicate falsified medicines completely. The introduction of FMD in the EU can thus be seen as an organised movement linking politicians, policy makers, regulatory organisations and other professional bodies across several territories to address a common concern. The question is therefore how successfully has this been achieved for FMD at the UK level?

In order to answer this question and explore the associated complexities, I use Shiffman et al's Political Priority Framework (PPF) to explain this global political priority, that is 'the degree to which international and national political leaders actively give attention to an issue, and back up that attention with the provision of financial, technical, and human resources that are commensurate with the severity of the issue'(20).

Assigning a political value to an issue is a complex concept that can exist at a national level also, but at its core identifies that the presence of global political priority facilitates the successful adoption of the issue and consequently implementation through appropriate policies and technological initiatives. To understand the successes and weaknesses of FMD implementation in the UK each of the complexities are reviewed in turn under the four categories of PPF (Table 6.1 and Figure 6.1): actor power, ideas, political contexts, and issue characteristics.

What is important to recognise within PPF is that where there are overlaps or common features in all of the four categories, the initiative or intervention is more likely to gain political support. The *Actor Power* category considers the influence that different individuals possess alongside the subsequent weight that representing organisations have in progressing and building an initiative.

This not only includes the concept of gaining momentum for the cause but ultimately strengthening the argument to either favour, weaken or reduce the credibility of the initiative (20, 146). Actor power includes: Policy community, Leadership, Guiding institutions and Civil society mobilisation.

PPF Category	Category description	Priority level in the framework
Actor power	The strength of the individuals and organisations concerned with the issue	1- Policy community cohesion: The extent of alignment within the network of individuals and organizations that play a central role in addressing the global issue
		2- Leadership: the existence of individuals with the ability to bring together the policy community and recognized as notably influential advocates for the cause
		3- Guiding institutions: the efficiency of organizations or coordinating systems tasked with spearheading the initiative
		4- Civil society mobilization: the degree to which local organizations have rallied to urge international and national political authorities to tackle the global issue
Ideas	The ways in which those involved with the issue understand and portray it	5- Internal frame: the extent to which the policy community shares a consensus regarding the definition, causes, and remedies for the problem
		6- External frame: how the issue is portrayed publicly in a manner that resonates with external audiences, particularly political leaders who wield resources
Political contexts	The environments in which actors operate	7- Policy windows: periods in politics when global circumstances align favourably for an issue, creating opportunities for advocates to impact decision-makers
		8- Global governance framework: the extent to which norms and institutions within a specific sector offer a foundation for efficient collective actions
Issue characteristics	Features of the problem	9- Credible indicators: transparent metrics demonstrating the problem's seriousness and suitability for progress tracking
		10- Severity: the scale of the issue's impact compared to other problems, as indicated by objective criteria like mortality rates
		11- Effective interventions: how well the suggested methods for addressing the issue are clearly defined, economically efficient, supported by scientific evidence, easy to implement, and cost-effective

*Table 6.1: **The Political Priority Framework (PPF)** showing the four categories for the framework on determinants of political priority for global initiatives (adapted from (20)).*

The policy community shape factor one at a global level and can be considered to be operating with the central issue as their main priority from a macro level. The individuals and

organisations of this layer are those such as government officials, international organisations, United Nations agencies, e.g., the WHO and, crucially, academics with in-depth knowledge of the problem (hence, an ability to quantify the scale of the problem or provide insight to possible solutions). The cohesiveness of this community in establishing the central issue and forming an authority on the subject is directly linked to probability of gaining political support for the cause. From these organisations, whether political or non-political, can emerge individuals with good standing and trust within the communities they represent in leading on the subject issue. These individuals provide leadership and champion the cause at the pharmacy practice level. This brings the need for a 'guiding institution', factor three of the framework. The purpose of such institution(s) is to lead the initiative and ensure that the intention of the cause is not lost. Often task forces are set up with this aim. It is important to note that there may be more than one organisation competing for this role, and whilst it is possible for unified action and agreement, the risk of continued competition in having ultimate control of the issues and outcomes could jeopardise the longevity of the issue and the respective organisations (20, 147). Finally, activists and grassroots organisations form the civil society grouping that is the fourth factor within the first element of the framework. This community can work at both a national and international level to draw attention to the issue and gain support from a number of sources including politicians.

Collectively across the factors these individuals and organisations aim to build strength of argument for the issue and provide a higher-level platform for debate and subsequent need for action. In so doing, placing the term 'power' to mean as Buse et al describe; *the ability to achieve a desired outcome* (146).

Ideas. *A thought, suggestion, aim or purpose* may inspire or guide towards a particular solution and provide a platform for which to interpret the events. These ideas, regardless of where they originate, allow for framing and classification of an issue. Shiffman (148) explains this using the example of HIV/AIDS and how the illness, depending upon the viewer's lens, can be looked on as a public-health problem, developmental issue, humanitarian crisis and security threat. Each of these is a plausible view and its selection is dependent upon the audience. For example, Paparini et al (149), when considering HIV prevention policy, focused on which variables were included in, and which omitted from, cost-effectiveness calculations of HIV pre-exposure prophylaxis (PrEP) to draw attention to policy gaps in improving availability of such interventions. In this way engaging the academic world as well as finance and health ministers who may be more inclined to be swayed by ideas and scale of the issue, economic costs, and health benefits vs losses respectively. This leads to the rise of factors five and six, internal and external resonance. Internal resonance defines the issue, whilst external resonance achieves activity.

The political contexts element of the framework takes account that all the actors operate within a political context and have a level of influence in the development of effective strategies (150). Shiffman acknowledges that there are many kinds of political contexts but that two in particular bear significance for his framework: policy windows (factor 7) and global governance structure (factor 8). Political and public health priorities do not always align perfectly (151). The policy window happens when all the conditions are favourable for the issue driven by advocates at a national and international level, and where, everyone involved, including political leaders, agree that action is needed and there is, at least broadly speaking, a shared belief on a direction of travel and how to proceed (factor 8)(152). These policy windows often have a narrow period of opening and occur as result of external or

unexpected shocks such as natural disasters or pandemics (e.g., earthquakes (local) or COVID-19 pandemic (global)), discoveries (the COVID-19 vaccinations) or forums such as UN conferences (20). The shared beliefs can be interpreted or conveyed as laws, treaties, declarations with institutions either existing or specifically created to oversee and enforce them. Below, I will explore at length how this lens applies to the regulator within my case study, the MHRA in regulating FMD within the UK.

The final element of the framework is *Issue Characteristics,* which considers credible indicators and severity. In most circumstances these factors should be simplest to capture and thereby promote the issue. Issues that can be captured quantitively are relatively easily measured, analysed and manipulated statistically providing data that can be shared and interpreted uniformly by policymakers and other actors (factor 9). An example of this is the daily number of deaths as a result of COVID-19, which resulted in a number of public health measures, including quarantines and lockdowns. The death rate data demonstrated the substantial level of harm that was occurring to public health leading to various actors including academics, government agencies, international organisations drawing attention to the issue resulting in resources being made available by policymakers, including governments to tackle the issue. These resources are often directed to sourcing cost-effective, evidence-based interventions (factor 11).

I have used this framework with one modification, this is to present the order of the categories in a way that aligns with the narrative and development of FMD based on literature identified during my narrative systematic review, present participant data and my knowledge and practical experience of the field. The categories will thus be presented in the following order: issue characteristics, ideas, actor power and political contexts.

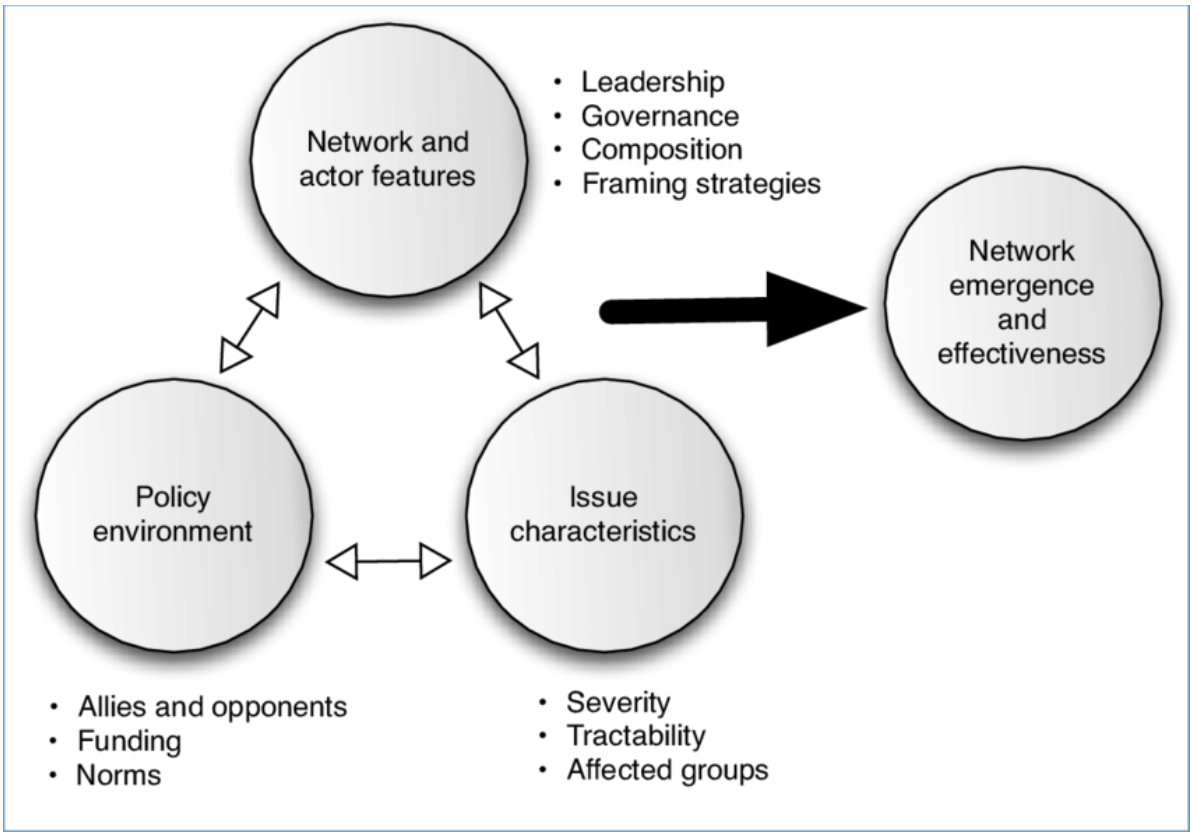


Figure 6.1: ***Shiffman et al's Political Priority Framework (PPF).*** *The framework is presented showing the four categories within the framework on determinants of political priority and their relationship (adapted with permission for reproduction from (153)*

6.2 Issue characteristics

6.2.1 Credible indicators and issue severity

It is widely documented that falsified medicines contribute to 1% of the total medicines market within the EU (2). To put this figure into context, if we consider that the total number of NHS prescription items dispensed from community pharmacies in England in 2019 was 1.12 billion medicinal items (154), 1% of this would equate to 11.2 million prescription items. Taking the approximate estimate of 1% for the whole of the UK's legitimate supply chain this figure would be substantially higher. Crucially though, this figure is an estimate, and the actual figure is difficult to quantify. Furthermore, the estimated figures from the WHO are from 2006 with no further updates or changes made to this data since its publication. This uncertainty is raised in the preliminary stages of implementation planning by an elite non-pharmacist participant when asked to quantify the scale of the problem:

> *"I'm not sure it, it does [the directive], on the basis of the current incidence in this country. But recognise that prevention is often important, and so the prevention issue. And the concern has always been expressed by European governments about particularly organised crime, and particularly in Eastern Europe. So, the kind of risks around that. So, I can see all of that. But yeah, I think it is probably a - There's an awful lot of [um] extra workload and expense to solve what doesn't appear to be a massively significant problem at this point, so. Yeah."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

The above seems at odds with what we have seen elaborated from participants in the study sites presented in chapters 4 and 5. Could it be possible that this is an example of the mismatch in the views of policy makers versus those on the front line of clinical care? Reflections on the view of other participants, demonstrate that this view may be associated with the job focus of this participant, this is to provide cost-effective services and campaign for better and fairer funding for primary care pharmacy services.

Other participants disagreed and were able to provide details and exact figures relating to the scale of the problem:

> *"Well, they reckon that the falsified market is actually worth about forty-five to a hundred and twenty billion pounds. [um] So the scale of it is massive. And that's only the - you know, when you bring - When you bring that to the fold as regards to any external presentations I've done, it's quite shocking to see people's faces, to know how big that problem actually is."*
>
> [Nick, Regulatory coordinator, First interview, September 2018]

To understand these perspectives, we need to revisit the details of FMD. The directive has at its core the view to protect public health, yet there are few, if any measures that are visibly in place to raise awareness to the public and demonstrate the enormity of the implementation process and needed cohesiveness across several territories to achieve this. Rather than risk awareness, which could result in fear of the use of medicines or mass panic that few measures to prevent, detect and remove falsified medicines exist, the public have been entirely excluded. Participants are keen to point out this omission and highlight that the risk is coming from other sources not covered by the directive, such as online and distance selling platforms which the public have ready access to and remains largely difficult for regulatory authorities to control. The focus for participants being the need to educate the public on these rather than alter pharmacy practice:

> *"So, I'd rather play to the clinical benefits than to the [er], you know, the potential to remove falsified medicines. Because I just don't think, you know - the population are not conscious of that risk. And as we discussed earlier on, they [sigh]. Over-selling protection from something which is at the moment a very, very low risk would be viewed cynically by a great many people. [um] And I think it's also just wider awareness of you know, if you buy medicines over the internet from - particularly from locations other than the United Kingdom, you can't be sure of what you're going to be getting, so. You know, if you don't get it from a legitimate pharmacy. [um] So, I, I think it's that broader understanding of the risks for people buying medicines via non-standard routes. [um]"*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

In respect of public education on the subject of falsified medicines and need to acquire medicines from legitimate sources or points within the supply chain, the overwhelming view from clinicians is that this is a good thing, but that already overstretched pharmacy teams are not the medium to address this need in silo from the wider healthcare profession. What is not explored is the view of patients and non-clinicians more widely, indicating that clinicians and more specifically pharmacists are the gatekeepers to quality and safety. The largest gap in data within UK impact assessments is that no effort has been made to capture the public's awareness of falsified medicines, what this could mean for their trust in the healthcare system or FMD as a process. I cannot accurately quantify the feelings on this based on the available data, but it may be plausible to consider that a reason for a lack of awareness of falsified medicines within high-income countries and those that have a universal healthcare system is the implicit trust by the patient to the clinician and the governance/policy systems in place. It certainly demonstrates that the ethos of the NHS which was established in 1948 is strongly shaped within communities such that *"The essence of a satisfactory health service is that the rich and the poor are treated alike, that poverty is not a disability, and wealth is not advantaged." Aneurin Bevan, Minister for Health (1945)"* is achieved.

Participants also express this sentiment:

> *"[um] No. No. I don't think there is a great public awareness. And I would be surprised if there is great public awareness to any significant degree. [um] I think it's largely going to be [um] - Patients are going to be largely unaware of this. You know, unless there is a lot of work undertaken to explain the process to them. And I'm not sure that pharmacies are necessarily going to want to be doing that. I'm not [um], yeah. [um] I'm-"*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Whilst many were able to provide details of cases that they had seen or heard or quantifying the cost and impact figures of falsified medicines, none were able to categorically state that they had ever themselves encountered such a case.

> *"…in the ten years that I've been here, never had a falsified product on our shelves, so. It shows that must be doing something right."*
>
> [Nick, Regulatory coordinator, First interview, September 2018]

6.2.2 Effective interventions

The global strategies for protection of public health against infiltration of counterfeit and falsified medicines into the legitimate supply chain varies with a wide variety of approaches being pursued at a national level (5, 6). An explanation for the disparity seen on a global scale is captured within chapter 2 and in the mainstay is due to the difference in economies and healthcare systems between LMICs and HICs. The presence of falsified medicines is known to have a higher level of economic impact on low and lower middle-income countries, but in recent times HICs are seeing an increase in prevalence of falsified medicines too (7-10). Studies have considered technological solutions for the detection of falsified and substandard medicines in a narrow index of therapeutic agents, predominately antibiotics, antimalarials and antiretroviral (ARVs); but very few have proposed high level strategies to prevent the infiltration of such products into the legitimate supply chain. It should be noted that only the legitimate supply chain has been considered in these policies and there is no account for medicine supply through unauthorised markets. This a point that I will discuss in more detail within chapter 8.

The unified action from EU countries, of which the UK was a member state until 23:00 GMT on 31st January 2020, was to address this issue through establishing the highest level of medicines authentication, with the main aim of protection of public health and sustainability of the European pharmaceutical market. This was achieved and introduced into EU law by the Falsified Medicines Directive 2011 (FMD 201162/EC). The four key parts of the directive are explained in detail within chapter 1. The focus here will be on the fourth and final phased section of the directive which impacts pharmacy practice and the digital system requirements, that is the implementation of the two obligatory safety features: i) a unique identifier ii) an anti-tampering device (13, 155).

The case for implementing an FMD solution in the UK remained unconvincing based on the severity and measures discussed in 6.2.1. Some participants considered that the drive for FMD is an EU one and not to do with any added risk seen in the UK's supply chain. The subject of Brexit drives the narrative here and provides a partial explanation as to why FMD might not be needed depending on the type of exit agreement that is achieved with the EU. The impact of Brexit is discussed in more detail within chapter 7. In the absence of the Brexit discussions and arguments, for and against, the running theme providing a source of evidence for the need in FMD implementation is the existence of other such systems in high-income countries where the measures have proved successful. A further example expressed by a participant is that if the UK does not adopt an FMD solution, it will be left behind and alienated from trade agreements, whilst leaving its supply chain exposed to falsifiers who will see the UK as a gateway into the EUs controlled supply chain.

