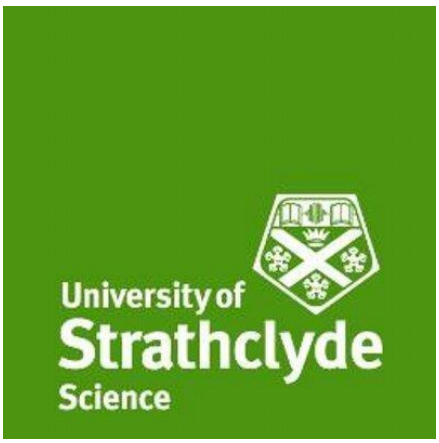

Electronic Prescribing Impact on Hospital Pharmacy Inpatient Medication Review Prioritisation

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A thesis presented in fulfilment of the requirements for the degree of Master of Philosophy

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Biomedical Sciences

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Copyright Declaration

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Date: 14/05/25

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Abbreviations

AFC	Agenda for Change
APP	Automated Patient Prioritisation
DRP	Drug Related Problem
CoRE-Values	Codes, Regulations, Ethical Principles, Values
EAHP	European Association of Hospital Pharmacists
ESRC	Economic and Social Research Council
GDPR	General Data Protection Regulation
GPhC	General Pharmaceutical Council
HCP	Healthcare Professional
HEPMA	Hospital Electronic Prescribing and Medicines Administration
MDT	Multidisciplinary Team
MHRA	Medicines and Healthcare products Regulatory Agency
MLM	Machine Learning Model
MMAT	Mixed Methods Assessment Tool
NHS	National Health Service
PIM	Potentially Inappropriate Medication
PIS	Participant Information Sheet
PSW	Pharmacy Support Worker
RPS	Royal Pharmaceutical Society
UK	United Kingdom

Thesis Abstract

Background:

Hospital pharmacy services are engaging with methods to prioritise inpatients for pharmaceutical review in response to the increased pressure on healthcare services and workforce challenges. Hospital Electronic Prescribing and Medicines Administration (HEPMA) systems continue to be implemented in developed countries across the world as a means to reduce medication errors. Use of HEPMA data within pharmacy service patient prioritisation tools is emerging in the literature but there is limited published research around the prioritisation methods used specifically with HEPMA data, or of any ethical implications in using automated patient prioritisation tools. The aim of this thesis was to identify and describe the methods used to prioritise hospital inpatients for medication review by hospital pharmacists after HEPMA system implementation, and to identify any ethical considerations from automated patient prioritisation tool use within this process.

Methods:

Stage 1 - A systematic literature review was conducted in the first stage of this thesis. The review sought to identify methods of patient prioritisation by healthcare professionals (HCPs) using a HEPMA system in Medline, Embase, CINAHL and The Cochrane Library between 2012 and 2022. An evidence gap with respect to the professional ethics of using patient prioritisation methods in the hospital pharmacy service was identified in the literature review, which consequently led to the second stage of this thesis.

Stage 2 - Two focus groups were conducted with 12 hospital pharmacists from a Scottish Health Board prior to the use of automated patient prioritisation (APP) to explore any ethical concerns using an ethical decision-making framework.

Results:

Stage 1 - Thirteen studies were identified in the systematic literature review and hospital pharmacists were confirmed as the HCP most often engaging with methods to prioritise patients. Antimicrobial teams and nurses were the other HCPs identified in the studies. Use of machine learning models (MLMs) was noted as a new and innovative way of prioritising patients by hospital pharmacists and three categories

of prioritisation method were identified: HCP prioritisation using HEPMA system functionality, HEPMA data presented for HCP prioritisation and HEPMA data automatically prioritised by software. Most studies either presented HEPMA data for HCP prioritisation or used software to automatically prioritise patients for the HCP. Pharmacists were the only HCP to use automated methods of prioritisation.

Stage 2 – Focus group participants agreed that APP use is a fair and pragmatic approach to managing daily workload by directing pharmacy staff to the patients most at risk of harm from prescribed medications but also highlighted ethical concerns that organisations should consider prior to adoption. Pharmacy staff must continue to use their professional judgement when using APP, avoiding an overreliance on automation to ensure that patient clinical information not included within an APP tool is included within professional prioritisation. A governance need was also identified to ensure review and update of the underpinning clinical rules of APP so it is reflective of current practice to support robust risk prioritisation. Complete visibility of high-risk patients was thought to have the potential to cause issue if a workforce does not have the capacity to meet the demand, which could have an impact on staff wellbeing. Any identification of workforce capacity limitations through APP use was considered a lever for business case development to secure further staff resource and/or service transformation.

Conclusion:

HEPMA systems can influence methods of patient prioritisation if they contain functionality specific for this purpose or by creating large scale electronic data sets for HCPs to engage with, which would not have been readily available prior to implementation. Ethical issues with APP can arise if pharmacy staff resource does not have capacity to review all identified high risk patients within working hours; if pharmacists use APP to prioritise patients without professional judgement there is risk that not all patient clinical information will be reviewed, and staff may lose autonomy; if APP tools are not updated to reflect current practice then there is risk of patient harm. Despite ethical concerns, use of APP brings opportunity for service evaluation and transformation.

Chapter 1: Introduction

1.1 Patient Safety Challenge for Hospital Services

Medication prescribing is the most common therapeutic intervention in healthcare (1), with the World Health Organization (WHO) estimating that globally, half of all preventable harm in medical care is medication related with an estimated cost of $42 billion annually (2). It has also been widely established that medication errors can prolong the patient hospital stay and result in increased morbidity and mortality (3); a substantial proportion of these errors are prescribing related which are a common focus for improving patient safety in hospitals (3,4). A medication error is defined as a preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional (HCP), patient or consumer (5). The Errors – Questioning Undergraduate Impact on Prescribing (EQUIP) study (3), commissioned by the General Medical Council, highlighted the prevalence of inpatient prescribing errors with a mean error rate of 8.9% per 100 medications identified by pharmacists across 20 UK hospitals. The Prescribing Outcomes for Trainee Doctors Engaged in Clinical Training (PROTECT) study (4) found that junior doctors made the most amount of prescribing errors in the UK but that they also do the majority of prescribing within the hospital environment. Both studies highlight the need for interventions to target and address hospital prescribing errors.

1.2 Medication Error Management in Hospitals

Medication error prevention is a high priority for health systems worldwide (6) and comprehensive systematic approaches to patient safety are reported to achieve this (5). Common factors that lead to medication error are environmental, staffing and workflow issues (5); the European Collaborative Action on Medication Errors and Traceability (ECAMET) White Paper (7) outlines strategies to reduce medication errors in hospitals. The White Paper recommends use of traceability systems as the most important way of achieving error reduction, in addition to establishing a safety

culture to improve error reporting, improving communication, multidisciplinary training meetings and use of quality management systems. Two interventions highlighted in the white paper that are frequently employed by healthcare systems internationally, in an effort to reduce hospital medication errors, are the use of technology and increased workforce (8).

1.2.1 Technology

Traceability systems such as Hospital Electronic Prescribing and Medicines Administration (HEPMA), automated dispensing cabinets and bedside bar-coded medication administration have all been identified as effective strategies to prevent medication errors (5–7). HEPMA systems have the biggest impact on medication error reduction, which is achieved by ensuring the prescription is legible and complete, reducing need for transcription and highlighting drug allergies and drug-drug interactions in systems with clinical decision support software (6,9,10). In 2017, the WHO launched a global initiative to reduce medication errors and associated harm by 50% over the following 5 years, with electronic system use recommended for medication prescription, preparation, dispensing, administration and monitoring (7).

1.2.1.1 Electronic Prescribing

Electronic prescribing is defined as computer based generation of a prescription in place of paper prescriptions (11) and some electronic prescribing systems also have functionality for electronic recording of patient medication administration. There are various naming conventions for electronic prescribing systems within the literature: ePrescribing, Electronic Prescribing and Medicines Administration (EPMA), Computerised Physician Order Entry (CPOE) and Hospital Electronic Prescribing and Medicines Administration (HEPMA) (12). For the purposes of this thesis, an electronic prescribing system with administration recording will henceforth be referred to as HEPMA unless quoting directly from a source with differing terminology. In addition to the various naming conventions between and within countries, there are also separate system names for the available software

solutions. System implementation has several benefits in addition to reduction in medication errors to improve patient safety (13–15): reduction in adverse drug events, releasing staff time to care, increased health professional efficiency and performance throughout the medication process as well as increased access to data and auditability are expected from system implementation (12–16). However, the systematic literature review conducted by Ahmed et al. (15) on the evidence of HEPMA impact on patient safety highlighted that in addition to the aforementioned benefits, HEPMA implementation can introduce unintended consequences through new error types e.g. incorrect selection from a drop down list or overriding alerts, and changes to workflow practices due to system functionality .