> *"I think if you work on the basis of serialisation has been introduced elsewhere anyway, and India already has it, and the Americas are looking, and Australasia are looking at it. There is an element of - For whatever reason, it is being implemented.*

And it may be more to do with good manufacturing practice, and traceability of products. Rather than the falsified medicines risks. That it was likely to come into place anyway."

[Benjamin, NHS Services Director, First interview, January 2019]

The closest comparator to implementation on a large scale across varying regulatory nuances is perhaps the USA, a single country whose 50 states have different relevant regulations, drawing parallels to how EU legislation is enforced within member states. Koshkouei et al (156) have described the two phased Drug Supply Chain Security Act (DSCSA) plan that has been put into place between 2013-2022. The act signed into US law on the 27th November 2013 by President Obama has a clear stepwise approach which includes a number of public meetings to discuss the Act. This is something that is visibly omitted from the EU plan, instead, focusing on the higher aims of the directive than the detail, with the expectation being that member states will conduct an Impact Assessment (IA) through their own regulatory bodies at a national level.

In the UK, regulatory IAs play a pivotal role in the government's decision-making process. They articulate the goals of policy proposals and assess the costs, benefits, and risks associated with various methods, both regulatory and non-regulatory, for achieving those goals. IAs aid ministers and Parliament in determining the most appropriate approach, whether regulatory or non-regulatory, when confronted with a policy issue.

To ensure that the evidence and analysis in these IAs are of high quality and relevance, the independent Regulatory Policy Committee (RPC) conducts evaluations of all qualifying IAs, whether they are produced by government departments or regulators. The RPC subsequently releases its assessment to facilitate parliamentary review and bolster confidence in the information presented. Review of the MHRA IA for FMD published in 2013

under secondary legislation measure type, considers two policy options: do nothing and implement the directive.

The document received a favourable opinion from the RPC. There were five areas identified where cost savings could be seen if FMD is implemented in the UK as a preventative tool against falsified medicines, within this the only cost saving that was thought to be achievable directly for pharmacy being documented as “product recalls at the pharmacy and patient level”(157). The IA follows the strategic social construction, where the means-ends calculations are conducted to persuade other actors’, key influencers and decision makers of the utility function change to assuage the need for commitment of the new norm (158, 159). This means that calculations are carried out based on the costs associated with carrying out the process as it currently stands and deducted from the costs thought to be incurred after the implementation of the new processes.

There is scepticism as to if the recall procedure will be improved:

> *“Whether it will have the full traceability, [er] under the 2D data matrix, I'm not so sure that that's going to work in the future. I, I'm not sure. Because I don't think - Although we'll be batch-recording as a wholesaler, I'm not sure [um] we'll be able to trace every single batch. Because if I think about the recall, and they say that it'll enable a recall, to facilitate traceability - I'm not so sure that it will. Only because I can see too many things going wrong, or - If I look at recalls today, does everything come back? I'm not so sure it does, if I'm honest”*
>
> [Nick, Regulatory coordinator, First interview, September 2018]

To test the parameters of the calculations that were presented in the MHRA IA on FMD and to understand if all the factors of pharmacy practice and impact within the UK had been considered, I set out to understand how everyday working practices would change upon implementation of FMD. To do this, I first needed to identify trends within pharmacy workflows and capture any commonalities with a view to better understand the optimal

point where authentication/verification and decommissioning activity could take place. My approach to this is shown in supplement 1. I then considered a number of workflow scenarios that could be adopted within pharmacy to embed verification and decommissioning practices into the dispensing process. These postulated workflows provided an indicative solution for FMD implementation alongside projected costs. This was pre-DPhil scoping work that I carried out in October 2015 and later updated in 2018 to understand the potential implications to pharmacy practice. This was primarily done to provide an indication of possible workflow scenarios with FMD and the associated direct and indirect costs. What became evident from this work, is that the impact to pharmacy was greater than what had been considered. This failing of the MHRA IA, I believe contributed to the financial implications for the primary care pharmacy sector and devalued the impact to the profession.

One of the key deciding factors stated within the IA as to why the intervention is theoretically justified is that the UK is seen as an entry point to the EU for counterfeit medicines:

> *"In a large number of the medicines cases examined, the UK is the point at which the counterfeit has entered the EU. This could suggest weakness in our importing controls (although without full European analysis, this could not be proven), but also shows that the majority of counterfeits are coming to the UK from outside of Europe."*
>
> MHRA IA, page 11, paragraph 2, published 20/03/2013

This admission by the MHRA suggests that although controls would be put in place to protect the EU supply chain, any medicinal items or active ingredients used in the manufacturing process that would be purchased by the UK from outside of the EU would not be subject to the level of scrutiny afforded by FMD.

One expert participant provides further details that might explain why the MHRA believe the UK falsified medicines incidence rate is low. By looking at the number of safety alerts issued, the majority of cases relate to theft and tampering with legitimate products:

> *"And you know, we're quite lucky in the UK that we don't see a falsified alert other than theft and diversion. Within Europe, it's falsified product or theft and diversion."*
>
> [Nick, Regulatory coordinator, First interview, September 2018]

Reviewing the type and number of safety and recall alerts is a very good way in understanding the type of medicines that falsifiers target, what the commonality is in the route of entry into the supply chain and build a data trend of what is happening for regulatory authorities. I discussed some studies in chapter 2 of how such data has been used to quantify the scale of the problem of falsified medicines in the UK and the impact to patient/public health.

Falsified medicines find their way into the legitimate supply chain through a number of different ways. The most common route of entry voiced by participants is parallel imported products from outside of the EU into the UK from countries such as Egypt. I provide an in-depth analysis of other routes of entry and why these routes exist in chapter 2. Other participants were quick to point out that the figures presented are immaterial because most are estimated:

> *"But I think most of it is guesswork, to a degree - nobody actually really knows exact numbers. But we do know it's a big problem. Because you know, you hear of incidents and deaths from falsified medicines, and there's always theft, which then leads to falsification and stuff, so."*
>
> [Christian, Regulatory Quality Assurance Manager/
> Pharmacy Technician, First interview, September 2018]

Other participants have indicated there are further flaws with FMD and UK legislation in general around this. FMD is centred around the fact that each medicine pack will have a unique serialisation number that will be different to another pack of the same strength,

formulation and brand. What policy makers have not discussed is the potential for these unique serialisation numbers to be the subject of falsification themselves. The argument here is that if falsifiers are advance enough to steal, divert, compound and manufacture falsified medicines that are hard to detect in the legitimate supply chain currently, what is the safeguard for these serialisation numbers to not be the subject of theft and/or falsification themselves:

> *"It's just - yeah, the challenge around whether this is ultimately the right solution. There's, there's a - There's a potentially fundamental flaw inside the system that we should be aware of, in terms of if the unique identifiers are somehow obtained, by nefarious means, [um] and the counterfeiters get their products first to scanner - clearly, the system's not going to detect that as a falsified product. So, now while that may be an unlikely scenario, or we hope it's going to be an unlikely scenario, [um] - yeah. I mean, the whole thing about organised crime is that they are very organised, and they have [laugh] ways and means, and [er]. Yeah. So. I don't think many pharmacists are at this point terribly conscious of that fundamental flaw. And I suspect a lot more would be questioning even harder than they are now why we're introducing this. So, [er]. Yeah. But the law is the law, at the moment [laugh] certainly."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Participants have highlighted a number of tensions at play across various factors shaping the political priority of FMD but are also aware that the intervention may bring unexpected values not yet identified.

> *"Yes. Yeah. Well, I mean, if - As long as the system continues, I think we will get to the benefits eventually. I'm confident of that. Or people will be able to realise them, if they choose to implement in the right way. The challenge is going to be what Brexit brings to us, and whether we end up, you know, with a delay - a further delay. So it ends up being a bit like EPS, you know, where you know, maybe eight or nine years' time we just say 'well, we finally got that', but [er]."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Benjamin who is one of the elite participants I have interviewed has increased scepticism around the usefulness of FMD in the proposed format. They akin this to the implementation of the other large-scale digital system implementation to hit pharmacy practice which was the electronic prescription system (EPS). EPS has had a number of phased releases over the last decade with a number of updates to fix problems with the software. The clinical and operational benefits are only beginning to be realised within pharmacy, with the primary benefits being the rapid communication with the prescriber and advanced receipt of prescriptions to plan workload. Taking EPS as a measure, Benjamin is indicating that FMD, given it is a national programme across several countries is likely to take at least the same period of time to embed and become part of everyday practice.

6.2.3 Practicalities of the characteristics

One of the common issues emerging from site visits and participant interviews has been the need for granular detail, interpretation of and implementing protocols at the pharmacy practice level. The overarching theme is how will the pharmacy team adapt their working practices? What are the longer-term impacts of driving these perceived efficiencies on the wider work force onward? Certainly, within pharmacy 2, the teams do not seem to understand how the workflow processes described within the FMD SOPs provided to them integrate into their existing workflow (as described in chapter 5). The elite and expert participants, however, do not see this as particular issue. Instead, the new process documentation was indicating to workflow efficiencies that can be seen with suggestions that human operators can be phased out of the pharmacy dispensing process and replaced by robotic dispensing and automated systems in general:

"I also think that the, the assumption that automation is cheaper than humans is being made by a great many people, including people at DHSC and NHS England. But I don't think they've got an evidence base for that, necessarily."

[Benjamin, NHS Services Director, First interview, January 2019]

"In terms of input of product. So [um]. Yeah. I think FMD technically doesn't really impact a great deal on the, on the robots. Because as I say, the - the FMD functionality has really been used at the PMR end, with what x products delivered to whoever's concluding the x process."

[Benjamin, NHS Services Director, First interview, January 2019]

What is striking is the acknowledgment at national policy level that practices will have to change but a lack of detail of how and if uniformity will ever be achieved between operations of pharmacists and their teams in different locations. This gives rise to the fundamental review of the varying workflows, of which there are many within primary care pharmacy practice, even between pharmacies under the same governance structure such as multiple/chain pharmacies. Supplement 1 presents an outline of preliminary work that I carried out to capture workflows in pharmacy and to establish to what extent the pharmacy workflow, certainly from a dispensing activity could be generalised. The review of the pharmacy workflow and working practices is seen as a positive step:

"That's what excites me about it. [um] And the opportunity for people to re-engineer their processes because of that"

[Benjamin, NHS Services Director, First interview, January 2019]

The other factor that is highlighted are previous cases of falsification that have originated from trusted sources. This is indicating that even within a reputable organisation that exists within a strong regulatory framework there can be an infiltration to use the knowledge gained with malicious intent. One such example is described by an expert participant:

> *"No, but criminal gangs work in mysterious ways. So it doesn't say that there's an insider anywhere within any organisation to say 'I'm doing this'. I always remember a story that Novartis had developed something, a product. [um] And someone inside counterfeited it. ……So. I do believe they exist, in any organisation."*
>
> [Nick, Regulatory Coordinator, First interview, September 2018]

It is difficult to comprehend how such an event can happen, but the very occurrence demonstrates that there needs to be strong internal and external governance of organisations producing and responsible for the health of the population.

This finding raises further questions about whether the directive goes far enough and how data for falsification is obtained for use in organised crime. Where and how do falsifiers obtain the knowledge of the medicines they falsify given that the majority of these are not available without a prescription? How are they able to accurately replicate the markings and engravings on medicines, such as those found on tablets? Where do they obtain the details for artwork that appears on a products' packaging including holograms? More concerning is where is the equipment for manufacturing of medicines obtained? Manufacturing equipment is a specialist field and obtaining them often requires special purchases and permits, or if falsifiers are making these machines, who is helping them with the required knowledge of engineering and manufacturing? All of these questions, and many more, remain problematic in the case of FMD. The directive does not touch upon when measures will be subject to a review or how the technology solution will be updated to keep ahead of falsifiers. Methods for achieving a continuous process of improvement or suggestions of how this could be achieved in practice remain as unknown.

6.3 Ideas

In PPF the power of ideas are separated into internal and external frames. The internal frame captures the policy community's degree of alignment with the proposed solution. These ideas are also powerful in gaining momentum and support for an initiative, recognising that individual's assign different meaning and value to the objects and living things around them. The frame in this context describes how an issue is understood and viewed by the wider community (20). FMD can also be framed in a number of ways: as a digital system development; global health issue; or contributing factor to organised crime. All of these frames can intersect, exist together or separately. In most cases, one frame will resonate more with one person or community than another, thereby creating a hierarchy of the importance assigned to the same issue by different individuals. The external frame is also important, it is what motivates leaders to act on an idea. Within our example of FMD, the policy may be developed and framed as a global health issue but the funding and support to implement the initiative requires the input of policy maker, politicians and regulatory authorities at the national level.

Actors at all levels have a vision of how FMD can be implemented, with great variability in where verification and decommissioning of medicinal packs should occur:

> *"But the potential to say 'do we want to allow people scope to decommission at point of entry into the pharmacy', for example. Which a lot of people would like to do, because it may be more efficient, [er] from a logistical perspective, to do that……. Well, I - Well I think that's where the you know, the technology needs to be scanning, verifying, potentially, but not decommissioning until handover to the patient."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

There are a number of immediate downsides of this legislation, and these contribute to the external frame (factor 6):

> *"It is a bizarre aspect of the regulation. And particularly the scenario that I may have talked about on the webinar, but I certainly talk about when I'm going, been doing talks around the country - about the split pack scenario, where you've got perhaps fourteen sitting on the shelf that can be reused, but fourteen that go out of date from an FMD perspective [laughing] sitting waiting for the patient to collect them. And they never get collected, and they need to go in the bin. You know, that. It's wasteful. And it's, it's illogical. That's, that's poor - that's poorly thought through legislation."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Some can foresee issues with the plans and solutions put forward:

> *"…there's a lot of gaps that people don't know. A lot of people think it's not going to affect us. But it's going to affect everybody. You know, whether you're a hospital, whether you're a pharmacy. A lot of these organisations thought that it wasn't going to touch - encroach, or touch on them. And it is. It is going to impact them, throughout the supply chain."*
>
> [Nick, Regulatory Coordinator, First interview, September 2018]

Those involved in the design of the processes, are often not pharmacists or healthcare professionals, who quite freely point this out. Their strength is in the knowledge of the legislation and the supply chain:

> *"What impact is it going to have on a pharmacy stuff? I don't know. Will it make more work? will it make easier work? I don't know, because I don't - I've seen them dispense products, and pick prescriptions, but that's about it. I've not worked in a pharmacy to know how would that impact me."*
>
> [Nick, Regulatory Coordinator, First interview, September 2018]

One of the key questions arising is who will pay for the needed equipment? The expectation seems to be for the private sector that provides NHS services to pick up the cost, but will it be the same across all pharmacy sectors to provide a level playing field? Whilst it becomes clear as time goes on that there will not be government funding for an FMD system there is

a heightened sense of awareness amongst different pharmacy sectors to ensure that should funding be made available it is provided to all pharmacies providing NHS services:

> *"There's no clear [um] descriptors of what that should look like. [um] The functionality that it should contain. Whose responsibility is it for paying for that hardware?..... So there's elements like that. Then there's the software piece. [um] …… and who has engaged and reached out and are working alongside [um] the likes of the Department of Health and NHS England and NHS Improvement"*
>
> [Beth, National Healthcare Development Manager/ Nurse, First interview, September 2018]

The compliance with processes and ability to track what is happening at pharmacy level is raised early by the local governance and technology team. They are concerned that the proposed system is not affording visibility of what is actually taking place, meaning that there needs to be trust that the pharmacy team are doing what is expected and set within protocols:

> *"Unless we as an organisation know that pharmacy x dispensed a hundred thousand packets, did a hundred thousand units of dispensing last month, or something, and they only scanned twenty products under the FMD thing. And we can sort of say well that doesn't sound right, you should've at least scanned fifty thousand because those products would've been FMD compliant sort of thing, so."*
>
> [Omarjeet, IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim), First interview, September 2018]

Package design was considered a rate limiting step, with operators having to familiarise themselves with a number of different options to ensure that the workflow runs smoothly—for example, wide variation in positioning of the barcode and anti-tampering device. As the following quote illustrates, this was thought to add significantly to workload, detract from making clinical observations, and increase general work fatigue.

> *"Because they don't realise how much it adds to process, sort of thing. So because you've got to orientate the package, even if you've - So, even if in a pharmacy you're*

going to manually handle it, you've got to work out which side of the packet that barcode is. You've also got to know where that anti-tamper device is, to visually examine it. So, in some cases it could be you've turned it around about five times."

[Omarjeet, IT – Business Relationship Manager (Operations)/
Enterprise Architect (Interim), First interview, September 2018]

6.4 Actor power

6.4.1 Policy community cohesion

The policy community within the PPF framework is defined as a 'network of individuals that share a concern for a particular issue'. The shared issue, in this case, is the detection and prevention of falsified medicines from entering the EU supply chain. What is less clear, is what factors about this issue would result in a cause for 'concern' to the actors at each level. Whilst there was still an overall positive support for the system and background policy from the actors at each level, in what way do these actors' then go on to influence others' within their respective networks.

Participants demonstrated this power imbalance and the holding on to information that creates the hierarchy within the professional body organisations in the view that knowledge and whomever has it retains the privilege of influence:

> *"Or alternatively, if it's based on guidance from pharmacy across Europe, which it may have been, it was poor lobbying on the part of pharmacy. [um] And you know, that's - that probably is the ultimate answer, [er] that we didn't advise the parliamentarians and the commission staff appropriately. We, we pharmacy, not we the organisations, because we've [er] - we've never had a - We've never been allowed an involvement in European stuff, that's always been jealously guarded by the NPA and RPS as the member of [um], of PGEU. So, [er]."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Concern is further expressed about the readiness of pharmacy by an expert participant. There are few individuals at this hierarchical level who are voicing negative opinions on the progress of FMD implementation and the ensuing requirements for readiness:

> *"I think we'd fall over tomorrow. If that comes in next year, on the 9th of Feb next year - I think we'd fall over if we had to batch-record every single product that comes through, your goods inward stuff. Because I don't think we'd, I don't think have the capacity to do it."*

[Nick, Regulatory Coordinator, First interview, September 2018]

6.4.2 Leadership

At every level there are individuals who emerge as champions for progressing the issue of FMD and what the following participant is describing is the emergence of individuals who understand the importance of the issue and the challenge in bringing others along for the 'journey'.

> *"I, I think there's now decent basic understanding around it, about falsified medicines, counterfeit medicines, whatever. But, but I think those who have thought more about it probably are in the challenging is there a significant need for this, what is the problem we're trying to solve? And we certainly see a lot of that when we've… other events. So yeah, we'll get challenged on that. [um] So. The rest of the pharmacy team? I suspect that the majority of pharmacy team at this point don't have a clue about FMD, for a start. We will see that change radically over the next few weeks, as it starts to become real, and equipment starts to be installed, etc."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

In identifying champions, Benjamin is emerging as a leader determined to highlight the progress that is being made. This is seen here when describing the use of the added value in the digital system that allows for paperless and print-free dispensing of NHS prescriptions:

> *"…I mean, I know one of our committee members, who's effectively our kind of lead committee member on IT, because they have a particular interest in it, does use that functionality and has for a long time. But other committee members who also use [this solution], you know, haven't chosen to adopt that…. is surprising, but [um]. I think it will become [um] increasingly unjustifiable to not be using such, such functionality.*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

Expectations on standards and quality varied among interviewees but the larger the organisation and its economical ability, the higher the value was perceived to be assigned in developing procedures that others within the industry will follow:

"The MHRA expect of the top three of us, that we should be setting the standard for the industry."

[Nick, Regulatory Coordinator, First interview, September 2018]

In larger organisations with pharmacies located in the UK and Europe, there were signs of a desire to work collaboratively to achieve a unified solution across the individual businesses at the very least. The competing interest and variation in the interpretation of the directive seem to have hindered this desire and ultimately led to failure in a unified approach with each part of the organisation complying with the norm for their respective territory:

"And the guys in [head office] did try to set, we did try to coordinate and do stuff. But every business unit had its own priorities and stuff, and they've gone their different ways. [er] but again, recognise the fact that if you did it as a group, it could've been difficult to get a supply that could support everybody as one thing. But then you're also putting all your eggs in one basket. And if it goes wrong then we're all, the whole thing – [goes] down."

[Omarjeet, IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim), First interview, September 2018]

6.4.3 Guiding institutions

There are a key number of negotiating organisations and professional bodies within the pharmacy field. One of these is the Pharmaceutical Services Negotiating Committee (PSNC), now known as Community Pharmacy England (CPE), that supports the interest of community pharmacies in England. When discussing the possibilities for different system types, integrated, standalone or interfacing with an EU wide system, this body emerges as positively supporting the interests of pharmacy and advances in methods to improve patient safety through computerised accuracy check as a safety net to human practice:

"….I think we would be arguing for that, from a PSNC perspective. Because I think that's what contractors would want. …… - If we looked five years from now, and if there's a significant patient safety incident that is a result of simple inaccuracy in choosing medicines, that a court or coroner is going to look kindly on any pharmacy that's chosen not to utilise that functionality within the FMD system."

[Benjamin, NHS Services Director, First interview, January 2019]

There is a distinct absence of an organisation that is coordinating pharmacy efforts for implementation of FMD. Although the government's roundtable on FMD was held in March 2016 with key community pharmacy professional bodies including the RPS and other representatives in attendance alongside the MHRA and Department of Health (DH), the community pharmacy FMD working group was not established until after this date (160). There was a view that pharmacy should look to other industries to find a solution and support that provides the needed regulatory standards:

"The veterinary industry is so tightly regulated, and so tightly controlled. Like meats. And yet medicines? It's a bit of a commodity. You know, to think that - It's like going to your newsagent and picking up a packet of sweets. That's how I see the wholesale sector. It has been 'we're selling sweets'. It's not tight enough controlled.

[Nick, Regulatory Coordinator, First interview, September 2018]

6.4.4 Civil society mobilisation

Identifying who has influence to develop a system that meets the criteria from a pharmacy practice level is not entirely clear, there is not one pharmacy or pharmacy organisation that can be identified. The onus seemingly placed on individual pharmacies to champion their needs and requirements and escalate this up to the policy and system levels. The exclusion of this level of detail is thought to not be required for definite within the legislation for FMD:

"Because it's not legislation that's required for that. We need to drive it. Pharmacy contractors need to drive that. They are the customers; they buy the systems. If the

systems aren't fit for purpose now, that's what - you know - the customer needs to tell the [er], the providers what they need. Now, I mean, … , the national bodies have got a role, NHS Digital has got a role. But the person that writes the [er] - well, sends the BACS for electronic payment rather than writing the cheque probably, these days, is the person who's got the ultimate power, because they're the customer."

[Benjamin, NHS Services Director, First interview, January 2019]

There was a concentrated effort in understanding problems associated with FMD implementation and creating a shared forum where ideas and problems can be exchanged:

"[um] We have an FMD working group teleconference on Monday, and we'll no doubt get an update from SecurMed on how the registrations are going, and it'll be very interesting to see how that is going. [um] Either way, I'm sure we'll need to do another push on comms, to remind people, but [um]. But, yeah. The process seems - On the grounds I'm not getting inundated with complaints - silence is always viewed as golden, from our perspective."

[Benjamin, NHS Services Director, First interview, January 2019]

Those championing the training and education on falsified medicines were receiving concerns from the pharmacy professionals querying the appropriateness and effectiveness of the intervention. These concerns were expressed at all levels from policy makers to the pharmacy teams, but the answer did not seem to be provided by anyone at a specific level. At the pharmacy practice level, leaders looked at the policy makers to provide a solution for the seeming gap in their proposal. It remained unclear how the policy makers would address this if at all, indeed no such development has been made to date.

"So, teaching that side of it, and you know, people turn round to me and say, 'well, what's a 2D data matrix going to do - surely that can be falsified'."

[Nick, Regulatory Coordinator, First interview, September 2018]

6.5 Political contexts

6.5.1 Policy windows

It is difficult to establish specific points where decision makers are influenced by advocates, but, one such opportunity arise early on in the interview process where an advocate for FMD uses a success example from another country to demonstrate that FMD is bringing practice in line with other countries.

> *"In the same way it's being used elsewhere in the world, examples… in Australia, for a great many years."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

6.5.2 Global governance structure

The pharmacy sector appeared relaxed in their implementation approach, collaborating and confident that the regulatory authorities would be lenient with compliance. There was some degree of taking the 'we will all progress at a similar pace and see what happens' approach. The outliers here were the small or independent pharmacies who were unprepared, and to some extent, and, as a direct consequence of a lack of funding to develop their system infrastructure in hardware and software.

> *"You know, we know that the large multiples have clearly got their systems sorted. They may not have implemented yet, but they know what they're doing. …… I think there are lots of independents who are probably just hoping it's going to go away, so there will be that panic. [um] But I think we're also going to see - The reality is, it's going to be a bit of a journey. It's going to be like the GDPR implementation, and the information commissioner, she talked about the fact this was a new journey, and you know, not everyone's going to be implemented overnight. Yes, there's technically a legal requirement there - MHRA, GPhC, aren't going to be wanting to start prosecuting people on the 10th of Feb if they haven't got [er] you know, compliant systems."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

This relatively hands-off approach by the regulators is echoed from other participants. The view being that if falsified medicines are not detected and are found within the supply chain then this will likely change the regulator's position on enforcing the terms of the directive more strictly. There was confusion also as to which organisation would regulate pharmacy. Would it be the GPhC as the pharmacist and pharmacy regulator or the MHRA as the competent authority and, in the view of many, the 'owner' of FMD legislation in the UK.

The 'see what happens' approach is thought to be in part a consequence of the struggles facing some community pharmacies with contractual year on year funding cuts:

> *"We will see more pharmacies closing, I'm sure. [um] And you know, while the government and NHS England are not necessarily willing to openly accept what previously was said in parliament, the reality is they probably do think we have too many pharmacies in England."*
>
> [Benjamin, NHS Services Director, First interview, January 2019]

The ingenuity of pharmacy practice in overcoming what is considered poorly negotiated terms of FMD and incompatible with UK practice is described by all levels within the UK from the policy makers all the way to the clinicians when considering the 10-day rule. This ruling effectively meant any decommissioned medicinal items would have a maximum of 10-days to be reinstated on to the FMD system before becoming obsolete. This is seen as wasteful in a UK system where advance dispensing, that is preparing a prescription ahead of time to reduce patient waiting times and increase pharmacist availability for clinical consultations, is the norm. The workaround was to find efficiencies and alternative ways of working within the existing system or influences on system selection:

"Well, the ten-day rule forces you to really adopt an integrated system. So, you know, if - if you don't adopt an integrated system, or you know, a system that has some kind of aggregation to a barcode on the back label, it's going to be very difficult. And I haven't given a great deal of thought to what that process would look like, because it just doesn't seem a sensible approach. You know, I think you either have a proper integrated system that builds in the aggregation, or you know, some of the standalone systems, as you'll be aware, have found a way to create a - you know, to aggregate to a unique barcode. So either way, I just think you need that. It's the only sensible way it's going to operate. [um] Unless you're willing to run the risk, and then ignore the fact that you know, technically it's not legal to reissue to another patient a medicine that has been decommissioned already, so. [er] People may well just choose to turn a blind eye."

[Benjamin, NHS Services Director, First interview, January 2019]

Others were less specific but were able to draw a comparison with the implementation that they are conducting in the EU:

"The implementation that we're doing in Europe and in the UK for the start off for next year, I don't think it's going to fill all the gaps, it's going to. The biggest burden is on the pharmacy."

[Omarjeet, IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim), First interview, September 2018]

6.6 Discussion and conclusions

In using the actor power framework Shiffman has articulated the factors involved in shaping political priority. Applying this framework to my own case study, I have confirmed Shiffman's earlier findings that health initiatives are more likely to attract political support when they share specific features spanning across several categories. What I have seen from following the implementation process, including pre- and post- Brexit is that taking these categories and aligning them with the policy and system levels does not necessarily translate or allow interpretation in the same way as in front-line pharmacy practice. This creates a disconnect between the central policy (which tends to assume a standardised implementation process)

and the variable reality of local implementation. This is something that has been previously observed when considering the subject of health inequalities. In the early stages of development of health inequalities agenda, national policy makers and clinicians welcomed the discussions. As time progressed their expectations were not met, because, of how the policy agenda evolved at the local level. What was found, is that national and local agendas need to work in unison to keep the policy window open for long enough for change to be made possible. Otherwise, wider policy and organisational issues become a barrier to policy implementation (161). The actual occurrence as observed is that central policymakers develop the ideal solution, this is translated with further detail at the national policy level, highlighting what is a possibility, then once implemented becomes the reality or what is operational at the pharmacy practice level.

If there is a power dynamic between policy makers, regulatory authorities, and clinicians at the pharmacy practice level it is not readily evident. There are no public disputes or publications supporting or criticising the policy development from clinicians nor from their professional and regulatory bodies. However, there is a distinct absence of pharmacy, pharmacists, and their patients mentioned or acknowledged as the ultimate end point of the pharmaceutical supply chain. This is evident in the development of FMD, where the IA conducted at international and national level omitted the impact on pharmacy practice. The MHRA, as a regulatory authority, omitting pharmacy as a key factor in the process and a leading healthcare profession critical in the delivery of the directive is a telling one. Arguably, the MHRA does not see itself as the authority to represent pharmacy and the clinicians that practice within it. The responsibility for pharmacy therefore rests completely with the pharmacy and pharmacist regulatory body the GPhC and to some extent the RPS as the professional body, to be the voice for this profession. Policy developments that impact it,

whether or not government wish to include, engage with or consider pharmacy as player within the supply chain needs to have the GPhC and RPS at the forefront lobbying for the interests of the project. If pharmacy and their representing professional and regulatory bodies are to be considered grassroots organisations (factor 4) then it is at odds with the framework that FMD should have succeeded at all.

The IA conducted by the government bodies have omitted the impact to pharmacy and pharmacy practice more widely. There is a disconnect between the level of power at the national and international level with the final end point, the transfer of medicines to the patients. This may be as a result of national authorities understanding of their supply chains or difference in practice between UK and EU healthcare systems more generally. It is widely understood that community pharmacy practice in the UK is different to that in some EU member states, not least due to the nature of the NHS and the way funding arrangements are made in comparison to those in the EU which are predominately insurance-based systems.

Fundamentally, the UK being cited by the MHRA as an entry point to EU for counterfeit medicines is an admission or at least an indication that although controls would be put in place under FMD to protect the EU supply chain, any medicinal items or active ingredients used in the manufacturing process that would be purchased by the UK from outside of the EU would not be subject to the level of scrutiny afforded by FMD.

It could then be implied that the measures would protect the EU but not the UK. This brings into question the appropriateness or completeness of the intervention for the UK supply chain. To a certain degree it would provide the EU with assurances when undertaking

medicine trade but would not necessarily afford the same level of public health protection for the UK.

Well-financed corporate and private agendas can act to undermine the pursuit of health for the wider public (158) which may be one consequence of Brexit, but yet does not explain the lack of funding for pharmacy to achieve compliance with the directive originally and only seeks to explain the resulting outcome post-Brexit. The subject of Brexit is discussed in more depth within chapter 7.

The political priority for FMD or a UK standalone solution has diminished, closing the policy window, if indeed a window existed at all, raising the question of where the pharmaceutical supply chain's power exists. Whilst the COVID-19 pandemic has required a great deal of research and resource on a global scale, the impact of falsified medicines on health and their existence within the supply chain remains an evident reality.

This is seen by the example of early reports in February 2020 that chloroquine and hydroxyquinol could be effective treatments for COVID-19, then in March 2020 falsified batches of chloroquine were detected within the official supply chain in Cameroon (162, 163). The quick timelines associated with the rise in demand of a medicinal item and the time to falsification can be seen through this example to be very small. This creates a narrow window of opportunity to detect falsified medicines and protect public health. It can therefore be concluded that there must be strict levels of control and regulation on the legitimate supply chain regardless of the route the medicine is sourced, along with full traceability in place at every step of the process.

A number of institution exemptions were put in place as part of the policy drafted for FMD which created a disparity between practices of different healthcare institutions under the article 23 sites (chapter 1). The type of institution listed in article 23, varies between each EU member state and in most cases exempts the organisation from verifying and decommissioning medicinal products subject to FMD by virtue of the impracticality of implementing a digital system for this purpose. In the UK for example, prisons and hospices were exempt from compliance with FMD, instead the verification and decommissioning of medicines rested with the medicine supplier. This removed the level of control of medicines up to the point of patient use as it created a gap between when the medicine was ordered, stored and then used. All time periods where theft of medicines could have taken place and been used for falsification purposes.

The nature of these political complexities and the tension that exists between selecting and prioritising health issues determine the collective value that is placed by politicians on public health. The retrospective exemptions put in place for certain sections of the healthcare system signal that policy development was not considered for all aspects of the system and entry points for which medicines would be retained and supplied to patients. This omission demonstrates that experts including clinicians within pharmacy were not consulted as part of policy development.

Chapter 7 Results 4: Impact of Brexit and policy adaptation post-Brexit

The UK exiting the EU, commonly referred to as Brexit, was an external shock to not only the implementation of, but also the continuation of FMD within the UK. The debate on what would happen under various scenarios was a point of discussion from the outset of FMD implementation. The regulatory bodies within the pharmacy and pharmaceutical sectors pushing forward penalties for non-compliance or an active willingness to demonstrate reasonable progress in adoption of the legislation, made some impact in the pharmacy sector's compliance but did not truncate the underlying scepticism of what would happen post-Brexit.

In this short chapter, I capture the views of the study participants over the duration of my fieldwork to present the essence of how the conversations evolved overtime.

7.1 The emergence of Brexit as a factor in FMD implementation

The potential impact of Brexit was a topic raised within the pilot interview I conducted in May 2017. At this point, there were no questions on the 'type' of Brexit that could take place but the hypothetical scenario of what would occur when it did:

> *"Yeah, well that's - So, the [um]. Where we are at the moment is that there's a letter gone to the government and everybody else this week from the [redacted], and the UK FMD working group. Two things - a) asking [um] - I suppose these are the people in pharmacy asking 'oh, will Brexit mean we don't have to do it'. And then the second point is trying to get the definition. So, somebody in the Department of Health has gone 'no, time of supply is when you hand it out to the patient'….."*
>
> [Ewan, Head of Operations, Pilot Interview, May 2017]

The sending of this letter mentioned by Ewan to the government and wider policy makers from the FMD stakeholders, demonstrates an early awareness of the impact that Brexit could play on healthcare and the FMD project in particular. In my follow up interviews, I attempt to establish if a response from government was receipted, but this did not prove to be the case. I did establish that this unknown looming possibility had a great impact in the priority and urgency with which FMD was looked at by stakeholders:

> *"Now, if we knew it was three years down the line, yeah you've got time to develop it. But because everybody's been 'it won't happen, it won't happen, it won't happen'. Everybody's used Brexit as the excuse for why it's not going to happen. And I suppose we did, as a business, but I think it got to about September, October last year and I said to [redacted name], 'no, this is going to happen'."*
>
> [Ewan, Head of Operations, First Interview, July 2018]

A number of participants expressed that some assurance had come from the then Prime Minister, Theresa May, that the Medicine's Law would continue to be applicable. This assurance gave the healthcare industry the guarantee they were seeking to continue with implementing a number of healthcare policies, of which FMD was one.