1.2.1.2 HEPMA Implementation

Electronic prescribing systems are reported in many developed countries around the world (17) with early adopters first describing use in the 1990s (18). Adoption approaches and evolution of electronic prescribing through secondary care have differed between countries due to varying healthcare systems, with lack of centralised funding and perceived impact to workflow cited as reasons for slow system adoption (19). Government policy, centralised funding and incentivising (20) are the main drivers behind increased system adoption from the early 2000s to the present day.

1.2.2 Workforce

Methods of medication error detection in hospitals are manual medication chart reviews, computerised monitoring and incident reporting (21); medication chart review is resource intensive but viewed as the gold standard in detection. Medication chart reviews consist of a structured and critical examination of each prescribed medication in agreement with the patient to optimise treatment, minimise drug related problems and reduce waste (22–24). A sample audit on the reduction of medication errors conducted by the European Collaborative Action on Medication Errors and Traceability (ECAMET) in 2022 with hospital chief pharmacists in Europe reported that 56% of the 317 sampled hospitals have a trained HCP to detect

medication errors and that hospital pharmacists are the main staff group employed for this purpose (25).

Staff recruitment and retention is a significant challenge facing healthcare organisations as workforces grow to meet increasing demand and therefore reliance on one HCP group for error detection would be impacted by this. Staffing shortages limit the capacity to deliver quality healthcare services and impact on staff wellbeing (26); a 2019 survey conducted in the UK showed that 40.3% of National Health Service (NHS) staff respondents reported feeling unwell at work due to stress (26), with data indicating an upward trend. Chronic excessive workload has been identified as a key factor of burnout and staff shortages (27) with the COVID 19 pandemic compounding this, NHS England reports a staff vacancy rate of 8% (26).

1.2.2.1 Hospital Pharmacy Service

A systematic review of randomised controlled trials conducted by Dawoud et al. (28) which investigated the effectiveness of pharmacist input at the ward level highlighted that a clinical pharmacy service within the hospital setting is an integral part of the ward multidisciplinary team (MDT) and contributes to patient safety by optimising patient medication and preventing adverse drug events. The pharmacist and pharmacy technician roles in secondary care have evolved from traditional dispensing and checking roles for medicines supply to ward based inpatient medication reviews (29,30). A medication review is comprised of a patient data review e.g. laboratory and medical treatment, patient interview, critical examination of the patient's medications e.g. dose and interaction review, with resulting recommendations for the hospital physician (31). Ward based pharmacist interventions have been shown to improve patient care, reduce harm and reduction in length of patient stay, thus making an economic case for benefit and staffing (28,29). This evolution of the role has occurred in multiple developed countries around the world but the extent to which activities are carried out varies as influenced by government policy, pharmacist availability and healthcare economics (30).

Key principles for a clinical pharmacy service are outlined in the Royal Pharmaceutical Society (RPS) Professional Standards for Hospital Pharmacy

Services (32), highlighting the need for patient medication review at each episode of inpatient care. Abuzour et al. (33) and Onatade et al. (29) describe the expectation that all hospital inpatients should receive a pharmacy medication review during an admission.

Due to service pressures and resource issues, clinical pharmacy staff can be responsible for several ward areas concurrently and may have other commitments within the pharmacy department throughout the working day that results in irregular ward cover, therefore limiting time that can be spent on the ward conducting inpatient medication reviews to identify errors and improve patient safety (28,33,34). Irregular ward cover can result in a reactive pharmacy service, increasing delay between prescribing and medication review, and some wards may not have any clinical pharmacy staff input due to staff shortage or lack of service funding (35,36). A 2022 survey conducted by the RPS in the UK showed that 88% of the pharmacist respondents in all settings of care were at high risk of burnout (37) which can lead to high vacancy rates. The 2023 RPS report on transforming clinical hospital pharmacy in Wales for enhanced patient care (37) recognised the need for reviewing traditional clinical pharmacy services to optimally deploy resource, to utilise the expertise of pharmacist prescribers as part of the MDT and incorporate them into long-term workforce plans as all new pharmacist registrants become prescribers from 2026. There is a recognised issue in the comparison of clinical pharmacy services (29) due to variation in the levels of services provided and activities undertaken (38).

1.2.2.2 Inpatient Prioritisation

Due to the increased pressure on healthcare services, better use of workforce has been identified as a vital role for increased efficiency (33). In recognition of the difficulties that hospital pharmacy departments face in delivering comprehensive medication reviews to every inpatient, which is not often achieved, the RPS hospital pharmacy standards state that systems should be in place to identify patients most likely to benefit from clinical pharmacy support, yet there is no national consensus to define this (32). The combination of reduced funding and staffing issues with increasing number of patient admissions with polypharmacy necessitates a pragmatic approach (36) to service delivery and patient safety. Patient prioritisation

is one method used to increase efficiency and cost effectiveness of the hospital pharmacy team by directing staff resource to patients that would most benefit from medication review (33).

Prior to HEPMA implementation, inpatient medication charts could not be accessed remotely from the ward, therefore clinical pharmacy services had to prioritise inpatients by attending the ward to screen medication charts and/or establish a referral system with the ward multidisciplinary team. An international systematic review by Alshakra et al. (36) in 2019 identified and summarised multiple tools (n=17) (Table 1.1) developed to aid pharmacy services in identifying high-risk patients for medication review. The tools identified in the review highlight the current period of transition from paper to electronic prescribing in hospitals and the evolution of prioritisation tools in harnessing electronic prescribing data with 29% (n=5) being paper based (requiring manual data entry), 23% (n=4) using electronic data, 35% (n=6) using electronic data that incorporated HEPMA data and the remaining tools (n=2) did not state format. The diversity of tool types in use demonstrates the innovative ways in which pharmacy services are utilising available patient information and systems to risk assess patients for pharmaceutical intervention. Electronic design is the most common format used with algorithms noted in some of the tools, lack of detail within the studies limits understanding on how the tools are operated, but use of electronic tools was reported as reducing time spent by pharmacists in retrieving patient records.

Common risk factors utilised to identify patients at risk of drug related problems (DRPs), or potentially inappropriate medications (PIMs) are polypharmacy (multiple medications), high-risk medicines, therapeutic drug monitoring, patient age, renal function and co-morbidities. DRPs are events or circumstances involving drug therapy that actually or potentially interfere with desired health outcomes (39) and PIMs are defined as medications with a greater potential risk than benefit for older people (40,41).

Table 1.1 Summary of published patient prioritisation tools used by pharmacists internationally in hospital setting (36).

Tool Type	Country	Population Group	Tool Risk Factors	Perceived Benefits to Patient Care
Paper (42)	Brazil	Inpatients	Drug related: Polypharmacy, Intravenous (IV) medications, High-risk medications, Parenteral feeding and Monitoring need Patient related: Age, Renal function, Liver function and Co-morbidities	Detects population at risk of adverse drug reaction
Paper (43)	Denmark	Inpatients. Adults (≥18 yrs)	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Age, Renal function and Co-morbidities	Detects population at risk of medication errors
Paper (44)	France	All patients hospitalised through the emergency room	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Age and Co-morbidities	Helps to identify patients at the greatest risk of medication errors
Paper (45)	UK	Obstetric patients	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Age, Renal function, Liver function, Co-morbidities and Allergy	Opportunities to improve medicines reconciliation, multidisciplinary team coordination and prevention of adverse events
Paper (46)	UK	Paediatric inpatients	Patient related: Age, Co-morbidities, Allergy and Type of admission	Assists in identifying patients in need of a greater level of care
Electronic Report (47)	France	Inpatients. Adults (≥17 yrs)	Drug related: Polypharmacy, High-risk medications, Parenteral feeding, Monitoring need and Blood substitutes Patient related: Age, Readmission and Type of admission	Predicts occurrence of medication errors to guide intervention for high-risk patients
Electronic Report (48)	UK	All acute care inpatients	Drug related: Polypharmacy, High-risk medications, Monitoring need, Significant drug interactions and IV antibiotics Patient related: Age, Renal function, Liver function and Type of admission	Improves patient prioritisation and quality of service, equity of patient care and patient safety
Electronic Report (49)	UK	Inpatients Adults	Drug related: Polypharmacy, Monitoring need, Drug Interactions, Drug specific issue Patient related: Age, Renal function and Liver function	Ensures patients with complex pharmaceutical needs are seen quickly
Electronic Report (50)	US	Not stated	Drug related: High-risk medications, Monitoring need, Severe drug induced side effects and Hospital acquired infection	May improve patient safety by identifying preventable adverse drug events