There was still scepticism even when the highest level of government office had indicated a business-as-usual approach within healthcare. The implementation though, seemed to be something that was needed even if it was to be over a fleeting period of time:

> *"I think - I think it's all about timing, isn't it. The challenge that's happened is that you know, FMD comes - or this bit of the FMD lands on the 9th of Feb. Just you know, literally months before the Brexit thing's supposed to go. So, there's definitely going to be three months where we're still in Europe, so we're going to have to do it."*
>
> [Orla, Head of Regulatory and Responsible Person/ Pharmacist, First Interview, July 2018]

The need for FMD to remain in place was seen as a way for the UK to continue to keep up with the EU regardless of the political situation:

> *"And then even with Brexit, people were thinking 'oh, it's going to go away'. And you look at it in a perspective of as a UK, as a country, the government really want to be putting people at - putting an inferior standard in, because it's just going to make - If we don't implement it in the UK, it's going to be a centre or a source for illegal - [er] pharmaceuticals to enter the market, sort of thing."*
>
> [Omarjeet, IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim), First Interview, September 2018]

Another participant echoed this:

> *"And who knows what Brexit's going to do? Although it's not going to affect FMD. We just don't know. And I don't think the government know, at the minute."*
>
> [Nick, Regulatory coordinator, First interview, September 2018]

The confidence in government, regulatory bodies and policy makers in general was quite strong. The conviction in which participants viewed no changes to FMD continued to be demonstrated:

> *"None whatsoever, in my view. And I've been quite clear on that. The government has said they want healthcare to be part of the transition period. So even if it's going to impact, it'll be right up until the end of 2020. And secondly, they've said actually, if we leave the EU and they don't allow us to play with the hub, we'll use a UK hub. We might not have it right from next year, February. But in time, I think the government wants to do what Europe is doing. And if we're not allowed to play with the Europeans, then we'll do it on our own. So I don't think Brexit will change - who knows? [laugh] That's the nature of Brexit, isn't it. Nobody knows, yeah."*
>
> [Christian, Regulatory Quality Assurance Manager/ Pharmacy Technician, First interview, September 2018]

The UK having FMD or some system in place to protect the public and ensure movement of pharmaceuticals and trade with the EU, continued to be a prominent point of discussion. Prior to my follow-up interview with Omarjeet, it was clear that there would not be a reversal

of the Brexit referendum vote that took place on 23rd June 2016, meaning that the UK would be leaving the EU and Brexit thus became a tangible reality (164). This though was not thought to affect FMD operations:

> *"The legislation as a whole, I think is fine. But it's then supporting it, backing it, giving that steer and guidance -…. Because we've invested all this stuff in there. And now if we then switch that off, if and when Brexit happens, it's like well how can we - We could either be inundated with falsified medicines, or we could be a country that [er] becomes a supplier of, into the wider, outside of the UK, of falsified medicines as well."*
>
> [Omarjeet, IT – Business Relationship Manager (Operations)/ Enterprise Architect (Interim), Second Interview, June 2019]

As the months progress from June 2019, there were a number of Brexit scenarios under consideration with two leading options. The first being a 'soft Brexit', where the UK would be out of the EU but would retain strong economic ties, make budgetary contributions, and allow free movement of people (165). The other option was 'hard Brexit', whereby the UK stops being a member of the EU single market and establishes full control of its own law-making and immigration (166).

The benefit of FMD was still thought to be a realisation, regardless of the type of Brexit scenario that ensues:

> *"As long as the system continues, I think we will get to the benefits eventually. I'm confident of that. Or people will be able to realise them, if they choose to implement in the right way. The challenge is going to be what Brexit brings to us, and whether we end up, you know, with a delay - a further delay. So it ends up being a bit like EPS, you know, where you know, maybe eight or nine years' time we just say 'well, we finally got that', but [er]… well, it's - It was - It's taken over ten years to implement fully."*
>
> [Benjamin, NHS Services Director, First Interview, January 2019]

There was a wider hesitation with the hard Brexit scenario and the clarity that this option would bring other challenges that were going to have wider and bigger implications for UK healthcare that would eclipse FMD policies:

> *"Depends what kind of Brexit we get. [um] You know? If we go in for a the full monty chaotic thrash out Brexit, then the Department of Health are clear that they will effectively pull the plug on FMD. It will cease to happen. At least in sort of the immediate future. But frankly, if we go for the full monty thrash out Brexit, that is the least of our problems."*
>
> [Kristoffer, International Pharmacy & Policy Manager, First Interview, February 2019]

In my second interview with Benjamin, the mood has shifted with thoughts progressing to 'what if' the hard Brexit scenario would take place. The potential that could be realised of this scenario, which is known to result in the most significant changes to current practice was viewed as a positive step-change:

> *"And it'll be further delayed if we end up with a hard Brexit, and we're out of the FMD European system and we have to redevelop our own system. [um] That does have the benefits though that you potentially could be, you know implementing law in a different way. [um] And it, it could give us the freedom then that - For example, scanning on entry, decommissioning on arrival at pharmacy could be a route that people could take. [um] You know, if people want to do that, well all well and good, and it'd be a shame to lose that accuracy checking aspect. But, you know, if people are so under the cosh from a kind of [er] economic perspective, you know, that - that at least - having a UK legal implementation would, would allow us to potentially do things differently. You know, some of the things like the ten-day rule. Which just isn't terribly practical."*
>
> [Benjamin, NHS Services Director, Second Interview, July 2019]

This view was not shared more widely however, with other senior stakeholders foreseeing problems in progressing any changes to FMD at the UK level, citing parliament and ministers as the rate limiting step in decision making:

"Ireland sort of really kind of suddenly leapt forward at one point, because you know, the line of sight between the guys doing it and the Minister, it wasn't that big. You know, eventually this went to the Minister and the Minister said 'fine', and suddenly it's happened, you know? The line of sight from us to the Minister - particularly once our Minister's going to start getting distracted with Brexit -I mean, it was always a struggle in the UK. I mean, getting them to commit to FMD, and say something in public - you know, that was …. It's never been a big thing, and they don't really understand what's going on in the background, and it was never a major issue. I mean, it wasn't - medicine supply chain isn't a major debating point in parliament at the best of times. You know, you're involving a sector that nobody really knows much about. Particularly invisible distribution parts of it that nobody even sees. And [um], it just happens in the background. And then, you know, Brexit was like the sort of dark cloud on the horizon that became, you know, the storm that it is now. You know? Encompassing, you know - Literally, a black hole opened up at the heart of government [um], with a proper event horizon, through which nothing was coming either way."

[Kristoffer, International Pharmacy & Policy Manager,
Second Interview, May 2019]

This uncertainty continued. By June 2019, there were some signs that the MHRA, as the regulatory body, was providing communications to the wider sector on progress with key decisions on legislative impact:

"…the MHRA have made all the right noises, that every single law will be aligned to Europe. The question is, do we get to play with the European hub? And if not, then what does the UK hub look like? And how soon can we get our own hub? You know? To be able to continue verification. And what risks does that bring for products which are coming then?"

[Christian, Regulatory Quality Assurance Manager/
Pharmacy Technician, Second interview, June 2019]

There were many unanswered questions. This, coupled with trust and reputation damage for pharmaceutical trade with other countries alongside problems with medicines supply to patients within the UK as a potential envisaged problem was a cause of concern:

"Because we don't have any mechanisms to ensure sort of compliance or validity here, that that could be the source [of falsified medicines]. And it then puts more burden on businesses and reputation."

[Omarjeet, IT – Business Relationship Manager (Operations)/
Enterprise Architect (Interim), Second Interview, June 2019]

7.2 Conclusion

It is clear from the data captured as part of my elite and expert interviews, that Brexit was always a consideration and point to be aware of for impending changes to legislation. It was never discussed or voiced by participants that Brexit would see the discontinuation of FMD completely within the UK and was seen as something that would only result in a devolved system, which could function independently of the EU system but would continue to interface in some fashion.

The policy experts in my dataset all firmly believed that some adjustment would be needed to the implemented FMD solution beyond the adaptation of the legislation and processes implemented over time to keep abreast of practice, clinical changes and counterfeiters' developments in order to account for the regulatory changes that would ensue post-Brexit. None believed that the UK would be left without any functioning system, exposing the country as the only Western European country without protective mechanisms for its medicines supply chain. This though is exactly what took place, with the exception of Northern Ireland (NI) which would continue to operate with the implemented FMD solution as part of the alternative trade agreements in place with the EU under the Northern Ireland Protocol (NIP), meaning medicines in NI will be governed by EU rules and regulations.

What is an extraordinary outcome is that the MHRA would continue to enforce this legislation in NI, thereby creating a split regulatory and enforcement procedure for devolved nations. Factors to consider here can be attributed to are the implications of having two sets of procedures within the MHRA, with the regulatory bodies' personnel and enforcement officers continuing to work with the status quo imposed on pharmacies since 2019 for FMD in NI and then a subset for England, Scotland and Wales of practice post-FMD. This disparity

in practice has the potential to cause regulatory confusion and requirement for specialists to be retained or created to look after matters relational to NI and be abreast of legislative updates within the EU. It also brings into question and disrepute the decision to dismantle FMD in the other devolved nations. If arguably there is a need to protect patient and public health against falsified medicines — and this is seen as a key factor as part of the NIP — then why should the public in other parts of the UK be exposed to the potential health impact of this exposure? This is a critical question for which, three years on, the MHRA does not have an answer, proposed solution, nor a timescale of when such a system, if any, will be achievable.

In the case of FMD, Brexit demonstrates how legislation — even those meant to serve and protect the public from detrimental health impacts — are subservient to the wider political agenda of the times.

Chapter 8 Discussion and conclusion

8.1 Introduction

In this chapter, I bring together all of the findings from the preceding chapters to make sense of the collected data and methods upon the presented results, coupled with future research directions and approaches. In addition to this summary of my research, I demonstrate the contribution of these results to digital system implementation in pharmacy practice, primary care and the wider healthcare field that will be as a result of policy-driven change. I then provide five key recommendations in the form of questions to policy makers for consideration in the selection, policy development and clinician support requirements for future policy-driven healthcare practice changes.

8.2 Summary of aims, methods, and findings

In this research, I have presented the factors that explain the fortunes of a policy-driven technology-supported implementation within primary care practice, through the case of FMD implementation within community pharmacies in England. To achieve this, I divided my overarching question into four sub-sets to understand the impact of policy-driven change on clinicians' practice, patient safety, clinical effectiveness and workflow, and challenges with implementation and sustainability more broadly.

In chapter 2, my literature review explored the global strategies to combat falsified, substandard, and counterfeit medicines, and the reasons for needing such strategies at national and international levels. My review found that literature in capturing and quantifying the scale of falsified medicines at UK, EU, and on a global scale is sparce and outdated. It can be argued that in order to identify the scale of the problem we must first

have in place a systematic and effective approach to detection of falsified medicines to accurately quantify in tangible numbers the quantity that would have entered the legitimate pharmaceutical supply chain in the absence of such measures. From this, a more accurate percentage of falsified medicines to the overall numbers of medicines within the supply chain can be obtained which would provide a picture of how effective these strategies are in practice and subsequently in what way, if any, they could be improved upon.

My literature review has given focus to three key case studies from high- and middle- income countries that have resulted in detrimental health effects on the target population for the legitimate medicines, a summary of which is presented in Table 2.2. It is correct that the majority of such cases occur in low- and middle- income countries and more specifically within the African subcontinent, but this should not be taken as comfort for countries such as the UK. With world travel and increasingly transient populations becoming more accessible and routine, the global problem will still exist through the transmission or evolution of infections alongside impeding drug resistance as a result of falsified and substandard medicines at the international level. One example of rapid transmission of infection on a global scale is coronavirus disease 2019 (COVID-19) which occurred during this research study.

In section 2.1.2, I provided a comprehensive overview of why substandard, falsified, and counterfeit medicines occur. I now return to one of the causes of these, which is medicine unavailability as a leading cause of falsified medicines, where demand and access drive the supply requirements for specific classes of medicines. This has been displayed profoundly during the COVID-19 global pandemic, where the WHO classified COVID-19 as a public health emergency of international concern on 30th January 2020, and subsequently characterised

the outbreak as a pandemic on 11th March 2020. The pandemic can be viewed as a quickly unfolding global situation with many unknowns, including the pathology of the disease and effective treatments. This resulted in public demand for treatments that were being reported to provide protection against the disease. One such example of a medicine is hydroxychloroquine, a medicine prescribed in the UK for the management of active rheumatoid arthritis, systemic and discoid lupus erythematosus, and dermatological conditions caused or aggravated by sunlight, and in the early days of the pandemic reported by some studies to be an effective treatment for COVID-19(167, 168).

There were initially concerns raised that such a demand would reduce medicine availability and cause shortages for the established prescribed indications and result in patients with existing autoimmune diseases stated to not be able to obtain their prescribed treatments (169, 170). In March 2020, some pharmacies in Africa, namely, Cameroon and the Democratic Republic of Congo, reported falsified batches of hydroxychloroquine tablets. Analysis of five samples demonstrated that these products were falsified and contained paracetamol and metronidazole. Whilst no other harmful excipients were detected, this identification did highlight that these products were not substandard and/or from reputable sources, but rather made and distributed by organised criminal entities. These falsified medicines were initially detected through visual observation of the labels which contained spelling mistakes and cited manufacturers that did not exist (162).

When there are legal restrictions in the procurement of medicines by patients, such as in the absence of a valid prescription, prescribers not being able to supply specific brands or the patient not qualifying for a particular therapy under the universal healthcare system, patients feeling embarrassed by their condition and/or wish to take the decision of self-therapy, the

most accessible form of acquiring medicines is often the internet. The internet serves as a gateway to the acquisition of medicines from unregulated sources, specifically within high-income countries (171), which exist alongside regulated online pharmacies that are often difficult for patients to differentiate between. One method by which FMD sought to address this problem was through the requirement of an EU common/obligatory logo (Figure 2.3) to be displayed on the website of online pharmacies and other websites trading medicines lawfully. This logo has the national flag of the EU country where the pharmacy or retailer is registered or authorised to trade and when accessed from a legitimate website directs the user to the national competent authority, which for the UK is the MHRA. This method provided a unified way for users across the EU to have one method of identifying websites trading lawfully and subject to regulation in each country. After Brexit, this functionality and mandatory registration scheme no longer exists within the UK. The GPhC do still operate their voluntary internet pharmacy logo scheme, however, as registration is not mandatory it would be difficult for members of the public to identify all websites providing or selling medicines legitimately.

The economic factor at patient/public and national level can also be linked with medicine availability and key driver in falsification. In Table 2.3, I summarised how The World Bank categorises member countries in to one of four income groups. A limitation of many studies I encountered within my literature review is the consolidation by researchers of these income groups into three categories, combining lower-middle and upper-middle income economies. This amalgamation poses a challenge due to the vast range spanning from the lower ($1,136) to the upper ($13,845) GNI per capita financial threshold. This creates a complexity that blurs the distinction between what is financially viable and what is influenced by political decisions.

Regrettably, this limitation persists across reviewed papers without acknowledgment. In this amalgamated (lower – to upper- middle GNI per capita) middle created group, political leaderships and health strategies may change within the electoral cycles or other political eventualities. Thus, creating a transient move between the official four income groups, but no real change in availability and healthcare infrastructure. Nevertheless, what does change significantly are individuals' access to healthcare and medications from legitimate suppliers due to economic shifts, including inflation, often leading to price increases. This issue is particularly pronounced in locations operating private or insurance-based healthcare systems. Addressing this gap requires explicit acknowledgment and transparent reporting in studies to present an accurate depiction of capabilities and hurdles. Given the UK's consistent classification as a high-income country over the past two decades, emphasis should remain on comparative analyses with other high-income countries concerning various established measures within the other three economic categories.

My literature review has broadly identified that the actions prior to FMD have predominately targeted the detection of falsified medicines through a variety of techniques which are covered in more detail within section 2.4, thus demonstrating a need for a continuous system of prevention to address the issues of the infiltration of falsified medicines into legitimate supplies. Having confirmed my postulated gap in practice, FMD and exploration of its fortunes as the continuous detection and prevention mechanism, became the focus of a single case study of policy-driven digital system implementation.

This detailed analysis and single case study approach provided the depth and relevance of the data, given that I was immersed in the field, able to gather data in the context of clinician and pharmacy practice to explain the how and why questions (84, 96). As explained by Stake,

case studies add to existing experiences and increase our understanding of these (97). The NASSS framework provided the theoretical approach for my research in capturing the rich narrative of FMD as a single case to demonstrate the potential for NASSS to be used more widely within the complex healthcare ecosystem of pharmacy practice and digital system implementation. Second, my findings show that policy-driven implementations within healthcare and pharmacy practice specifically, do not dictate the absolute acceptance of the policy or the accompanying clinician practice changes. The view that policy can direct, dictate, and control clinical work is misguided. Instead, I propose that pharmacy practice should be viewed as a complex system existing at a cross-sectional layer within wider healthcare and that policy needs to fit into the frame of clinical work to support the innovation.