Tool Type	Country	Population Group	Tool Risk Factors	Perceived Benefits to Patient Care
Electronic - HEPMA data (51)	New Zealand	Inpatients	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Age, Renal function, Co-morbidities and Readmission	Facilitate the identification and monitoring of patients at high risk for medication errors and adverse drug events
Electronic - HEPMA data (52)	Switzerland	Inpatients. Adults	Drug related: Polypharmacy, High-risk medications, Monitoring need, Cytochrome P450 inducers and inhibitors, IV acetaminophen, Anti-infectives > 3 days and Digoxin with low serum potassium Patient related: Age and Renal function	Facilitates efficient and rapid screening of patients at risk of drug related problems
Electronic - HEPMA data (53)	UK	Inpatients	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Allergy	Helps to provide safe, effective, and patient centred care.
Electronic - HEPMA data (54)	UK	Adult inpatients	Drug related: High-risk medications, High cost and Monitoring need Patient related: Renal function, Liver function and Co-morbidities	Ability to rank patient acuity into 3 levels to identify those at greatest risk for developing adverse drug events
Electronic - HEPMA data (55)	UK	All pharmacists covering electronic prescribing wards	Drug related: Polypharmacy, High-risk medications, Monitoring need, Drug interactions and Pharmaceutical biochemistry alert Patient related: Type of admission and Length of stay	Enables activities that improve patient safety such medicines reconciliation, drug interventions and biochemistry review
Electronic - HEPMA data (56)	US	Inpatients paediatric and adult patients	Drug related: High-risk medications, Parenteral feeding and Monitoring need Patient related: Age and Renal function	Enables the identification of patients who could benefit from detailed medicines reconciliation
Not stated (57)	Spain	Paediatric patients with chronic conditions	Drug related: Polypharmacy and High-risk medications Patient related: Age, Co-morbidities and Type of admission	Stratifies paediatric patients with chronic conditions into distinct risk levels and patients who will benefit from pharmacist intervention
Not stated (58)	UK	Inpatients	Drug related: Polypharmacy, High-risk medications and Monitoring need Patient related: Age, Co-morbidities, Readmission and Length of stay	Can be used to identify patients at high risk of readmission, mortality and longer hospital stay

1.2.2.3 Ethics of Inpatient Prioritisation

Patient prioritisation tools require criteria (or clinical rules) to be agreed during development in order to prioritise patients to an agreed standard i.e. risk factors displayed in Table 1.1. The literature review conducted by Alshakrah et al. (36) highlighted several different types of tools used by pharmacists to prioritise patients but the professional ethics of using tools to do this rather than pharmacist professional judgement was not discussed. Patient prioritisation criteria could systematically disadvantage patient groups if the underpinning selection criteria is not applied consistently (59).

As hospital pharmacy services do not routinely review every inpatient in a ward or hospital on a daily basis, patient risk is not always known. Use of automated patient prioritisation (APP) tools enabled by HEPMA data could change that by identifying all inpatients with agreed risk factors that were previously unknown.

1.3 UK Approach to Medication Error Management in Hospitals

Within the UK, electronic prescribing was first used in primary care GP practices (60) and is now focussed on secondary care with HEPMA implementation, promoted through national strategic policy in the four nations, with targets set for universal use (10). Despite this, system adoption has lagged behind set timescales and in 2011, Ahmed et al. (61) reported that even though electronic prescribing was prevalent, only 13% of English Trusts, out of the 101 that responded to survey, had implemented HEPMA across all medical and surgical wards. Over the last decade, government investment continues to drive system adoption towards the goal of universal use within secondary care. The qualitative study conducted by Ahmed et al. (62) exploring the use of multiple HEPMA systems within a single NHS England Trust showed that system implementation is not always strategically planned, which can result in multiple systems in use, particularly across specialist areas. Multiple system use can increase patient risk through fragmented patient journey documentation, lack of system integrations and differing functionality for clinicians to work with (62).

A survey exploring patient prioritisation for hospital pharmacy services in the UK conducted by Abuzour et al. (33) in 2018 reported over half of the NHS Trust Chief Pharmacist respondents (70/130) used a prioritisation tool or process to direct clinical pharmacy services, demonstrating that many UK hospital pharmacy services are exploring ways to increase workforce efficiency. Limited staffing and increasing workload pressures are both cited as reasons for adoption of risk prioritisation tools. Several types of locally developed prioritisation tools are described in the survey (Table 1.2) with format, paper or electronic, identified as the key differentiating factor between them. Pharmacists emphasised the benefits of quick access to real-time data to direct resource with electronic prioritisation tool use.

Table 1.2 Types of patient prioritisation tool used by pharmacists in UK hospitals (33).

Type of Tool	Definition
Electronic based E1	Integrated tools that are automated to extracted data and use algorithms to assign a priority level to a patient for pharmacist review.
Electronic based E2	Software e.g. dashboards that can highlight patient indicators and track tasks for completion by pharmacists. Pharmacists will manually assign a priority level to each patient.
Electronic based R	Reported data based on preselected patient risk factor indicators. Pharmacists are required to review data and manually prioritise patients using clinical judgement.
Paper	Pharmacist review of patient indicators and risk score manually assigned based on review for prioritisation.
Paper-Electronic	Paper based manual prioritisation based on patient indicators with recording on an electronic system.

Abuzour et al. (33) noted that evaluation and internal validation of such tools is not often reported as only two studies completed this. One study where validation was conducted during the development was the Medicines Optimisation Assessment Tool (MOAT) by Geeson et al. (63) to ensure robustness of the electronic scoring system in predicting the probability of a patient DRP. The work completed by Alshakrah et al (36) highlights the UK as having the highest number of patient

prioritisation tools used by pharmacy services, stating the unique funding model of the NHS through Government taxation as a possible reason for the need to maximise resources in managing existing patient and financial pressures.

1.3.1 Scottish Approach to Medication Error Management in Hospitals

HEPMA implementation began in Scotland with the first Health Board in 1997 and the second in 2013, with a total of 12 out of 14 Health Boards now having established systems for secondary care. In recognition of the benefits HEPMA systems can bring, a Scottish Government lead National Implementation Funded Programme was launched, which resulted in the recent system uptake in further Health Boards through a national tendering exercise. Each Health Board has selected the same software for implementation and nationwide adoption is expected by 2025 (64), with only one Health Board still to adopt.

In addition to technology, NHS Scotland continues to invest in workforce to manage increasing workload as shown through workforce trends, staffing has increased for the majority of professions since 2014 (65). Despite the staffing increase, vacancy rates in NHS Scotland rose to record levels during the COVID-19 pandemic (2020-2021) and have only recently started to decrease as of March 2023 (66). Expenditure on medical and nursing agency staff employed to cover vacancies continues to increase each year and sickness/absence rates are at their highest in the last ten years (66), highlighting the challenge of workforce management and need for supportive technology.

In 2010, an incident within a Health Board with a HEPMA system prompted a review of a hospital pharmacy service provision that resulted in the creation of a prioritisation tool using HEPMA data to identify patients at greatest risk of harm from medications. Utilising HEPMA system data, hospital inpatients are automatically assigned a score of low, medium or high risk according to agreed local criteria e.g. high-risk medication, unlicensed medication or restricted supply medication. The tool, named Pharmacist Early Warning (PhEW) system, is noted to have had a positive impact on the timely provision of pharmaceutical care to patients identified at risk of harm from prescribed medication and further work is required to refine and develop the tool to include data from other clinical systems. (53,67)

1.4 Rationale for Research

With the continued implementation of HEPMA systems internationally, the landscape of inpatient prescribing is still undergoing a period of significant change. Hospital pharmacy services are under increasing pressure to deliver optimal pharmaceutical care to an expanding patient population with the backdrop of reduced funding and staffing issues. Patient prioritisation is viewed as a pragmatic way to deliver safe and efficient hospital pharmacy services and there is a growing need to explore how HEPMA systems can influence this. With the cited benefits of HEPMA systems, there is potential for innovations in patient prioritisation once established within a hospital and it is evident that specific features of HEPMA systems can be used to help pharmacists prioritise patients as noted by McLeod et al. (68). It is also evident from the findings of Alshakra et al. (36) that electronic assessment tools are already in use internationally for patient prioritisation by pharmacists. Research to demonstrate how HEPMA systems impact on patient prioritisation and staff perception of ethical use will allow better understanding on how they can best be used to support hospital pharmacy services in reducing medication errors and improving patient safety in clinical areas. There is also a unique opportunity in Scotland to study hospital pharmacy patient prioritisation after a HEPMA system has been implemented due to nationwide adoption of the same HEPMA software.