8.3 The fortunes of policy-driven technology supported initiatives: factors identified from the case of FMD

To understand the factors that explain the fortunes of FMD and wider lessons that can be learned, I approached data collation from a number of sources that are shown in section 3.3.11. My fieldwork, although interrupted prematurely due to the COVID-19 pandemic, was fruitful and provided 162 hours of researcher observation accompanied by fieldnotes. I set out to make sense of this qualitative data set utilising the NASSS domains as presented in chapter 5. In the context of FMD, it is domains 2 to 7 that bear relevance to the implementation, since domain 1 is obsolete given that there was no specific target patient population. This though created a gap and a silence in the data with respect of the impact that FMD would have on the patient population and what choice, if any, patients would have on the design of this policy and its adaptation over time. In the IAs and subsequent toolkits

created to guide implementation, there was no focus given to seeking the opinions of patients or the wider public. This sits at odds with the primary aim of the policy being protection of patient/public from harm as a consequence of falsified medicines. The changes in workflow that I witnessed within both research sites that were active with FMD demonstrated distinct variance to their previous practices and what the patients see. This being two-fold, primarily an indication for increased waiting times due to the added step in scanning each individual pack of medicine to be supplied against a prescription and secondly, the final decommissioning step on prescription transfer to the patient. The increase waiting time was more substantial with the standalone system in pharmacy 2. This came from comparison of data for one week of activity to review workload from pre- and post- FMD implementation. Whilst not replicated and with limited dataset availability, the data indicated on average an additional five minutes per prescription for those eventualities where the system was functional and not bypassed by the operators. This finding also brings about the necessity to critique the practicalities of the implemented FMD processes and workflows within pharmacy. The example of 74 packs of cefalexin capsules prescribed for one patient (section 5.3.2) highlights the significant time investment that would be required to conduct verification and decommissioning processes within the prescription dispensing process. Any future such systems would thus need to afford sufficient flexibility to allow for large quantities of medicines to be processed with ease by the pharmacy teams.

Another operational issue highlighted by the pharmacy teams in both research sites was the sensitivity in the physical scanners and multiple barcodes presented on the medicine packaging which confused the system as to which barcode was require for FMD. To overcome this sensitivity, the pharmacy team in pharmacy 2 had created a window using a piece of paper that they placed over the packaging to cover up the additional barcodes in order to

prevent the scanner picking up non-FMD compliant barcodes that had the potential to cause the system to crash. This shows how paper and digital work together to bring about the desired result. A workaround that demonstrates that even within a policy-driven change for technology implementation there is scope for manual paper-based solutions. In pharmacy 1, the team simply placed their hands over the additional barcodes. This had the same effect but using a different mechanism to overcome the problem. The other noteworthy point here is the medicine's packaging, the designs created by the manufacturers are shown to not be ideal for use in practice. Often containing information to meet the requirements of multiple territories and their respective legislation yet not accounting for how that packaging will be used in clinical work. This aspect is the first of the five questions for policy makers to consider: *How do you manage the tension between commercial and public good?*

In pharmacy 1, the waiting time varied between prescriptions and created additional tasks for resolution only when there was an error with the selected item presented by the operator in terms of strength, quantity, brand selection or the system with nonrecognition of the 2D barcode or other error code. The final decommissioning step occurred in real-time, with the operator conducting the necessary clinical tasks such as counselling with the patient at the point of collection at the same time as decommissioning the medicines using an aggregate code to ensure only one scan was required. This provided a streamline approach and documented the collection date, time and individual's detail collecting, for the pharmacy's records.

In pharmacy 2, the decommissioning took place in one step alongside verification within the dispensing process. The system did not link this data to a specific patient. This lack of interface or connectivity created an added task for the pharmacy team in reuploading the

decommissioned pack to the NMVO in the case where the dispensed medicine(s) was not required or collected by the patient within the 10-day permitted timeframe. These points about waiting times and decommissioning that the patient may see directly or be impacted by indirectly, give rise to my second of the five questions for policy makers to consider: *How do you involve patients on an ongoing basis as the technology and project evolves?*

The optimal pharmacy workflow therefore varied between the three research sites and demonstrates the need for flexibility in policy wording as to when specific activities need to take place or when they should take place. The FMD stipulated in the original policy wording, that decommissioning should take place at the point of medicine transfer to patients. This wording created impracticalities for certain pharmacies and their operations, thus subsequently resulting in amended wording for different clinical settings and countries. Supplements 1, demonstrates an overview of the workflow mapping work I undertook as a starting point in establishing the postulated workflows that would provide compliance with the FMD policy wording alongside a fiscal analysis for each in the operational context of UK community pharmacies. I decided to carry out this alternative IA to capture the effect on pharmacy practice, given that the MHRA IA from 2013 had omitted pharmacy and pharmacists as an organisation and profession within the pharmaceutical supply chain and healthcare practice.

Pharmacy is often the last point of the pharmaceutical supply chain and the first point of contact for patients to receive their prescribed medication. It would therefore stand to reason that the practice and financial impact on this important sector of the healthcare profession be given priority within the context of FMD alongside manufacturers and wholesalers. However, as I describe in chapter 6, this was not the case for a number of

reasons. Critically, the MHRA is not the regulatory body for pharmacists and the pharmacy profession and consequently do not hold the expertise to critique this type of clinical practice; the seeming lack of interorganisational communication and cooperation with the GPhC as the pharmacy professionals regulatory body and by extension, the RPS as the professional body; the disconnect between UK and other EU countries' healthcare structure and where pharmacy practice and patient interaction occur in addition to funding arrangements both privately and for universal healthcare, alongside government commissioning of healthcare services and funding for technology projects. Nevertheless, the omission of pharmacy from the IA demonstrates experts, including clinicians, were not included within the early stages of policy development and analysis. As mentioned in section 6.4.3. the government roundtable to discuss FMD was held in March 2016 and brought together the FMD Ministerial Implementation Advisory Board, following which a number of working groups were created, including the UK FMD working group for community pharmacy. The pharmacy regulator, the GPhC was not listed as an attendee at the roundtable meeting with its regulatory function in the context of FMD and pharmacy operations being clarified in January 2019 as part of joint legislative enforcement measures with the MHRA. The timelines of these meetings demonstrate that pharmacy was not a key consideration in 2013 when the government's original FMD IA was developed. This had two key consequences, the first that experts in pharmacy were not sought to provide or assess implications and impact to pharmacy practice in the preliminary stages of policy development and adoption for the UK which were potentially required in 2013, and second, sources of funding for community pharmacy to achieve compliance with FMD was not considered as part of the government's investment in infrastructure. The issue of funding thus registered in August 2018 as a point for the national community pharmacy negotiators

to address in future NHS funding arrangements (172). Two further questions can be raised here for policy makers' consideration; question three: *how can you make your Impact Assessment (IA) fit for purpose?* And question four: *How do you engage with experts in the field within each impacted profession?*

What further compounds the preparation for implementation of FMD in the UK since the IA in 2013 and subsequent efforts since, is there being a distinct absence of an organisation that is coordinating pharmacy efforts for implementation of FMD. In fact, the UK government opened a public consultation on FMD on 16th July 2018 and closed it on 23rd September 2018, focusing on exemption categories for certain classes of healthcare institutions. Focusing on pharmacy specifically, the opinion of study participants was pharmacy should look to other industries to find a solution and support that provides the required regulatory standards. This for example being the veterinary industry which is strictly controlled and regulated alongside food produce in general. Interestingly, veterinary medicines were not included within FMD regulations even though some are supplied through UK pharmacies for animal use. Coordination did come in the later stages of implementation in the UK when it was confirmed that the GPhC would regulate pharmacy compliance. This coupled with various organisations setting up their own working groups such as the pharmacy multiples and the PSNC's IT stakeholder group did provide pockets of collaboration within the pharmacy world. The involvement of a pharmacy regulatory or professional steering committee consisting of leaders from the various sectors of pharmacy at the point of the original government IA would have facilitated identification of complexities within the project at the pharmacy level. In addition to creation of a platform for a unified steer for the pharmacy profession for guidance on implementation as the project progressed. It would also have served as a communication and strategic platform for the embedding and adaptation elements after

implementation, or as it transpired and detailed within chapter 7, a source of coordination for the resulting de-implementation of FMD that took place after 31st December 2020. To address future communication and collaborative resources needed from the outset, I propose the final of my questions for policy makers to consider, *what are the requisite facilitation roles?*

Question for consideration	Description
1. What are the requisite facilitation roles?	
2. How do you manage the tension between commercial and public good?	
3. How can you make your Impact Assessment (IA) fit for purpose?	
4. How do you involve patients on an ongoing basis as the technology and project evolves?	
5. How do you engage with experts in the field within each impacted profession?	

Figure 8.1 Questions for policy makers *The five questions for policy makers to factor in as part of their policy considerations is summarised herein alongside an explanatory detail for each.*

Although continuation of this study was not possible to see the embedding and adaptation of FMD beyond the first year of implementation the need for such a unified system at a national and international level can still be justified through other mechanisms. The incidence of falsified medicines via other detection methods is one such way. The MHRA has reported that 15000 falsified medicine packs have been detected within the UK's legitimate supply chain from January 2020 to February 2022 (173). It has been reported that this detection was as a result of Good Distribution Practice, which is a legislation in place covering movement and storage of medicines from manufacturers and wholesalers.

It is intended for a UK based FMD system to be created to ensure there is legislation at every part of the legitimate supply chain to strengthen these detection and prevention measures. The UK government took steps to introduce the provision of unique identifiers and antitampering devices to medicinal packs for human use by inclusion of these measures within the Medicines and Medical Devices Act 2021, which received royal assent on 11th February 2021(174). The Medicines and Medical Devices Act 2021 was followed by a policy paper released to provide further guidance on the Act. Within this policy paper, the Department of Health and Social Care (DHSC) set out the ambitions for a UK FMD consultation plan. The policy paper states that "We expect to have a staged approach to engagement and consultation across the supply chain, with an initial aim of issuing a public consultation within 12 months of Royal Assent, subject to other priorities around medicines regulation."(175). To date no such public consultation has taken place nor an update provided on the plans to progress this task. The Act itself also does nothing to provide detail on who has ownership for setting up the required infrastructure, systems and processes, incur the financial costs and ensure the maintenance of these, but rather outlines that there should be provisions in place to cover such activity. This demonstrates that whilst some of the challenges in the original implementation have been identified we are still no closer in this policy-driven approach to delegate responsibility to any specific party. There has been active engagement from the pharmacy profession, with the RPS becoming further involved in October 2022, having first released a policy statement in August 2013(176), in conversation with the DHSC on creating guiding principles for a proposed national FMD system for the UK. As someone who has followed FMD closely for a number of years, I was requested to share some of the findings of my research to help with guiding these discussions. The overarching focus at the time was for authentication and verification

activities to occur at points within the pharmaceutical supply chain that ends with the wholesaler. This is rather significant and indicates a profession that suffered from the implementation pressures and investment needs of the first policy-driven approach under FMD. This approach, if followed, would not bring about some of the added benefits realised by pharmacy 1. In reality, what made the implemented digital system desirable within pharmacy 1, was not only the ease with which operators interacted with the system, ensured the pharmacy's compliance with FMD, but also the additional features and process changes that the adoption afforded. These included the additional check/verification of the selected medicinal product (for name, strength, formulation and pack size) with that prescribed, linking of each unique pack with a specific patient, and enabling a quick search capability to identify patients affected in the event of medicine recalls. When considering future such implementations, policy makers should also investigate the additional benefits that could be afforded by adoption of the proposed technological solution to address some existing difficulties faced by clinicians or to further strengthen safe clinical practice.

Working with other agencies is paramount in the detection of falsified medicines, as highlighted by a case that was first reported in August 2018. A UK based wholesaler was detected to have supplied Germany with medicines including Herceptin, Avastin, and Enbrel, that had been originally stolen from hospitals in Italy. This incident was detected by the European Medicine's Agency's Rapid Alert Notification system and ensured the quick removal of the medicines from the German supply chain and triggered an MHRA investigation to the UK wholesaler who was found to have distributed £2.9m worth of medicines sourced from Egypt without the correct licences or storage conditions for these products (177). This case indicates that terminating a falsified medicines detection system at the wholesale segment may still leave the supply chain open to infiltration of falsified

medicines. Notwithstanding that pharmacies themselves also distribute medicines nationally and international.

On a global scale, the WHO released statements alerting countries to the presence of contaminated over-the-counter paediatric cough medicines. The cough medicines were found in seven countries including Gambia, Indonesia and Uzbekistan over a four-month period and found to contain high levels of diethylene glycol and ethylene glycol, substances commonly found in industrial solvents and antifreeze. This incident is known to have caused more than 300 fatalities, with the majority of these being in children under the age of five (178). This incident served as a reminder to the wider global community on the implications that falsified and substandard medicines can pose, how quickly such falsified and substandard medicines can be distributed on a global scale, entering the legitimate supply chain and created a renewed call for countries to implement the WHO member state mechanism on substandard and falsified medical products. FMD did not provide a mechanism for consideration of all over-the-counter medicines, and what this case demonstrates is a need for a system to allow sufficient flexibility to expand to this arm of medicines supply within the legitimate supply chain. This being a necessary action to protect every part of the supply chain and subsequently the patients who access them from medicines falsifiers.

Most recently, the UK has also seen an incidence of falsified medicines within its legitimate supply chain with cases of patient hospitalisation from their use. Between January and October 2023, the MHRA reported seizing 369 potentially falsified Ozempic (semaglutide 1mg solution) pre-filled pens for injection, a medicine used in the treatment of type 2

diabetes and weight loss, with pens also detected at two UK wholesalers, which were intercepted and did not reach patients (179, 180).

The ongoing incidents of falsified and substandard medicines demonstrate the continued need for a system to be in place for their detection and prevention, working alongside other countries to share knowledge and information for the benefit of people globally.

8.4 Strengths and limitations of the study

I encountered many challenges throughout the duration of this research project. The first hurdle to overcome began with the confusion over what type of ethics review was required for the project, given that community pharmacy is a private sector providing NHS services. As explained in section 3.3.2, the process for completion of each phase and referral to onward application processes resulted in the loss of a pharmacy site from the study given that implementation began and concluded during this application process. This additionally created difficulties in recruiting a replacement fourth site to the study, as many pharmacies had begun some part of the process or had encountered difficulties with implementation which made them less willing to invest time in participating within research. This small sample of cases and improbability of further research site recruitment originally resulted in much deliberation on my part as to the quality, reliability and transferability of any findings. Though this is something that did not prove to be true here. I was able to visit pharmacy 1 and 2 on a number of occasions at various stages within the implementation and adoption process. This allowed time between each visit for me to carry out analysis of the gathered data (SOPs, impromptu interview transcripts, field notes and digital images) improving my understanding of the field to focus on areas that I wanted to explore further in future visits. The case study methodology therefore aligned seamlessly with my research, as it

necessitated for me to possess a thorough understanding of the problem's intricacies before undertaking fieldwork.

The three remaining pharmacy sites did provide the variance on characteristics that I was seeking in a number of key areas, these are described in chapter 5 and summarised in table 5.2. The variety of data sources have been grouped to provide a national context, community pharmacy, and individual pharmacist perspective through fieldwork at the research site, semi-structured interviews and surveys has provided depth and quality to the reliability of this study and my findings. The case study approach therefore allowed for the narrative of FMD implementation and adoption to be captured from multiple angles. My own ability to become immersed in the field, coupled with my grasp of pharmacy practice at a senior level and consultancy in a number of healthcare settings afforded several advantages. Chiefly that I was able to easily understand the 'natives' that is the pharmacy teams within each site and those elite and expert participants from the semi-structured interviews. Secondly, my knowledge of pharmacy practice, law and ethics was crucial in organising my thoughts and probing the events that were unfolding to understand the implications that the policy-driven approach, that is FMD as a legislation, and the technology-supported initiative, the physical hardware and software, were creating.

The premature interruption of ethnographic fieldwork due to the COVID-19 pandemic was a significant setback and resulted in the planned number of site visits to not reach completion for pharmacy site 1 and 2, and only limited virtual meetings and tour of pharmacy 3. The global nature of this pandemic was unique and one that is unlikely to be repeated in my lifetime. FMD was still in place until 31st December 2020, with the first national lockdown measures to control the spread of COVID-19 enforced from 26th March 2020(181). This is a

40-week time period where compliance with FMD activities were not possible to observe. The inability to continue with fieldwork did detract from planned data gathering and the ability to understand the impact of FMD during this pressured and unique set of circumstances which may have been useful to capture as part of pandemic preparedness strategies for pharmacy for future projects. This then coupled with Brexit implications (chapter 7) made it physically and morally difficult to approach the study participants for a final follow-up interview to discuss FMD de-implementation, given the strain on clinicians and the general fatigue these factors placed on the healthcare profession. Brexit can be considered a unique eventuality and case within the policy context. Whilst the possibility of Brexit was known for a few years prior to FMD becoming enforceable legislation within the UK, how this policy unfolded over time could not have been predicted nor is it likely for such an eventuality to recur. Caution should therefore be exercised to not draw generic conclusions of this case as purely a technology project implementation, but to rather view this case as a complex policy-driven initiative utilising technology-supported means.

8.5 Conclusion

FMD was devised to be a multi territory approach to prevent infiltration of falsified medicines into the legitimate supply chain. FMD brought with it a secondary consequence through introduction of a continuous end-to-end system for the detection of falsified medicines and safety measures within UK pharmacies.

Whilst the scale of falsified medicines within the UK and globally cannot accurately be defined, the implications to human health are well documented (10, 70, 182-184). This study however was not designed to test the hypothesis that FMD results in improved safety for patients, although one pharmacy successfully identified a possible falsified medicine. The

ethnographic study identified various local-level process improvements from use of a fully integrated verification and decommissioning system. This new technology also allowed a second check on the picking process, supporting the operator in selecting the correct medicine, strength and formulation thereby reducing the likelihood of errors through lookalike soundalike medicines. Another unintended advantage was a simplified medicines recall process where specific batches could be identified within a matter of minutes as each dispensed medicine with its unique identifier became linked with an individual patient. However, some drawbacks were identified, and these played out differently in each research site. Within the integrated system, errors and medicines issued required addressing in real-time or absolutely in all cases and could not be bypassed by the operators.