Chapter 2: Thesis Aim and Objectives

2.1 Research Questions

What impact does electronic prescribing have on hospital pharmacy inpatient medication review prioritisation?

What are the ethical implications of using an automated patient prioritisation tool in a hospital pharmacy service?

2.2 Aim

The overall aim of this thesis was to identify and describe methods used to prioritise hospital inpatients for medication review by hospital pharmacists after HEPMA system implementation, and to explore ethical considerations from automated patient prioritisation (APP) tool use within this process.

2.3 Objectives

1. To conduct a systematic review of the literature to identify, summarise and describe methods of inpatient prioritisation used by HCPs after the implementation of a HEPMA system.
2. To ascertain and describe hospital pharmacist views on professional ethical considerations of APP tool use with a HEPMA system within a hospital pharmacy service and identify common themes using an ethical decision-making framework.

Chapter 3: Systematic Literature Review

3.1 Introduction

HEPMA systems continue to be implemented across developed countries worldwide to reduce medication errors and improve patient safety in secondary care (6,17), at the same time as health services face workforce challenges (69). Paper and electronic prioritisation tools used to identify patients in most need of care have been shown to be effective in making efficient use of resources in a climate of reduced workforce (33,36,70). Three previous systematic literature reviews (33,36,70) have explored patient prioritisation tools used by HCPs with a focus on tool identification, types, characteristics, benefits and limitations. Two reviews (33,36) looked specifically at hospital pharmacist use of prioritisation tools, one international and the other within UK context. Both studies identified paper and electronic tools in use but did not focus on the types of prioritisation method used with a HEPMA system, which is necessary to understand in order to comment on system influence. The reviews highlighted that electronic systems can identify and prioritise patients for pharmacy review much faster than paper based methods to optimise resources and that electronic prioritisation tools are useful in retrieving real-time data, which can improve pharmacy workflow (33), therefore indicating that HEPMA systems are having an influence on patient prioritisation by pharmacists. The third review by Déry et al. (70) described international health service use of prioritisation tools to manage patient access to non-urgent care, which was predominantly elective surgery and was not focussed in the hospital setting. Identifying studies on prioritisation tools used with a HEPMA system and conducted with HCPs in the hospital setting would allow a greater understanding of how HCPs are utilising technology to assist with continued workforce issues. Alshakrah et al. (36) was the only review to describe prioritisation tool perceived benefits and did so with two categories (patient care and pharmacy services), identification of further studies with HCP prioritisation tool benefit descriptions would assist in describing any HEPMA system influence.

Benefits of HEPMA system implementation are frequently cited in the literature. This is a particular focus in the UK where healthcare is free at point of care and funded by Government taxation. In recognition of this, NHS England published benefits

realisation guidance for ePrescribing projects (71) to assist Trusts in describing system benefits and recommending methods in which they can be demonstrated. It is recognised in the guidance that HEPMA systems can improve staff efficiency by releasing time to care and it is noted that clinical pharmacist activity can be targeted to patients with greatest need, further indicating that methods of patient identification for care by HCPs change after HEPMA implementation and reinforcing justification for a literature review.

A systematic review of existing literature on patient prioritisation by HCPs after HEPMA implementation would identify methods used specifically with electronic prescribing systems to enable evaluation and description of associated system impact. As HEPMA systems can improve access to prescribing and administration data for HCPs (15), there is potential for improved patient prioritisation after implementation. Widening the scope of the literature search to encompass all HCPs will provide an evidence base for multiple professions to build upon, identify learning that can be shared across healthcare staffing for ways to maximise staff efficiency and reduce risk of medication errors for patients. The objective of this systematic review is to identify, summarise and describe the methods used to prioritise hospital inpatients by HCPs after HEPMA system implementation.

3.2. Aim and Objectives

Aim

To systematically identify, evaluate and summarise the existing literature on HCP patient prioritisation methods after HEPMA implementation.

Objectives

- To report on the characteristics of studies where patient prioritisation methods are used by HCPs after HEPMA system implementation.
- To categorise the different types of patient prioritisation methods applied by HCPs after HEPMA system implementation and describe the benefits.

3.3 Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) statement and checklist (72). Review registered with PROSPERO on 13th March 2022 (Appendix 1) with subsequent amendment made on 16th July 2025 to indicate review completed.

3.3.1 Search Strategy

Search terms were derived from Medical Subject Heading (MeSH) terms in conjunction with peer reviewed key words (allowing for word variation) and grouped under the headings of Electronic Prescribing System, HCP and Healthcare setting as documented in Appendix 2. Database searches were completed in Medline, Embase, CINAHL and The Cochrane Library (reviews only) with a date range of the previous 10 years (Feb 2012-Feb 2022) to focus on the time period where internationally identified paper and electronic pharmacist patient prioritisation tools were in use (36).

3.3.2 Inclusion and Exclusion Criteria

All HCP groups were included to describe the evidence base on the wider impact of HEPMA implementation on patient prioritisation or triage methods. Any method of patient prioritisation with HEPMA system data was included to highlight innovations for shared learning between HCP groups. Studies conducted in critical care were not included since this is an area were specialist electronic prescribing and monitoring systems are often deployed with high ratio of staff to patient care. The full list of study eligibility criteria is outlined in Table 3.1.

Table 3.1 Study Eligibility Criteria for Literature Screening

	Inclusion criteria	Exclusion criteria
Electronic Prescribing System	All supplier systems included	No supplier systems excluded
Healthcare setting	Hospital setting only. Inpatients within secondary care.	Settings that are excluded in this review: Primary care Community Care homes Home care Critical care
Healthcare professional (HCP)	All Healthcare professionals (HCPs): Physicians Pharmacists Nurses Allied HCPs	No HCPs excluded
Patient prioritisation	Studies that include patient prioritisation or triage methods to identify patients that have most need of HCP input. Key words (informed by Medical Subject Headings) used during literature screening: Health priorities Patient prioritisation Work prioritisation Clinical prioritisation Clinical processing Clinical pathways Clinical triage Acuity	Studies that do not include patient prioritisation or triage methods
Types of studies	All study designs will be included, including but not limited to: Qualitative Quantitative Mixed methods	No restriction on study type
Language	Studies that are written or have been translated into English language	Studies that are in language other than English
Geography	All geographical locations will be included	No geographical locations will be excluded

3.3.3 Study Selection

Studies retrieved from database searches were imported to the Covidence online platform via EndNote, where duplicates were removed. Study titles and abstracts were screened for relevance against the eligibility criteria (Table 3.1) by lead

reviewer and University of Strathclyde student (DC). Another University research student (DH) independently assessed 10% (n=321) of the study titles and abstracts by random sample for validity. Full text articles were retrieved for those studies selected as potential for inclusion and screened against the eligibility criteria (Table 3.1) by lead reviewer (DC), exclusion reasons were documented for those studies not included from full text review. Another University research student (DH) independently assessed 10% (n=12) of the full text articles by random sample for validity. Percentage agreement was calculated for validation using the following criteria: <70% poor; 70-79% fair; 80-89% good; and ≥90% excellent (73). Agreement percentage above 80 was considered acceptable otherwise a third University research student (NG) was consulted.

3.3.4 Data Extraction

Data from included studies was extracted by lead reviewer (DC) using a data extraction template on Microsoft Excel to standardise the data collected from each study. Extracted data included lead author, year published, geographical location, aim, study design, HCP involved, study intervention, HEPMA system, method of prioritisation used and results. A random selection of 10% was used to validate extraction by a second reviewer (DH), with any disagreement resolved by a third reviewer (NG).

3.3.5 Quality Assessment

Study quality was assessed using the Mixed Methods Assessment Tool (MMAT) (74) by lead reviewer (DC), a random selection of 10% was validated by a second reviewer (DH) for quality assessment and any disagreement resolved by a third reviewer (NG). The MMAT was selected for this systematic review as it is suitable to appraise qualitative, quantitative and mixed method empirical studies. Studies were categorised by study design, assessed against the methodological quality criteria for that design (as outlined in Appendix 3) and recorded with Yes, No or Can’t Tell responses to each criterion. Percentage of quality criteria met was calculated by assigning a score to each criterion response: Yes = 1, No = 0 and Can’t Tell = 0.

Scores were totalled and assigned a percentage as shown in Table 3.2, 80-100% was considered high quality.

Table 3.2 Mixed Methods Assessment Tool (MMAT) Scoring Percentage

Score	Percentage (%)
0	0
1	20
2	40
3	60
4	80
5	100

Mixed method studies were scored individually for the three study design criteria of qualitative, quantitative and mixed method (to give three separate scores out of 5), assigned a percentage of criteria met for each, then awarded the lowest percentage of the three overall as outlined in Appendix 3. The MMAT screening questions were not included in the scoring as these were to inform if the study was empirical. Studies were not excluded based on quality to support the research aim of identifying, evaluating and summarising HCP patient prioritisation methods after HEPMA implementation. (74)

3.3.6 Data Synthesis

The Economic and Social Research Council (ESRC) Methods Programme guidance on the conduct of narrative synthesis in systematic reviews (75) recommends a framework for effectiveness and implementation reviews, consisting of four main elements:

- Develop a theory of how the intervention works, why and for whom
- Develop a preliminary synthesis of findings of included studies
- Explore relationships in the data
- Assess the robustness of the synthesis

Theory development was not undertaken due to the variability of study interventions included. Following the guidance, the steps undertaken were:

Step 1 - A preliminary synthesis of the findings was conducted on the extracted data by grouping study characteristics (lead author, year of publication, country of origin, study design, setting, HCP and HEPMA system) and tabulating.

Step 2 – Study interventions and methods of prioritisation were separately grouped then categorised inductively through identification of commonalities, before tabulating. Each assigned category was then defined.

Step 3 – Methods of prioritisation were categorised into benefit descriptions as demonstrated within each study using the NHS England benefits realisation guidance for ePrescribing project definitions (71).

Step 4 – Studies in each method of prioritisation category were described and tabulated, displaying lead author, year of publication, intervention, description of prioritisation method, prioritisation outcome and demonstrated benefit category.

A convergent synthesis approach (76) was taken by analysing both quantitative and qualitative methodology together during data synthesis.

3.4 Results

3.4.1 Study Selection

A total of 3146 studies were identified for screening from the search terms after duplicates had been removed, 115 studies remained after title and abstract review. Percentage agreement of title and abstract review was 91% before discussion and 100% after discussion between reviewers, demonstrating excellent agreement (73). Thirteen studies were included after full text review as displayed in Figure 3.1. Percentage agreement of full text review was 67% before discussion and 100% after discussion between reviewers, demonstrating excellent agreement. There was no requirement for the third reviewer to resolve a disagreement at either stage.

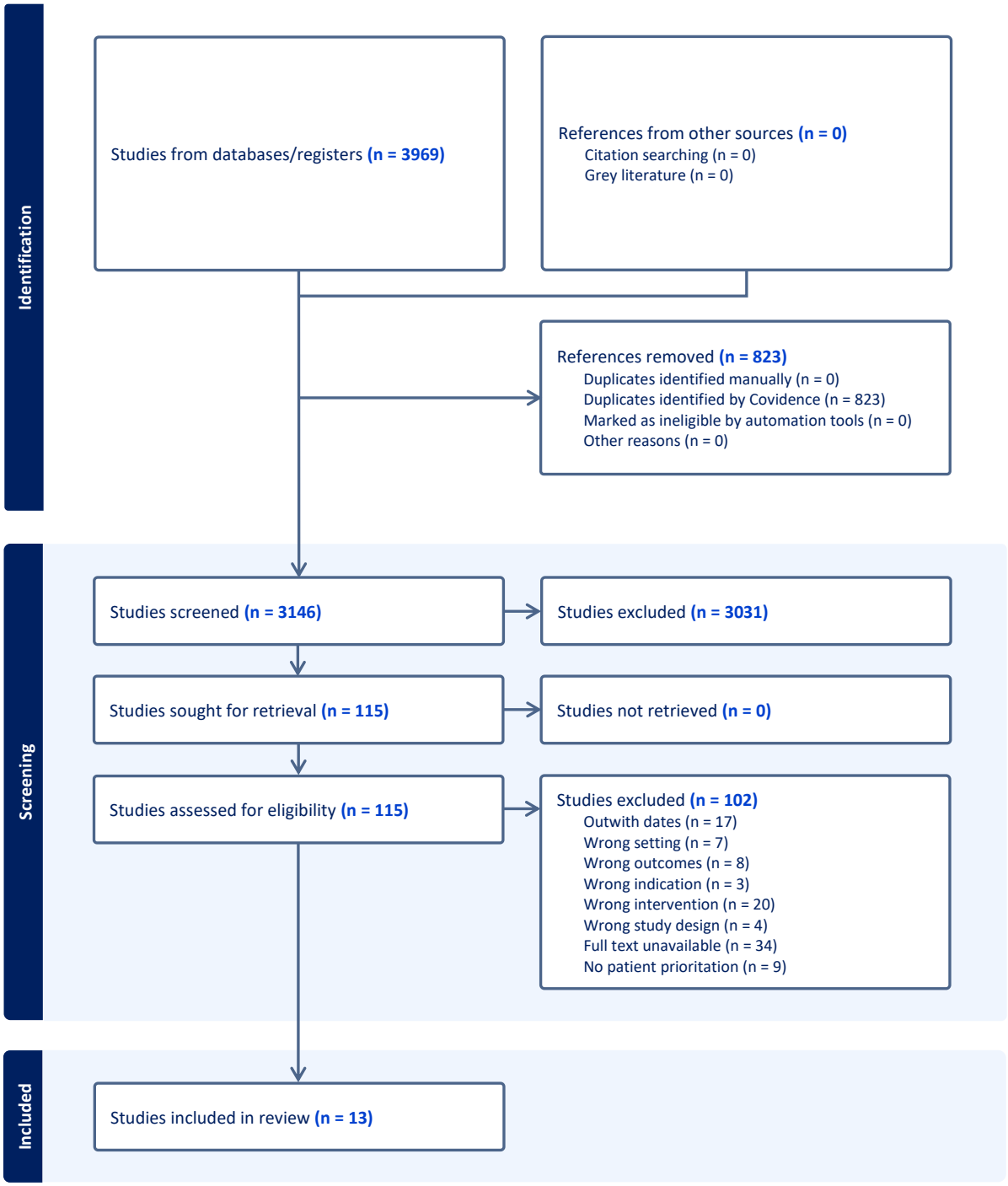

Figure 3.1 PRISMA flow chart of study identification and screening (Feb 2012 – Feb 2022)

3.4.2 Quality Assessment Results

All 13 studies were categorised by study design and assessed against the methodological quality criteria outlined in the MMAT as displayed in Appendix 3. The results of the study quality assessment are summarised in Table 3.3, with 9 scored as high quality. No studies were excluded after the assessment as recommended in the Mixed Methods Assessment Tool guidance (74) and in support of the research aim. Two studies were validated by another University research student (DH) using the MMAT to independently score. Agreement was achieved (100%) upon discussion and comparison of MMAT scoring against the criteria.

Qualitative Studies (n=2)

Both qualitative studies were high quality, included clear research questions and collected appropriate data to answer them. Cresswell et al. (77) met all of the qualitative quality criteria but Tan et al. (78) did not explain the reason for using the data collection method to address the research question.

Quantitative Studies (n=9)

Six of the quantitative studies were of high quality (79–84) but one study was of notably low quality with only 20% of quality criteria met (85). Balestra et al. (86) and Granko et al. (85) did not include clear research questions and therefore did not allow for adequate assessment of appropriate data collection, which resulted in unclear assessment of appropriate measurement or statistical analysis in both cases; the remaining seven studies did include clear research questions and collected data to address them. Due to lack of clarity in the text, risk of nonresponse bias could not be assessed for Devchand et al. (80) and Peterson et al. (87). Adequate justification for statistical analysis to answer research question could not be interpreted for Peterson et al. (87) and Rommers et al. (84), the remaining studies (79,81–83) satisfied all of the qualitative quality criteria.

Mixed Method Studies (n=2)

One of the mixed method studies was of high quality (68), both studies included clear research questions and collected data to allow them to be addressed. McLeod et al. (68) satisfied all of the mixed method quality criteria, whereas McMullen et al. (88) did not sufficiently substantiate the interpretation of the qualitative results with the data and despite the study satisfying the quantitative criteria, it resulted in overall uncertainty in quality assessment with a score of 40% for quality criteria met.