The standalone system did not provide these additional clinical benefits, such as the added layer of accuracy checking to the human operator's actions, which was realised from the integrated FMD system and subsequently presented more operational challenges for use in practice without added benefit. The ability for the operators to override the FMD checks completely when faced with system errors, system malfunctions, and increased workload, alongside time pressures can be considered a flaw in ensuring that FMD implementation and processes occurred 100% of the time for all prescription medicines subject to the verification and decommissioning checks. This is a learning that can be taken forward for any future such systems: how can policy ensure full compliance to realise complete patient safety in all cases? From my analysis of the presented pharmacy sites, it can be suggested that a fully integrated system is the means to achieving such compliance.

The benefit to many organisations in adoption of a standalone solution was the quick ability to implement FMD and then subsequently de-implement the system and processes within

their pharmacies following the termination of FMD as a consequence of Brexit with minimal to no changes within their existing workflows and clinicians' practice.

The fiscal impact in both cases can be chiefly credited to the investment in hardware, software, development of SOPs and related procedural documents alongside personnel time in implementation and training which was not covered by specific government funding to the pharmacy sector.

It is difficult to quantify the benefits of FMD in the UK given that the legislation was not in place for any sufficient time for the primary aim of detection and prevention of falsified medicines nor for the secondary added benefits of increased safety measures to provide efficiency savings for clinicians and the wider pharmacy teams to be realised. It does however afford learnings for implementation practices within pharmacy practice and the wider healthcare arena and can be a useful guide in deciding operational flows and accounting for probable changes to clinicians working practices. In short answering the question of: What is this system attempting to achieve? Who will need to use it and why? How does this affect the clinicians' current working practice? Does it work in all cases or will adjustments be required in some scenarios? What is the funding for this project? How and at what stage(s) will patient and public involvement be sought? These questions expand upon domains five and six, organisations and wider system within the NASSS framework, and serve as clear guidance for policy makers. NASSS has therefore been proved to be an effective tool in identifying the complexities with FMD implementation in many regards, though it could never have predicted the external shock that Brexit presented and the termination of data sharing agreements with the EU.

This case study of policy-driven digital system implementation highlights the explicit need to distinguish and differentiate between what policy needs against what clinical practice requires. The NASSS framework is a useful tool in understanding and addressing some of the main issues and complexities within digital system implementations and should therefore be utilised when considering policy-driven technology-supported initiatives in healthcare and could be extended to include the five additional questions below for policy makers' consideration within domain 6 the wider system:

1) What are the requisite facilitation roles?
2) How do you manage the tension between commercial and public good?
3) How can you make your Impact Assessment (IA) fit for purpose?
4) How do you involve patients on an ongoing basis as the technology and project evolves?
5) How do you engage with experts in the field within each impacted profession?

My involvement with FMD began in 2015 as a senior clinical standards manager and clinician involved with policy and clinical guidance implementation amongst other responsibilities. This then gave rise to my proposal for this research project in 2018 with a view to better understand digital system implementations within pharmacy practice and healthcare more broadly to achieve ways in realising the benefits that such innovations can afford to clinicians' practice and patient safety. This DPhil has sought to capture this through the case of FMD implementation within the UK. The many learnings that I have captured will be most pertinent as the UK seeks to establish an independent system for the prevention and detection of falsified, substandard and counterfeit medicines in the coming years.

I hope to be able to build on this research which has combined my role as a clinician and researcher alongside my background in health policy and academia, to further develop understanding in this field and actively engage stakeholders including policy makers, governments, regulators, and professional bodies to support the use of innovative technology to enhance clinical practice and create a solution where policy harmonises standards to achieve public safety and effective health policy.

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Appendix I Study protocol

Note: the original protocol was submitted with multiple sections and appendices which provided the official policy context; a shortened version is reproduced here with a selection of sections and their associated appendices

Study Title: The Clinical and Operational Impact of Regulatory Change on Pharmacy Practice: The Implementation of the European Union Falsified Medicines Directive in the United Kingdom.

Internal Reference Number / Short title: COIRC

Ethics Ref: R62266/RE001

Date and Version No: 13th September 2019, version 3.3

Chief Investigator:	Miss Mona Koshkouei
Investigators:	Professor Trish Greenhalgh, Professor Sue Dopson, Professor Gary Ford
Sponsor:	University of Oxford
Funder:	The study is supported by the following grant: Oxford NIHR Biomedical Research Centre Partnerships for Health, Wealth and Innovation theme (BRC-1215-20008) on which TG is principal investigator
Chief Investigator Signature:	

Conflict of interest: MK is a past employee of McKesson Corporation as a practicing Clinical Standards Pharmacist Manager.

Confidentiality Statement

This document contains confidential information that must not be disclosed to anyone other than the Sponsor, the Investigator Team, HRA, host organisation, and members of the Research Ethics Committee, unless authorised to do so.

1- SYNOPSIS

Study Title	The Clinical and Operational Impact of Regulatory Change on Pharmacy Practice: The Implementation of the European Union Falsified Medicines Directive in the United Kingdom.
Internal ref. no. / short title	COIRC Study
Study Design	Each community pharmacy will be treated as a 'case' within the overall case of the FMD implementation. I anticipate recruiting three to six community pharmacies using a purposive sampling strategy to obtain maximum variety in relation to key variables (e.g. size, maturity, management structure, staffing skill mix, specialist medicines dispensing (e.g. Clozapine), outsourced dispensing services (e.g. HIV and Discharge medicines), locally commissioned services (e.g. Emergency contraception) and retail activity). Within each community pharmacy, we will collect the following data: Quantitative data: - Survey analysis- structured interviews - Web-based questionnaires - Data from management information systems e.g. prescription dispensing volumes, time taken to dispense per item, product recall volumes and pharmacovigilance reports submitted Qualitative data: - Semi-structured interviews - Focus groups (reality test the implementation plans and development strategies) - Local documentation (e.g. standard operating procedures, protocols, business plans) - National and international level documentation (e.g. EU and UK impact assessments) - Review of policy maker's decision papers, public consultation records - Ethnographic observation - Shadowing operational staff - Observation of strategy development meetings The study will involve participant observation of pharmacy staff working within 3 - 6 individual sites over the study period with up to

	44 individual visits lasting 12 hours each collectively, equating to 528 hours of ethnographic observation across the study duration for all sites. The online survey aims to capture the perception of participants with experience and expertise across all pharmacy sectors of the change in legislation. The survey will then inform any key areas that will require further exploration. The recruitment aim for the survey is 100 participants. The recruited participants will be asked to complete a single survey via the online provide, Survey Monkey (https://www.surveymonkey.com). This will be followed up survey to the pilot conducted in 2016 and will take place in after the 9th February 2019, following the implementation date of the directive. The survey will be open to responses from pharmacy professionals across all pharmacy sectors. The survey will be advertised for participation through professional publications e.g. Pharmacy Journal (PJ) and social medial platforms e.g. Twitter, Facebook, LinkedIn. Paper copies of the survey will be available for completion upon request. Semi-structured interviews will be utilised to extract and obtain in depth analysis of industry/organisational leads and their proposals, perceptions and plans for implementation of FMD, in addition to pharmacy professional's working within community pharmacy. The maximum number of participants for this will be 20 individuals.
Study Participants	Ethnographic/Participant observation – Pharmacy professionals within their daily workflow environment in the pharmacy dispensary. Online survey analysis – Pharmacy professionals or allied professionals to pharmacy. Semi-structured interviews – Industry leaders/Directors of Pharmacy/ Chief Pharmacists/ Pharmacists/ Operational Staff Focus group – Pharmacy professionals of all levels and lay persons
Planned Sample Size	Ethnographic/Participant observation – 3-6 Pharmacy sites Survey analysis – maximum 100 participants (Pilot), 100-1000 (second wave) Semi-structured interviews – maximum 20 participants Focus groups – maximum 30 participants
Planned Study Period	From: 01/10/2019 To: 01/10/2022

Objectives		Outcome Measures
Primary	Identify the factors that explain the fortunes of a technology-supported initiative to implement the EU Falsified Medicines Directive in community pharmacies	- Ethnographic observation of pharmacy professionals - Perceptions data from semi-structured interviews -
Secondary	Establish the clinical and operational effects of implementing the European Union Falsified Medicines Directive with a specific focus on the impact on pharmacy practice within the United Kingdom	- Workflow pathway mapping - Workflow timing - Categorisation of specific processes and tasks - Financial assessment of each workflow
Tertiary	Identification of touch points for collating prescribing interventions to improve patient safety	- Classification of prescribing intervention types made by pharmacy personnel

2- STUDY DESIGN

The study comprises of mix-method research to include ethnographic observation, survey/questionnaire analysis and semi-structured interviews.

The study will involve non-participant observation of pharmacy staff working within 3-6 individual community pharmacy sites over a period of 2 years.

The survey will then be issued and open for a response for a period of 1 year to pharmacy professionals in the UK via an online platform to 100 participants in the pilot phase and then to all pharmacy professionals for the national survey.

Implementation of processes and specific Standard Operating Procedures will be provided to the pharmacy team by the individual pharmacy's management/governance team. Only some specialist pharmacy services sites will have the practice SOP stated in this document.

Sample survey and semi-structured interview questions can be found in appendixes A and B respectively. The Standard Operating Procedure (SOP) for use at the specialist pharmacy sites can be found in appendix C.

3- PARTICIPANT IDENTIFICATION

Study Participants

Study participants will be Pharmacy professionals or allied professionals of all grades from Directors of Pharmacy to Healthcare Assistants and professionals allied to pharmacy practice e.g. management functions whom do not specifically hold a pharmacy/pharmacist qualification.

Inclusion Criteria

- Participant is willing and able to give informed consent for participation in the study
- Male or Female, aged 18 years or above
- Currently in employment within a pharmacy related sector, government agency, not for profit organisation, regulatory board, professional body or policy maker

Exclusion Criteria

The participant may not enter the study if ANY of the following apply:

- Under 18 years of age
- Undergoing training/work experience placements

STUDY PROCEDURES

Recruitment

Participants will be identified through personal, academic and commercial networks i.e. Emailing of survey link to work email accounts and advertisement on pharmacy and professional social media groups. Purposive and snowball sampling will be used to recruit individuals for participation in the semi-structured interviews and focus groups.

Pharmacies will be identified through personal, academic and commercial networks including recruitment of pilot sites already assigned to the FMD project with NHS digital.

Informed Consent

In respect of interview participants, the researcher will provide written and verbal versions of the Participant Information and Informed Consent form (Appendix D) to the participants detailing no less than: the exact nature of the study; what it will involve for the participant. It will be clearly stated that the participant is free to withdraw from the study at any time for any reason without prejudice to future care, without affecting their legal rights, and with no obligation to give the reason for withdrawal.

The participant will be allowed as much time as wished to consider the information, and the opportunity to question the Investigator, or other independent parties to decide whether they will participate in the study.

At the first meeting with the participant the written consent form will be explained and signed. In respect of telephone and video interviews, an electronic copy of the consent form will be sent to the participant ahead of the meeting for their consideration. Verbal consent will then be sought at the beginning of each call/meeting.

Participants will be asked to provide consent by clicking on the 'next/start' tab on the online survey.

Written Informed Consent will then be obtained by means of participant dated signature and dated signature of the person who presented and obtained the Informed Consent. The person who obtained the consent must be suitably qualified and experienced, and have been authorised to do so by the Chief/Principal Investigator. The original signed form will be retained by the research institution/lead researcher.

The designated lead at the research site will provide overarching consent for non-participant observations. Where possible written consent will be sought from individuals practicing and, in all cases, verbal consent will be gained. For data collation at the pharmacy sites a written notification (email or paper) from the lead person(s) for the organisation will be obtained providing access to the premises and data from management systems (where appropriate). Where professionals from the research sites are to be included within the semi-structured interviews a separate consent form will be obtained from the individual.

Written consent will be gained from individuals participating within focus groups.

Discontinuation/Withdrawal of Participants from Study

Each participant has the right to withdraw from the study at any time. In addition, the Investigator may discontinue a participant from the study at any time if the Investigator considers it necessary for any reason including:

- Ineligibility (either arising during the study or retrospectively having been overlooked at recruitment)
- Significant protocol deviation
- Significant non-compliance with study requirements
- Withdrawal of Consent

Any data gathered prior to the withdrawal of participant consent will be used as part of the research for analysis purposes.

New participants will be recruited for the semi-structured interviews, where a participant withdraws prior to the interview taking place.

The reason for withdrawal will be recorded.

Definition of End of Study

The end of study is:

- Ethnographic observation: The date of the last visit to the final research site.
- Survey analysis: The closing date set on the survey tool, after which time the survey will not be re-opened.
- Semi-structured interviews: The completion of the interview with the final participant.

STATISTICS AND ANALYSIS

Quantitative data (pharmacy management information system data, including prescription volumes, dispensing timelines, associated interventions and survey of pharmacy professional's perceptions of FMD) will be analysed statistically in SPSS. Qualitative data (Semi-structured interviews including pharmacists, policy makers, managers, and software suppliers; ethnographic field notes including observation of pharmacist activity; in addition to local and national documentation) will be analysed thematically. The respective community pharmacy case studies will thus be presented as a narrative summary merging the qualitative and quantitative findings to build a comprehensive profile of adoption of the digital technology for FMD compliance whilst capturing key challenges and wider lessons for technology supported initiatives within pharmacy practice.

DATA MANAGEMENT

Access to Data

Direct access will be granted to authorised representatives from the host institution for monitoring and/or audit of the study to ensure compliance with regulations.

Data Recording and Record Keeping

Participant interviews will be recorded using a digital voice recorder. The recordings will be kept on the device with password protection and fingerprint access recognition. The data files will be retained on the university's servers with password protection and any files held on storage devices will have password protection and encryption applied.

QUALITY ASSURANCE PROCEDURES

The study may be monitored, or audited in accordance with the current approved protocol, GCP, relevant regulations and standard operating procedures.

1. ETHICAL AND REGULATORY CONSIDERATIONS

2. Declaration of Helsinki

The Investigator will ensure that this study is conducted in accordance with the principles of the Declaration of Helsinki.

3. Guidelines for Good Clinical Practice

The Investigator will ensure that this study is conducted in accordance with relevant regulations and with Good Clinical Practice.

4. Approvals

The protocol, informed consent form, participant information sheet and any proposed advertising material will be submitted to an appropriate Research Ethics Committee (REC), for written approval.

The Investigator will submit and, where necessary, obtain approval from the above parties for all substantial amendments to the original approved documents.

5. Reporting

The CI shall submit on request, a Progress report to the REC Committee, HRA (where required) host organisation and Sponsor. In addition, an End of Study notification and final report will be submitted to the same parties.

6. Participant Confidentiality

The study staff will ensure that the participants' anonymity is maintained. The participants will be identified only by a participant ID number or pseudonyms on all study documents and any electronic database, with the exception of the participant consent form, where participant full name will be added. All documents will be stored securely and only

accessible by study staff and authorised personnel. The study will comply with the Data Protection Act, which requires data to be anonymised as soon as it is practical to do so.

7. Expenses and Benefits

There will not be any remuneration to any participants or affiliates of the organisations of the research sites.

8. Other Ethical Considerations

Disruption to the pharmacy operations though observational study which may reduce staff concentration and result in errors leading to patient safety issues. To prevent this from occurring, all staff working on the day of the visit will be notified in advance that observation is due to take place, and this is for research only and will not be used within any performance or organisational management strategies. The peak operating hours have been identified within each site and during peak periods a suitable observational space has been identified that will not impede or interrupt the pharmacy operations.

Survey may result in follow up questions by participants to their respective organisations, this has been addressed by clarifying the background of the survey clearly within the introduction section of the survey. Email contact details of the primary researcher are available for participant enquires.

Accessibility to patient identifiable data. The primary researcher is a registrant of the General Pharmaceutical Council (GPhC) of Great Britain and is bound by the codes of practice and ethics. Any patient identifiable data will be anonymised or eliminated prior to removal from the study site with the pharmacy operations manager notified at the end of each visit where such information is to be extracted.

9. FINANCE AND INSURANCE

10. Funding

The study is supported by the following grant: Oxford NIHR Biomedical Research Centre Partnerships for Health, Wealth and Innovation theme (BRC-1215-20008) on which TG is principal investigator

11. Insurance

The University has a specialist insurance policy in place which would operate in the event of any participant suffering harm as a result of their involvement in the research (Newline Underwriting Management Ltd, at Lloyd's of London).

12. PUBLICATION POLICY

The Investigators will be involved in reviewing drafts of the manuscripts, abstracts, press releases and any other publications arising from the study. Authors will acknowledge all study funders as applicable. Authorship will be determined in accordance with the ICMJE guidelines and other contributors will be acknowledged.

13. APPENDIX D: PARTICIPANT CONSENT FORMS

Audio/video/photographic consent form:

Dept. of Primary Care Health Sciences
Radcliffe Observatory Quarter
Woodstock Road
Oxford; OX2 6GG

Principle Investigator: Professor Trisha Greenhalgh
Principle Investigator email address: Trish.Greenhalgh@phc.ox.ac.uk
Primary researcher: Mona Koshkouei, DPhil student
Telephone: +44(0) 1865 289300
Primary researcher email address: Mona.Koshkouei@phc.ox.ac.uk

PARTICIPANT CONSENT FORM

Central University Research Ethics Committee (CUREC) Approval Reference:

R62266/RE001

The Clinical and Operational Impact of Regulatory Change on Pharmacy Practice: The Implementation of the European Union Falsified Medicines Directive in the United Kingdom

Purpose of Study: This research project is looking at the impact that this legislation change may have on community pharmacy practice within the UK through the adoption of new technology as a result of the Falsified Medicines Directive (FMD).

		Please initial each box
1	I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without any adverse consequences or penalty.	☐
3	I understand that research data collected during the study may be looked at by authorised people outside the research team. I give permission for these individuals to access my data.	☐
4	I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.	☐

5	I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	☐
6	I understand how this research will be written up and published.	☐
7	I understand how to raise a concern or make a complaint.	☐
8	I consent to being audio recorded	☐
9	I consent to being video recorded (research site participants only)	☐
10	I consent to having my photo taken (research site participants only)	☐
11	I understand how audio recordings / videos / photos will be used in research outputs	☐
12	I give permission to be quoted directly in research outputs but only fully anonymously	☐
13	I agree to take part in the study	☐
Optional:	I agree for research data collected in this study to be given to researchers, including those working outside of the EU, to be used in other research studies. I understand that any data that leave the research group will be fully anonymised so that I cannot be identified.	☐
Optional:	I agree that my personal contact details can be retained in a secure database so that the researchers can contact me about future studies.	☐

_____	dd / mm / yyyy	_____
Name of Participant	Date	Signature
_____	dd / mm / yyyy	_____
Name of person taking consent	Date	Signature

Participant ID number:

Please complete the following fields as part of the participant demographic data for the project. The below information will be used in published data and will not be attributable to your name.

Gender:

Ethnic Origin:

Number of years practice in current field:

Consent without audio/video/photography:

Dept. of Primary Care Health Sciences
Radcliffe Observatory Quarter
Woodstock Road
Oxford; OX2 6GG

Principle Investigator: Professor Trisha Greenhalgh
Principle Investigator email address: Trish.Greenhalgh@phc.ox.ac.uk
Primary researcher: Mona Koshkouei, DPhil student
Telephone: +44(0) 1865 289300
Primary researcher email address: Mona.Koshkouei@phc.ox.ac.uk

PARTICIPANT CONSENT FORM

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		Please initial each box
1	I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without any adverse consequences or penalty.	☐
3	I understand that research data collected during the study may be looked at by authorised people outside the research team. I give permission for these individuals to access my data.	☐
4	I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.	☐
5	I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	☐
6	I understand how this research will be written up and published.	☐

7	I understand how to raise a concern or make a complaint.	☐
8	I give permission to be quoted directly in research outputs but only fully anonymously	☐
9	I agree to take part in the study	☐
Optional:	I agree for research data collected in this study to be given to researchers, including those working outside of the EU, to be used in other research studies. I understand that any data that leave the research group will be fully anonymised so that I cannot be identified.	☐
Optional:	I agree that my personal contact details can be retained in a secure database so that the researchers can contact me about future studies.	☐

Name of Participant	dd / mm / yyyy Date	Signature

Name of person taking consent	Date	dd / mm / yyyy Signature

Participant ID number:

Please complete the following fields as part of the participant demographic data for the project. The below information will be used in published data and will not be attributable to your name.

Gender:

Ethnic Origin:

Number of years practice in current field:

Oral consent only:

NUFFIELD DEPARTMENT OF PRIMARY CARE HEALTH SCIENCES

UNIVERSITY OF OXFORD

ORAL CONSENT SCRIPT

Oral Consent only

Hello (insert participant name), I'm Mona Koshkouei from the University of Oxford and I wanted to talk to you about the project I gave you information about before. To recap, the broad aims of my project are to look at changes to pharmacy practice through adoption of the falsified medicines directive.

Are you still interested in taking part in the project? *[Await confirmation].* Now I'd like to confirm some of the details of the project to make sure you understand what's involved for you:

- It's a project about the falsified medicines directive and it's being used for my postgraduate research.
- Have you had the opportunity to look at the consent and participant information sheets sent/given to you? (If yes-any questions? If no-talk participant through all information on the PIS including)
- If you agree to take part, we can proceed to the interview lasting approximately one hour. [I may also contact you for a follow-up interview.
- You don't have to agree to take part; you can ask me any questions you want before or throughout; you can also withdraw at any stage without giving a reason.
- I would like to [audio record you / take photographs of you / video you].
- You're aware that my written work will be published online and in the Oxford Research Archive.
- The project may be published in a thesis, academic journal, book or website.

Are you still willing to take part? Do you give your permission for me to interview you/ take your photo/ video / audio record you?

(For telephone/video interviews): Do you give your permission for me to re-contact you to clarify information?

[*Await confirmation]* So if you're happy with all of that, and have no more questions, let's start.

Appendix II CUREC I Ethics approvals

MEDICAL SCIENCES INTERDIVISIONAL RESEARCH ETHICS COMMITTEE
Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD
Tel: +44(0)1865 616577 Fax: +44(0)1865 280467
ethics@medsci.ox.ac.uk

CONFIDENTIAL

Ref: R62266/RE001

30th September 2019

Miss Mona Koshkouei
Nuffield Department of Primary Care Health Sciences
University of Oxford
Radcliffe Observatory Quarter
Woodstock Road
Oxford

Dear Mona

Research Ethics Approval - CUREC 1

Study title: The Clinical and Operational Impact of Regulatory Change on Pharmacy Practice: The Implementation of the European Union Falsified Medicines Directive in the United Kingdom

Short title: COIRC Study

The above application has been considered on behalf of the Medical Sciences Interdivisional Research Ethics Committee (IDREC) in accordance with the procedures laid down by the University for Ethical Approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to the IDREC, the proposed research has been judged as meeting appropriate ethical standards, and approval has been granted for a period of **3 years**, commencing on **1st October 2019**. The reference number for this study is **R62266/RE001**.

This is **subject to:**

a) **you following the BPS guidelines for online research**

b) **the PI agreeing to comply with the requirements for administering any tests or questionnaires and, if in doubt, to contact the publisher of those tests or questionnaires**

c) **the PI ensuring that, where new research staff are engaged, they are suitably qualified by training and/or experience.**

I would like to remind you that your study may be selected for review by the MS IDREC for the purposes of monitoring and/or audit.

Amendments
Should there be any subsequent changes to the study, you should submit details to the MS IDREC for consideration and approval. Details of changes must be listed on an amendment form.

Please do not hesitate to contact me if you have any queries.

Yours Sincerely

H. Barnby-Porritt

Dr. Helen Barnby-Porritt
Research Ethics Manager, Medical Sciences

R62266/RE002: COIRC Study - Amendment Approval

MSD Ethics <ethics@medsci.ox.ac.uk>

Fri 07/02/2020 13:21

To: Mona Koshkouei <mona.koshkouei@phc.ox.ac.uk>
Cc: Trish Greenhalgh <trish.greenhalgh@phc.ox.ac.uk>

Dear Mona,

Thank you for submitting a request for an amendment to project R62266, which has been reviewed on behalf of the Medical Sciences Inter-Divisional Research Ethics Committee (IDREC).

I am pleased to inform you that your requests to:

- update the survey questions for UK FMD survey (length shortened and question structure changed)
- extend the survey to five EU countries (Croatia, Republic of Ireland, Netherlands, Portugal and Germany), meaning an additional 100 participants will be recruited
- use advertisement posters to aid recruitment

has been judged as meeting appropriate ethical standards, on the basis of the information provided to the IDREC, and approval has been granted, under reference R62266/RE002.

Please note that this email is your sole approval.

Best wishes
Leah

Leah Butts
Research Ethics Administrator – Medical Sciences | Research Services

Postal Address: University of Oxford, University Offices, Wellington Square, Oxford, OX1 2JD
T: +44 01865 616575 **E:** ethics@medsci.ox.ac.uk
http://researchsupport.web.ox.ac.uk/governance/ethics/apply/msidrec

My normal working days are Tuesday, Thursday & Friday (9.30pm – 2pm) & Wednesday (8am – 5pm)

Please consider the environment before printing this email

Supplement I Pharmacy workflow scenarios

Note: this is preliminary work that I carried out in early 2018 as part of consultancy work to understand pharmacy workflow practices more generally. Please refer to section 6.2.2 for further information.

Title: Dispensing process workflow analysis in UK pharmacies with a view of identify the optimal step to conduct authentication and decommissioning practice within an FMD compliant scenario: ethnographic case study

Abstract

Objective To analyse, compare and identify trends within pharmacy workflows across the community and hospital sectors to identify key processes within pharmacy practice with a view to developing a workflow model to identify an efficient workflow process for optimal authentication and decommissioning activity to take place.

Design Ethnographic case study.

Setting Ten UK pharmacies with diverse organisational structure, covering both hospital and community pharmacy practice sectors. One site inpatient hospital pharmacy, five sites outpatient hospital pharmacy and four sites within community pharmacy.

Participants A total of 22 site visits contributing to 176 hours of ethnographic observation of pharmacy personnel, and 14 documents (primarily protocols and policies) relating to pharmacy practice.

Main outcome measures Workflow mapping and analysis of pharmacy dispensing practice.

Methods Analysis and observation of pharmacy personnel practice in dispensing prescriptions from the point of prescription reception to prescription transfer. Observational studies highlighted deviation and complexity in the dispensing practice within each sector and cross-sectors in comparison to document policies and protocols drawn together through narrative synthesis.

Results Dispensing practice comprises of an intricate network of processes, conducted by a number of personnel of varying qualifications. There exist defined and designated roles or 'tasks' that each individual is specifically trained to undertake and that personnel can transfer between each process dependent upon the clinical complexity, time constraint and staffing levels of the pharmacy. The dispensing process for certain clinical specialities has a number of personnel involved, whom, may not always be present within the same physical location and thus prescriptions may need to securely be transferred from one location to another efficiently and with minimal impact on patient experience and care.

Conclusion When broken down to its core dispensing practice can be categorised into three key phases: Phase one: Prescription reception, Phase two: Dispensing process, Phase three: Prescription transfer. Each of these three phases then have a number of processes steps contained within them, each of which will vary dependent upon the pharmacy sector under consideration, the clinical complexity of the prescription and the knowledge/qualification of the person carrying out the activity.

Introduction

Pharmacy workflow constitutes all practices involved in ensuring the safe dispensing of medicines to patients, clinical screening tasks, in addition to operational work. Regulation changes and introduction of innovative technological health systems solutions over the past 5 years have resulted in an evolving pharmacy practice to accommodate such solutions; with analysis of the workflow being considered for solutions to ensure the safe dispensing and error prevention perspective (185). In more recent times introduction of electronic prescribing (186) and prescription systems has resulted in a re-evaluation of the workflow within pharmacy to account for the change in prescription receipt of an often paper-light or paperless system. This reactive change in working methodology exposes pharmacy practice to an evolving workflow pattern. Advancements in technology to support healthcare will continue and pharmacy will need to integrate a safe and efficient working practice to not only support but benefit from such systems.
The working practices can be complex, supported by personnel of varying qualifications undertaking a segment or number of activities within a chain of events to produce the end product, the dispensed prescription. The Standard Operating Procedures (SOPs) in place are designed to facilitate this safe and efficient working practice, however, coupled with humans undertaking such tasks not all steps within a process are strictly adhered to creating deviation. The deviation may be a necessary step to overcome the barriers encountered such as resource, time and specific action requirements arising from an intervention. Thomas et al (187) have analysed the views of community pharmacy staff, highlighting the importance of deviating from processes and use of professional judgment as being important to pharmacists, whilst highlighting reasons as to why processes may not be strictly adhered to.

To fully understand and plan for efficient and safe working practices within pharmacies, there must exist an assessment of the intricate practice in place for all sectors, hospital and community. This plan will help shape the theoretical operational and financial impact of changes to working practices driven by innovation at an organisation or national policy level. Good practice standards have been published to aid organisations and procedure makers to consider key areas for consideration in developing and implementing SOPs (188) these standards provide a level consistency in the overall structure of such documentation.

Healthcare professionals work with a number of protocols and policies of varying depth and information to cover both clinical and operational practices. Pharmacy practice is no different, with Standard Operating Procedures (SOPs) in place to guide pharmacy staff on the must and should follow processes (189) consistency in approach and to instil safe working practices to minimise the incidence of errors (190) A number of studies (191-194) have highlighted the risk of inflexible working procedures resulting decreased efficiency of working practices, but none have specifically looked into pharmacy workflow scenarios to categorise and establish the key processes contained therein.

This ethnographic study of hospital inpatient and outpatient, in addition to community pharmacy will describe the workflow scenarios in place, compare and contract practices between each pharmacy sector and the respective protocols, identify key practices and processes within all workflow scenarios; and contribute to the knowledgebase of safe and efficient pharmacy practice.

Methods

This study is part of a wider project to investigate the impact of implementation of the Falsified Medicines Directive (FMD) on UK pharmacies with a primary aim of understanding the current pharmacy practice workflows in operation within both hospital and community settings.
A summary of the study protocol is shown in Figure 1 and ethical approval was sought from the ethics advisory board and submitted to each individual organisation involved for approval prior to research being undertaken.

The study included: one hospital inpatient pharmacy, five hospital outpatient pharmacies and four community pharmacies. These pharmacies were identified based on interaction and engagement with the Director of Pharmacy for participation in research, a legitimate approach in such study types and not unlike access to GP based practices (115).
The one inpatient pharmacy under consideration is also linked with 3 of the outpatient pharmacies mentioned. These pharmacy sites are part of a large multi-site tertiary NHS Trust, were dispensing for named patients occurs for 30 clinical speciality areas to adult and paediatric patients in addition to medicines supply as stock to wards and other hospital sites.

The hospital pharmacy also comprises of a specialist compounding (aseptics) unit servicing such departments as Oncology and Dermatology. The Trust employs a total of 10,000 staff, with pharmacists accounting for 123 of this figure and further 500 staff in allied support roles to pharmacy practice (e.g. technician and dispensers) treating over one million patients annually.
The other two outpatient pharmacy sites are part of the same multi-site tertiary NHS Trust located at different hospitals and servicing over one million outpatient contacts annually and employing over 1000 staff across the medical directorate.
The four community pharmacy sites were selected based upon accessibility of geographical area to the researcher's location and healthcare setting; one was attached to a health centre practice, the other on a main high street and two within local residential setting. All comprised of one full time pharmacist, dispensers, technicians and healthcare assistants.

A total of 22 site visits contributing to 176 hours of ethnographic observation of pharmacy personnel was undertaken in total across the 10 pharmacies in combination with 14 protocol and policy reviews.
Additionally, desk research of published organisational Standard Operating Procedures (SOPs) was conducted for hospital and community pharmacy sectors.
The site visits were conducted over a 3-month period and an average of two full days, 12-hour visits per pharmacy location was undertaken during the pharmacy's normal working hours. The extended time period was to allow for observation of practice across peak clinic times and staffing shift changes.
Observation of 95 pharmacy staff across all sectors was undertaken comprising of: 12 specialist pharmacists, 14 pharmacists, 45 technicians/dispensers and 20 healthcare assistants (HCAs).
An ethnographic picture was built by following the prescription journey through the pharmacy from the point of reception to completion and documenting each contact point that was observed and the grade of staff undertaking each activity, on visit two a number of these activities were timed to allow for dispensing workflow times to be considered as part of a future study plan considering the financial impact of changing the workflow processes.
The overall prescription journey was mapped for non-clinically complex prescriptions as shown in Figure 2 and data grouped together based on activity trends.

Results

It can be difficult to ensure that pharmacy personnel react in the same way as they would do, if their practice was not under observation. The observation by a researcher can cause the team to be more vigilant of their own practices even where they are not aware of which element of practice is under observation, Reeves et al (195)also highlight the difficulty in obtaining repeated access, which is something that was experienced within this study, owing to primarily the disruption caused to the team by the researcher asking questions of the practice being observed. The teams at all levels where extremely engaged with the process and were willing to share insight into their working practices. All personnel were able to accurately describe their working routine and workflow, highlighting the reasons as to why they undertook the activity that they had accountability and ownership of. Over 80% identifying 'patient safety' as the primary reason for undertaking a variety of activities within the workflow from prescription reception to the details covered as part of patient counselling.

Pharmacy Standard Operating Procedures
Through desktop analysis of organisational SOPs, we have identified a common theme, in that all processes are modular and allow pharmacy staff to train on one process but not necessarily the full pharmacy operations scope. In this way all pharmacy personnel are trained on processes that pertain to their individual activity, skillset and role designation within the team. Furthermore, all the process documentation provides additional guidance to support the professional and good practice requirements expected from each respective organisation.
The process documents varied in their tone of language, some with passive language such as: 'should' and others more descriptive and direct with the expectations noted as 'must' follow processes to allow clarity between what is to happen on every single occasion and what constitutes a flexible process.
Interestingly, pharmacy teams do not distinguish between these words as a barrier to practice and often refer to practical training they had received in following processes and procedures.

Pharmacy workflow
The level of interaction of the pharmacy staff and the person presenting the prescription varied considerably, with the full prescription reception questions stated within the protocol being asked where a patient or their representative

presented the prescription to the pharmacy counter for dispensing and that sent to pharmacy from a healthcare professional.
It can be noted that the prescription reception process within the inpatient pharmacy was markedly different to that for outpatients, in that there was no prescription reception questioning undertaken. The activity involved screening of the prescription initially for a required completion timeline and location to which it should be sent for actioning and assembly (e.g. aseptic unit).
Conversely the level of questioning upon prescription receipt within the community sector consisted of 3 primary questions covering: confirmation of name and address (or date of birth), prescription payment or exemption, waiting or calling back. When compared with the minimum of 6 questions within the outpatient setting with the additional points covering: allergies, clinic/consultant details and any other prescribed/routine medicines.