Table 3.3 Summary of Study Quality Assessment Question Responses

	Screening		1. Qualitative					2. Quantitative randomized control trials					3. Quantitative non-randomised					4. Quantitative descriptive					5. Mixed methods					Quality Criteria Met
Lead Author, Year	S1	S2	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5	
Bouchand 2017 (79)	Y	Y																Y	Y	Y	Y	Y						100%
Cresswell 2014 (77)	Y	Y	Y	Y	Y	Y	Y																					100%
Diaz 2013 (81)	Y	Y											Y	Y	Y	Y	Y											100%
Levivien 2022 (82)	Y	Y						Y	Y	Y	Y	Y																100%
McLeod 2019 (68)	Y	Y	Y	Y	Y	Y	Y						Y	Y	Y	Y	Y						Y	Y	Y	Y	Y	100%
Quintens 2019 (83)	Y	Y																Y	Y	Y	Y	Y						100%
Devchand 2019 (80)	Y	Y																Y	Y	Y	CT	Y						80%
Rommers 2013 (84)	Y	Y																Y	Y	Y	Y	CT						80%
Tan 2013 (78)	Y	Y	Y	N	Y	Y	Y																					80%
Balestra 2012 (86)	CT	CT																Y	Y	CT	Y	CT						60%
Peterson 2014 (87)	Y	Y																Y	Y	Y	N	N						60%
McMullen 2015 (88)	Y	Y	Y	Y	CT	N	Y						Y	Y	Y	Y	Y						Y	CT	Y	CT	CT	40%
Granko 2012 (85)	CT	CT																CT	Y	CT	CT	CT						20%

Questions displayed in Appendix 3. Y – Yes, N – No, CT – Can't Tell

3.4.3 Study Characteristics

Included studies were published from 2012 to 2022, with 54% (n=7) published prior to 2017 and 39% of studies (n=5) published during 2013/14. Almost one third (31%, n=4) of the studies originated from the USA, 15% (n=2) from the UK, 39% (n=5) from the rest of Europe with the remaining two studies from Australia (n=1) and Singapore (n=1). A variety of study designs were utilised; two qualitative, nine quantitative and two mixed method design. All thirteen studies were conducted in a hospital setting as per the inclusion criteria, study characteristics are summarised in Table 3.4.

Table 3.4 Study Characteristics (n=13)

Lead Author, Year	Country	Study Design	Setting
Balestra 2021 (86)	USA	Quantitative study	Three urban hospitals
Bouchand 2017 (79)	France	Cohort study	Acute hospital
Cresswell 2014 (77)	UK	Qualitative case study	2 Hospitals with minimum of 2yrs system utilisation
Devchand 2019 (80)	Australia	Prospective audit	Inpatients at a tertiary referral centre
Diaz 2013 (81)	Spain	Quasi-experimental, one group, pre-test post-test study	Tertiary teaching hospital
Granko 2012 (85)	USA	Quantitative study	Hospital
Levivien 2022 (82)	France	Randomized, single-blinded, comparative effectiveness study	Adult Hospital
McLeod 2019 (68)	UK	Uncontrolled before-and-after study using an explanatory sequential mixed methods design	Acute admissions ward and a medicine-for-the-elderly ward in a large English NHS teaching hospital
McMullen 2015 (88)	USA	Mixed method	Hospital
Peterson 2014 (87)	USA	Pilot intervention	Academic, tertiary care hospital
Quintens 2019 (83)	Belgium	Retrospective observational study	Academic tertiary care hospital
Rommers 2013 (84)	The Netherlands	Prospective non-randomized observational study	Internal medicine and cardiology wards
Tan 2013 (78)	Singapore	Qualitative post pilot study	Five pilot wards (four medical and one multi-specialty ward with both medical and surgical patients)

The HCP groups involved in the studies were categorised into three types: Pharmacist (n=10), Antimicrobial team (n=2) and Nurse (n=1). Pharmacists were the HCP group that most explored patient prioritisation post HEPMA implementation from the extracted studies, they were also part of the antimicrobial teams in the two HCP studies, displayed in Table 3.7.

After the preliminary synthesis was complete, study interventions were reviewed and inductively categorised into four types, as defined in Table 3.5: HEPMA system (n=2), report (n=7), dashboard (n=2) and machine learning model (n=2). Use of a report was the most frequently used intervention in the extracted studies, displayed in Table 3.7.

Table 3.5 Study Intervention Categories

Intervention Category	Definition
Hospital Electronic Prescribing and Medicines Administration (HEPMA) System	HEPMA system hospital adoption used as the study intervention.
Report	Use of software to extract specific data from a HEPMA system at a single time point (static), then sent and viewed by a healthcare professional (HCP).
Dashboard	Use of software to display a visualised overview of real time data from a HEPMA system, which was accessed and viewed by a HCP.
Machine Learning Model (MLM)	Use of an intelligent computer file that has been conditioned with an algorithm to learn specific patterns in datasets to give insights and predictions from patterns, which can replicate experiential learning (89). In the context of HEPMA data, MLMs predicted what medications should be prioritised for review based on system user behaviour.

Methods of prioritisation were then reviewed and inductively categorised into three types, as defined in Table 3.6: HCP prioritisation using HEPMA system functionality (n=2), HEPMA data presented for HCP prioritisation (n=6) and HEPMA data automatically prioritised by software (n=5). HEPMA data presented for HCP prioritisation was the most frequently used method of prioritisation, displayed in Tabel 3.7.

Table 3.6 Categories for Study Methods of Prioritisation

Method of Prioritisation Category	Definition
Healthcare professional (HCP) Prioritisation using Hospital Electronic Prescribing and	HEPMA system with functionality for HCP to manually add a priority status to patient medication charts on system based on clinical judgement.

Medicines Administration (HEPMA) System Functionality	
HEPMA Data Presented for HCP Prioritisation	HEPMA system data extracted via report or dashboard software for HCPs to view and use information as part of manual patient prioritisation based on clinical judgement.
HEPMA Data Automatically Prioritised by Software	Pre-determined patient prioritisation criteria automatically applied to extracted HEPMA system data by software. Patients are displayed to HCP in a ranked list so that they do not need to prioritise patients manually.

Four studies did not state the HEPMA system used (68,77,78,83), two were conducted with the Cerner™ system (80,88) and the remaining studies were conducted with a variety of commercially available systems as outlined in Table 3.7.

Table 3.7 Study Categorisations

Lead Author, Year	Aim	Healthcare Professional (HCP)	HEPMA System	Intervention	Method of Prioritisation
Balestra 2021 (86)	Development of a machine learning model to identify prescribed medication orders that require pharmacist intervention.	Pharmacists	Epic™	Machine learning model	Hospital Electronic Prescribing and Medicines Administration (HEPMA) data automatically prioritised by software
Bouchand 2017 (79)	Evaluate targeted antibiotic stewardship computerised tool.	Antimicrobial team	Phedra™	Report	HEPMA data presented for healthcare professional (HCP) prioritisation
Cresswell 2014 (77)	To understand HEPMA system consequences after implementation.	Pharmacists	Not stated	Report	HEPMA data presented for HCP prioritisation
Devchand 2019 (80)	Evaluate penicillin allergy de-labelling pharmacist led ward round.	Antimicrobial team	Cerner™	Report	HEPMA data presented for HCP prioritisation
Diaz 2013 (81)	Test efficacy of system to identify patients with reduced renal function with prescribed medications that may require dose modification.	Pharmacists	Selene™	Report	HEPMA data presented for HCP prioritisation
Granko 2012 (85)	Development of a tool to determine allocation of clinical pharmacist resources.	Pharmacists	PharmNet™	Report	HEPMA data presented for HCP prioritisation
Levivien 2022 (82)	Assessment of a decision support tool using artificial intelligence to rule out prescriptions for pharmacist review.	Pharmacists	DxCare™	Machine learning model	HEPMA data automatically prioritised by software
McLeod 2019 (68)	Investigate effects of HEPMA on pharmacist activities.	Pharmacists	Not stated	HEPMA system	HCP Prioritisation using HEPMA System Functionality
McMullen 2015 (88)	Investigate HEPMA system impact on pharmacy workflow.	Pharmacists	Cerner™	HEPMA system	HCP Prioritisation using HEPMA System Functionality
Peterson 2014 (87)	Test feasibility of a dashboard displaying patients with potentially	Pharmacists	Horizon Expert Orders™	Dashboard	HEPMA data automatically prioritised by software