When the prescription is presented to the dispensary team, within the hospital sector (inpatient and outpatient) there exists the routine involvement of 3 pharmacy staff comprising of a pharmacist, dispenser/technician and pharmacist/Accredited checking technician (ACT), in comparison to the minimum of two staff in community pharmacy practice where often the pharmacist on duty will see the prescription through to completion with the support of a dispenser/technician during the dispensing and assembly process. All prescriptions undergo the following 4 key processes: 1- Clinical screening, where the prescription is checked to ensure compliance with all legal requirements and assessment of the appropriateness of the prescribed medicines for the patient taking into account factors such as allergies, weight, age, drug interactions with existing therapies and in some cases blood results, renal and liver function. This list is not comprehensive and there may be other checks that the pharmacist deems necessary for assessment. 2- Labelling where the required prescribed item details are inputted into the pharmacy dispensing system to generate a label that is affixed to the packaging of the product with dosage and warning instructions for the patient. 3- Assembly, a process where the required products are picked/selected to the correct quantity and the dispensing label produced affixed to the correct container. 4- Final accuracy check, in this process the prescription is reviewed, and the dispensed items are checked for accuracy to ensure that no errors have occurred in the assembly of the prescription prior to prescription transfer.
Whilst it is possible to group activities into four key areas, this grouping does not mean that each step is mutually exclusive of the other, in some cases steps 1 and 4 may be conducted as one step by the pharmacist if there is not another pharmacist or ACT present within the staffing model or absent when the prescription is required. Similarly steps 2 and 3 can be combined and carried out by the same dispenser/technician.

Prescription transfer processes were also noted to differ between the three practice settings under consideration. Inpatient pharmacy had no patient facing prescription transfers and often transported the dispensed medicines directly to the wards/clinics that required them. Outpatient pharmacy predominately patient facing would conduct prescription transfer directly to the patient, their representative or carer and would conduct a basic or enhanced level of counselling; the level of counselling received would be dependent upon whether the prescribed item was new, existing or if enhanced counselling had been provided by the clinical team on that visit. A degree of prescription transfers occurred directly to healthcare professionals, distribution to wards/clinics or home delivery.
Community pharmacy demonstrated a reduced level of counselling directly from the pharmacist, with the pharmacist handing out the dispensed prescriptions only where patient counselling was required or affixing a sticker/marker to the prescription to highlight that a pharmacist would need to be involved in the hand-out procedure. A number of prescriptions were assigned as home delivery to patients.
When looking at prescription processing times from the point of receipt to transfer, eliminating all prescriptions that required an intervention or follow up by the pharmacy team, the average range in prescription dispensing time is calculated as: community pharmacy 5 to 25 minutes, outpatient pharmacy: 15 to 45 minutes and inpatient pharmacy: 30 minutes to 3 hours.
Analysis of the workflow can be summarised as three key phases for UK Pharmacies, Phase one: Prescription reception, Phase two: Dispensing process, Phase three: Prescription transfer. Each of the three key phases can then comprise of further sub activities which can vary depending upon the sector and clinical complexity of the prescription. Pharmacy staff were observed deviating from their organisational process for approximately 45% of the prescriptions processed, the analysis of the type of deviation is beyond the scope of this study however, 36% of these deviations were necessary to ensure completion of the prescription dispensing process, an observation noted for other healthcare staff (196, 197).

Discussion

Pharmacy workflows can be categorised as three main overarching phases, each phase then subdivided in a number of categories based upon the pharmacy sector and the clinical complexity of the prescription. The further division of sub-

activities is in line with findings of a similar research conducted in other European pharmacy models where the researchers proposed a layered workflow process, difference to our proposed model being that 10 key workflow processes are identified (198).
When looking at prescription processing timings it is important to note that this data has been extracted over a short study period and may not be reflective of the average working practices on a day-to-day basis. A number of factors are at play in the overall time taken to process a prescription including handling interventions or queries (199) awaiting pathology results to confirm the appropriateness of a prescribed treatment regimen, the speed or functionality of the dispensing or other IT systems required in the processing of prescriptions or simply human speed in cognitive and systematic processing (200, 201) . Reasons for interruption of the dispensing process were document but have not been presented here as suspension from any part of the workflow would mean that the prescription is either fully discarded and therefore not completed or the additional workflow steps reach completion at a later time.
Taking the four key steps in a dispensing process demonstrates a desire for a methodological way of working to create an efficient workflow, when these activities occur by different individuals a production line is created where a number of prescriptions are worked on simultaneously and thus a larger volume of prescriptions reach completion within a shorter time period. The additional benefit to this is the theory that a greater number of individuals involved within the dispensing process are likely to be more vigilant to the discreet process they are conducting and thus have greater ability to identify errors negating the Swiss cheese model effect (191) thus ensuring a safe dispensing practice, this production line process may not always be possible due to staffing levels and time pressures as an example.
A larger empirical study is required to provide detailed analysis of the impact of technology systems on the overall workflow process in respect of patient safety, process efficiencies and financial impact to comply with applicable regulation.

Strengths, Limitations and Follow up work

This study has been conducted over a limited number of hours per site and repetition of the study was not possible due to the workflow interruptions this would cause to the pharmacy team's operations. In addition, whilst every effort was made to select study sites that provided a diverse range of clinical specialities and working practices a larger empirical study is required to further explore the common themes identified within this study.

The data has been obtained from experts in the field as well as staff with full operational knowledge and skillset to carry out pharmacy activities within a variety of practice settings. The outcome of this work will help to inform additional research planned as part of this project to analyse pharmacy workflow changes as a direct result of policy and regulatory requirements.
Further work is required to fully map all pharmacy workflow operations, specifically within the hospital inpatient sector and robotic dispensing operations (202) in addition to study of the impact of Information technology systems on pharmacy practice utilising the ethnographic approach (203). Use of manual mapping and data trend analysis with Excel proved difficult in collating for this large data set and for future studies the use of Work Observation Method by Activity Timing (WOMBAT) tool will be considered to collect data (204). In this way the study tasks can be developed as main and subcategories to allow for ease of data comparison and replication of method for future work. We will also be able to document the workflow interruptions and nuances observed, there may also be a need to include additional onsite local researchers to assist with data collation and training will need to be considered for these personnel to ensure consistency in practice.

Conclusion

This study has highlighted the intricate and varied operations for dispensing of prescriptions, with the hospital inpatient and outpatient sectors presenting the more complex workflows than community pharmacy practice owing to dispensing for a wide variety of specialist clinics and patient groups, Oncology and Haematology being a prime example of where a number of healthcare professionals are involved in processing of the prescription from clinical screening through to onward distribution for patient use.
Pharmacy dispensing practice can be summarised as three key phases as shown in Figure 3. This analysis is true for all sectors, but it should be noted that a prescription may not necessarily be processed in the same workflow order within phase 2, where some processes can be merged, conducted earlier or later in the chain or by one or more individuals, and dependent upon the sector of pharmacy practice.

Aims:

1- Map workflow of prescription dispensing within a variety of pharmacy sectors
2- Identify key steps within the dispensing process
3- Identify time taken to complete each step within the dispensing process
4- Develop method to inform larger scale study

Design:

Multi-site case study within UK pharmacies:

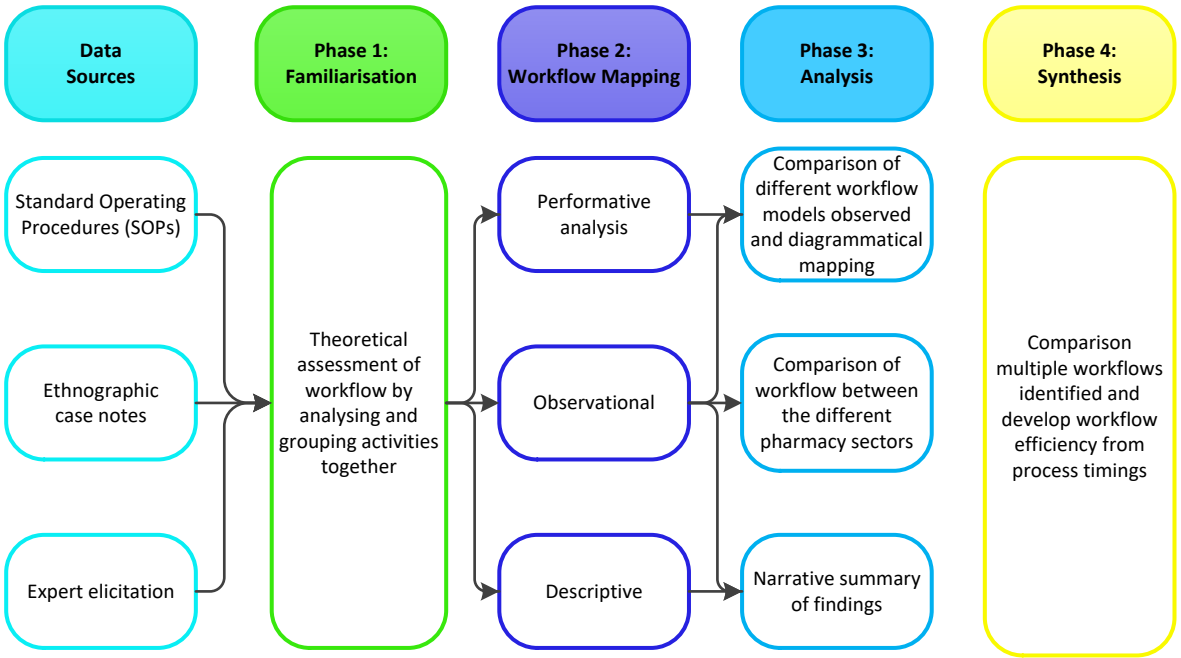
- Hospital inpatient pharmacy (1 site)
- Hospital outpatient pharmacy (5 sites)
- Community pharmacy site (4 sites)

Desk research of published organisational Standard Operating Procedures (SOPs):

- Hospital outpatient pharmacy (49 sites)
- Community pharmacies (951 sites)

Time and motion

Method:



Outputs:

1- Clear identification of pharmacy prescription dispensing workflows within hospital and community pharmacy.
2- Process timings to identify efficient workflow models.
3- Develop theory of suitable FMD compliant workflows with optimal authentication and decommissioning activity.

Fig1. Study protocol

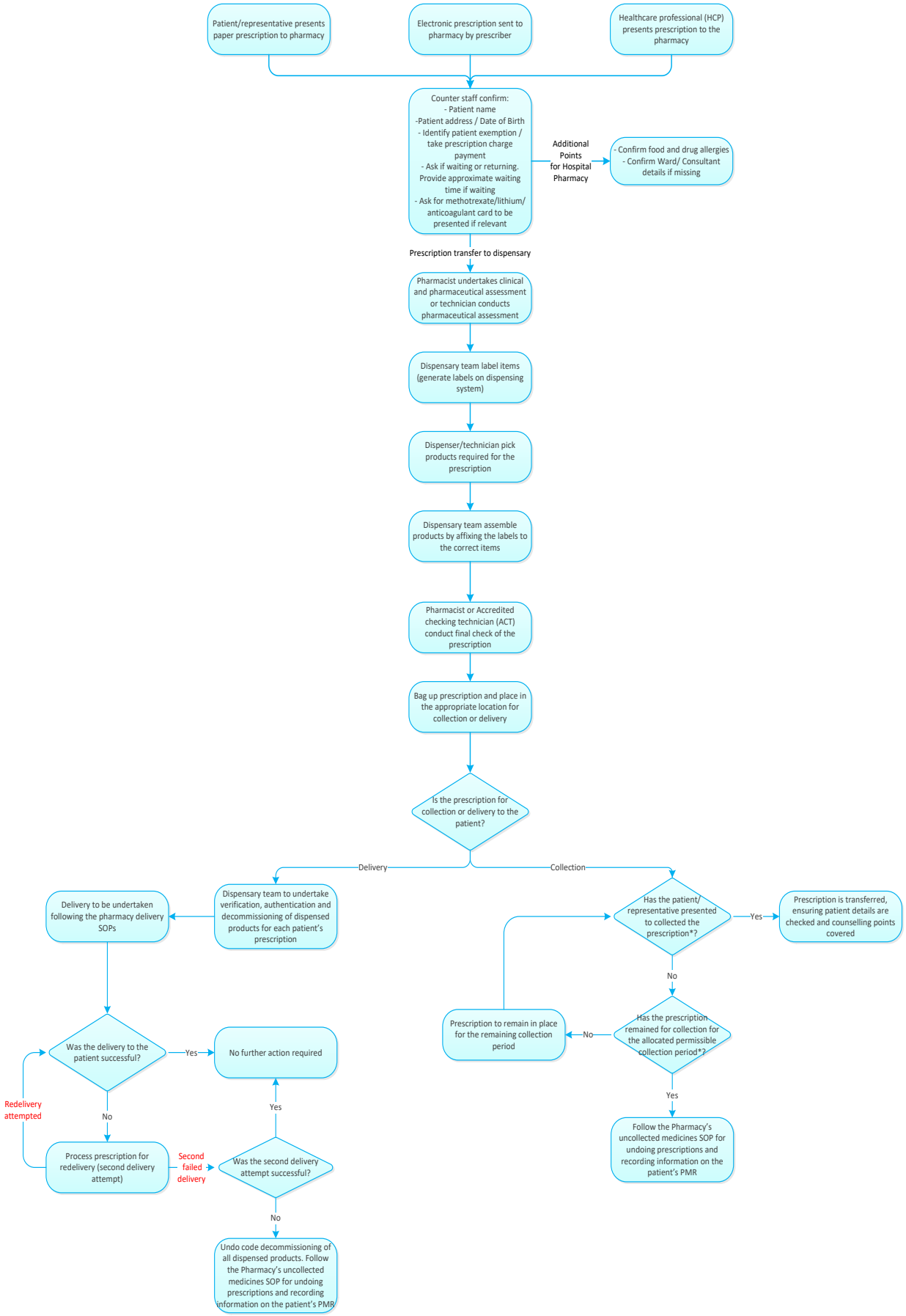


Fig2. Pharmacy workflow overview

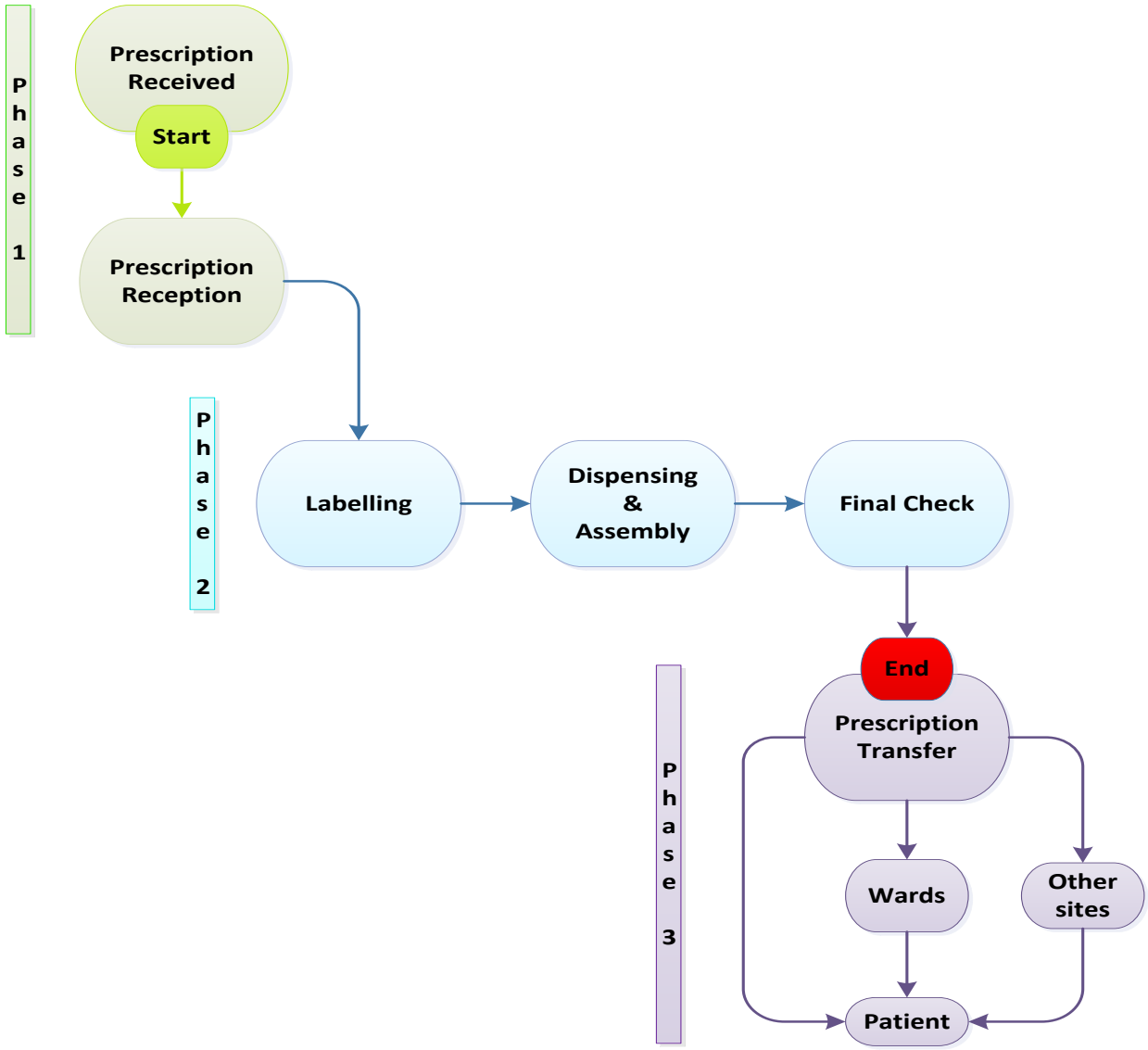


Fig3. Three phases in pharmacy workflow