Lead Author, Year	Aim	Healthcare Professional (HCP)	HEPMA System	Intervention	Method of Prioritisation
	inappropriate medications prescribed for pharmacist review.				
Quintens 2019 (83)	Implementation and evaluation of clinical rules to identify prescribed medications for pharmacist review.	Pharmacists	Not stated	Report	HEPMA data automatically prioritised by software
Rommers 2013 (84)	Evaluate use of clinical rules to identify patients at risk of an adverse drug event from prescribed medication.	Pharmacists	Medicator™	Report	HEPMA data automatically prioritised by software
Tan 2013 (78)	Evaluation of an interactive electronic dashboard for nursing staff to improve visibility of vital patient data.	Nurses	Not stated	Dashboard	HEPMA data presented for HCP prioritisation

3.4.4 Methods of Prioritisation

HCP Prioritisation using HEPMA System Functionality

Software functionality was highlighted as facilitating prioritisation in the two studies summarised in Table 3.8, achieved through manual prioritisation by pharmacists using specific aspects of system design inherent within the software. McLeod et al. (68) detailed patient prioritisation for pharmacist review, whereas McMullen et al. (88) described prioritisation for pharmacist verification of urgent medication orders. Minimal detail was given on how the medicines management page was used by pharmacists to prioritise patients in McLeod et al. (68) and the system used was not stated. In McMullen et al. (88), pharmacists noted the ability to organise the order verification queue to identify stat orders in the Cerner™ system. They further identified that orders could be manually colour coded by priority level and that prior to HEPMA implementation, pharmacists were reliant on "stumbling" across urgent orders or being alerted to them by ward staff. The intervention in both studies was the implementation of a HEPMA system, indicating that no data was extracted to enable patient or medication order prioritisation. Both studies concluded that HEPMA systems improve pharmacist workflow by allowing manual prioritisation of patients and medication orders based on staff interviews, demonstrating staff efficiency benefits. McMullen et al. (88) further identified that HEPMA systems improve the availability of patient information to pharmacists for workload prioritisation.

Table 3.8 Studies with Patient Prioritisation by Hospital Electronic Prescribing and Medicines Administration (HEPMA) System (n=2)

Lead Author, Year	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
McLeod 2019 (68)	HEPMA implementation with unspecified system	Pharmacist assignment of patient priority by viewing medicines management page within HEPMA system	Pharmacist interviews highlighted the HEPMA system medicines management page is helpful for prioritising patients	• Efficiency gains (releasing time to care)

Lead Author, Year	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
McMullen 2015 (88)	HEPMA implementation with Cerner™ system	Pharmacist arrangement of medication verification queue on HEPMA system to identify stat orders and assign priority level to medications for verification with colour coding	Pharmacist interviews highlighted that the HEPMA system medication verification queue helped pharmacists to prioritise their work and this contributed to an improved pharmacy workflow.	• Availability of information • Efficiency gains (releasing time to care)

Benefit categories adopted from NHS England published benefits realisation guidance for ePrescribing projects (71).

HEPMA Data Presented for HCP Prioritisation

Data extracted from a HEPMA system and presented to HCPs for identification of specific patient prescriptions was the most common type of patient prioritisation method used as outlined in Table 3.9, allowing clinical judgement to determine patient prioritisation. Five studies used a data report to highlight specific patient prescriptions and one used a dashboard, showing that there are multiple ways in which to present data to HCPs depending on data content and available software. Extracted data for prioritisation was used by the widest range of HCPs from the included studies: pharmacists, antimicrobial teams and nursing staff all used electronic data to identify prescriptions of interest.

Reports viewed by pharmacists on locally defined high-risk prescriptions from a HEPMA system was noted in two of the studies. Cresswell et al. (77) identified from interviews that pharmacists used high-risk medication (categorisation not stated) and missed dose reports to prioritise individual workload, whereas Granko et al. (85) used the data alongside pharmacy staffing, patient acuity, medication costs and teaching need to prioritise and allocate pharmacy resource to services within a hospital. Both studies demonstrated efficiency gain for pharmacy staffing at individual and service level.

Antibiotic prescription reporting to antimicrobial teams was the focus of two other studies. Bouchand et al. (79) extracted prescription data on locally agreed targeted antibiotics from the HEPMA system, which was then used to populate a spreadsheet for monitoring of drug choice against pharmacist and microbiologist opinion, allowing the antimicrobial team to prioritise patients for review. Devchand (80) reported on patients with a prescribed antibiotic and documented penicillin allergy for antimicrobial pharmacist prioritisation of patient allergy review. Both studies demonstrated increased availability of patient information to HCPs and improved formulary management by the antimicrobial team; Bouchand et al. (79) further demonstrated staffing efficiency gain and improved communication between antimicrobial and medical team.

The final two studies presented patient laboratory results in combination with prescribed medications in the HEPMA system to HCPs in order to prioritise patient care. Diaz et al. (81) reported a list of patients with renal impairment and a prescribed medication that could require renal dose adjustment according to local guidelines, the list was reviewed by a pharmacist to prioritise assessment. Tan et al. (78) described a dashboard displaying real time patient information on urgent HEPMA prescriptions for administration, abnormal laboratory results and infection control alerts for review by nursing staff; dashboard data was refreshed every minute to allow nursing staff to have better situational awareness of critical patient data. Both studies demonstrated an improved availability of information to the HCP as additional data was combined with the HEPMA data. Diaz et al. (81) further demonstrated a reduction in inappropriate prescriptions and Tan et al. (78) also showed a reduction in time taken to identify medication for administration and efficiency gain for nursing staff.

There was no commonality between the HEPMA systems reported for this method of prioritisation and the data extracted varied depending on aim of report or dashboard. Availability of information and HCP efficiency gain were the two most common benefits demonstrated with this type of patient prioritisation.

Table 3.9 Studies with Hospital Electronic Prescribing and Medicines Administration (HEPMA) Data Presented for HCP Prioritisation (n=6)

Lead Author, Year	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
Bouchand 2017 (79)	Computerised tool to extract HEPMA prescribing data on targeted antibiotics	Identification of targeted prescribed antibiotics that differ from antimicrobial pharmacist and microbiologist advice	Time saving and limited misuse of targeted antibiotics	• Availability of information • Efficiency gains (releasing time to care) • Communication • Improved formulary management
Cresswell 2014 (77)	HEPMA implementation with patient data reports	Identification of high-risk medications and missed dose report	Pharmacist interview noted reports are helpful for pharmacists to prioritise workload in identifying high-risk medications and missed doses.	• Efficiency gains (releasing time to care)
Devchand 2019 (80)	Penicillin allergy de-labelling using antibiotic allergy report	Identification of patients prescribed an antibiotic with documented penicillin allergy through report from electronic prescribing	Reduced penicillin allergy labelling in patients and reduction in restricted antibiotic prescribing.	• Availability of information • Improved formulary management
Diaz 2013 (81)	Patients with reduced renal function and medicines that may require renal dose adjustment displayed to pharmacist	Identification of patients with renal impairment on medications that require adjustment in renal impairment	Reduction in number of inappropriate orders for patients with renal failure.	• Availability of information • Medication error
Granko 2012 (85)	Assessment tool of services to direct clinical pharmacist personnel	The annualised daily pharmacy census and average acuity level of the patients served, the importance of the service to teaching activities, the cost of medications dispensed on the service, and the extent of the use of “high priority” medications in the service.	Services identified as most in need of clinical pharmacist expertise.	• Efficiency gains (releasing time to care)

Lead Author, Year	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
Tan 2013 (78)	Interactive dashboard "Andon Board" to alert nurses to pertinent patient issues	Patients that have urgent orders, abnormal results, infection control alerts, discharge process tracking and radiology scheduler. Icons display with different colour statuses to indicate criticality.	Nursing staff satisfaction questionnaire showed agreement for improved awareness of critical patient issues.	• Availability of information • Medicines administration • Efficiency gains (releasing time to care)

Benefit categories adopted from NHS England published benefits realisation guidance for ePrescribing projects (71).

HEPMA Data Automatically Prioritised by Software

Extracted HEPMA prescribing data prioritised automatically by software to highlight patients or prescriptions for review by a HCP was the second most common method of prioritisation. Pharmacists were the only HCP group reported in five studies to utilise this method, study summaries in Table 3.10.

Machine learning models (MLMs) used to identify HEPMA system prescriptions for review by pharmacists were the focus of two studies. Balestra et al. (86) used prescriber system interaction with prescription type and quantity to predict orders requiring pharmacist intervention and Levivien et al. (82) assessed a tool that calculated the likelihood of a prescription with an error that could lead to a drug related problem, but did not state how the risk categories were assigned. Balestra et al. (86) was the only study to report prescriber behaviour as part of the prioritisation calculation.

Applied clinical rules to HEPMA prescription data to identify prescriptions for pharmacist review was the focus of the final three studies. Peterson et al. (87) and Quintens et al. (83) identified patients with locally defined PIMs prescribed on the HEPMA system and displayed them on a dashboard or worklist accessible to pharmacists, and Rommers et al. (84) developed a medication surveillance tool to identify patients at risk of an adverse drug event. Cited clinical rule criteria of automated patient prioritisation for pharmacists varied and depended on patient type. Peterson et al. (87) identified PIMs prescribed for patients 65 years of age or older if the medication was included in a national guideline's list of PIMs for older adults, included within a published anticholinergic risk scale, or did not appear within the hospital formulary. Patients with the highest number of PIMs in conjunction with benzodiazepine prescriptions were automatically prioritised to the top of the list displayed on the dashboard by the applied clinical rules. Quintens et al. (83) looked at high-risk wards i.e. paediatrics, geriatrics, surgery etc. when developing the clinical rules, which were developed based on literature, national and international guidelines to give a total of 78 rules, which were approved through a local governance committee. Rommers et al. (84) agreed clinical rules through a multidisciplinary team who defined seven risk categories for use in six clinical wards of various specialties e.g. cardiology, haematology and medicine.

Three studies reported on physician acceptance rate of pharmacist interventions from automated patient prioritisation (APP) (83,84,87) and one study reported

clinical pharmacist agreement of prioritised prescriptions for review (82). Use of other system data in combination with HEPMA system data was cited in three studies as part of prioritisation automation. Additional system data was extracted from the patient's electronic health record, hospital laboratory system and drug information database. There was no commonality between the HEPMA systems reported for this method of prioritisation and all studies concluded that APP is an efficient method for hospital pharmacists to identify patients for medication review. Potential for error reduction and efficiency gain for pharmacists were the system benefits demonstrated by all studies.

Table 3.10 Studies with Hospital Electronic Prescribing and Medicines Administration (HEPMA) Data Automatically Prioritised by Software (n=5)

Author	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
Balestra 2021	Machine learning model of prescribing errors	Pharmacist intervention prediction from machine learning tool based on prescriber system actions: • Clinician engagement with patient electronic health record in hour preceding prescription • Type of prescriptions • Contextual data for clinician and prescription e.g. day and time, clinician type	Prescriber action on electronic systems can be used to assist in predicting medication that will require pharmacist intervention.	• Medication error • Efficiency gains (releasing time to care)
Levivien 2022	Digital tool combining machine learning with artificial intelligence and rule-based expert system to prioritise pharmacist medication reviews	Prescription score assigned by tool based on probability for the prescription to require a pharmaceutical intervention. Patient data used to determine probability of drug related problem: • Laboratory reports • Demographics • Medical history • Physiological data	Digital tool shown to be accurate in detecting drug related problems from prescriptions.	• Medication error • Efficiency gains (releasing time to care)
Peterson 2014	A computerised dashboard that displays patients with at least one potentially inappropriate medicine or a high calculated anticholinergic score	Patients were ranked to reflect the estimated risk of an adverse event by identifying patient's aged 65 years or older with one potentially inappropriate (locally defined) medication prescribed or high anticholinergic score.	Dashboard demonstrated to be an efficient way for clinical pharmacists to identify potentially inappropriate medicines.	• Medication error • Efficiency gains (releasing time to care)
Quintens 2019	Clinical rule alerts to identify potentially inappropriate medications	Clinical rules algorithms to identify patients with a potentially inappropriate medicine on worklist for pharmacist to review. Clinical rules: • Alert overrule of very severe drug interactions • Restricted drug prescribed • Medication use potentially leading to biochemical changes	High number of pharmacist actions generated from the clinical alerts that resulted in adequate (69%) physician acceptance rate.	• Medication error • Efficiency gains (releasing time to care)

Author	Intervention	Method of prioritisation	Prioritisation Outcome	Demonstrated prioritisation method benefit category
		• Potential sequential therapy for bio-equivalent drug • Drug not suitable for prescribed route		
Rommers 2013	Adverse Drug Event Alerting System (ADEAS)	Clinical rules applied to patient prescriptions to generate alerts for pharmacist review. Clinical rules: • Combination of biochemical laboratory values or therapeutic drug monitoring values with initiation or ongoing use of a drug • Combination of use of a drug with non-use of a drug indicated for prevention of an adverse drug event (ADE) • Medication used to treat an ADE • HEPMA medication safety alerts fine-tuned to high-risk patients • Safety alerts from inspection authority • Medication errors and high-risk drug situations	ADEAS shown to be effective with 76% pharmacist intervention acceptance rate from physicians or nurses.	• Medication error • Efficiency gains (releasing time to care)

Benefit categories adopted from NHS England published benefits realisation guidance for ePrescribing projects (71).

3.5 Discussion

This systematic review aimed to identify, evaluate and summarise HCP patient prioritisation methods after HEPMA system implementation to inform on any potential impact HEPMA may have on patient prioritisation as previous systematic reviews sought to identify prioritisation tools in use and did not focus on potential prescribing system influence. The review identified that pharmacists are the healthcare profession most frequently using prioritisations tools with a HEPMA system, predominantly in the USA and Europe. The results were structured to highlight patient prioritisation tools that have been developed for use with a HEPMA system. Studies were categorised into intervention type and method of patient prioritisation; the most frequently used study intervention was a report (static data extract), and most commonly used method of prioritisation was HEPMA data presented for HCP prioritisation.

3.5.1 Study Characteristics

Thirteen studies were extracted during the literature review, with the majority (n=9) published between 2012 and 2017, which is suggestive of an increased period of HEPMA system implementation during this time and recognition of workforce challenges within health services. The limited number of published studies during the search period (2012-2022) indicates that utilising HEPMA systems to assist in patient prioritisation is still at an early stage of development. The majority of studies originated from Europe (n=7), which is a region with recognised healthcare workforce challenges (90) and where technology is recommended to reduce medication errors (7).

A limited range of HCPs were reported in the studies as detailed in Table 3.7, the majority consisting of pharmacists, reinforcing the message that pharmacy services are looking at innovative ways to maximise efficiency of resource. Multidisciplinary antimicrobial teams (n=2) and nursing staff (n=1) were the other professionals reported, highlighting other means of using patient prioritisation to benefit patient care. Several different types of HEPMA system were reported and some studies did not state system type (n=4). Cerner™ was the only system noted to be in use in

more than one study and these were in different countries, which indicates the variety of systems available and non-standardised approach to system use within countries.

There were four types of intervention used across the studies, demonstrating that a variety of tools are being evaluated by HCPs to manage prescribing and administration data for prioritisation depending on resources available. A static data extract in the form of a report was the most frequent intervention tool evaluated by 54% of the studies. This finding is likely due to the inexpensive production using existing software e.g. spreadsheets (79) and locally developed reporting systems (77), in addition to flexibility in combining data sets from different systems to present to a HCP (84).

3.5.2 Methods of Prioritisation

All studies utilised HEPMA system data as a way of identifying hospital patients for prioritisation, with three different method categories identified within the studies, emphasising the diversity of ways in which electronic prescribing and administration data can support this aim. As the most frequent HCP looking at ways to prioritise patients, pharmacists used each category of prioritisation method, whereas both the antimicrobial teams and nursing staff used HEPMA data presented for HCP prioritisation. Variation in tools used by pharmacists to prioritise is consistent with the findings of Abuzour et al. (33) and Alshakra et al. (36) and is largely dependent on the clinical context and available software.

HEPMA Data Presented for HCP Prioritisation

HEPMA system data viewed by HCPs to assist in patient prioritisation was the most commonly used method identified. This method is more flexible to target a specific cohort of patients depending on clinical focus and simpler to create than APP. Patient data was predominantly viewed via a report (n=5) with content depending on the clinical aim for the HCP, either a specific patient parameter displayed e.g. renal function or a wide range of patient information e.g. high-risk medication prescriptions.

Half of the studies (n=3) in this category were focussed on HCP groups other than pharmacists but 5 out of 6 of the studies involved pharmacy staff within the patient prioritisation method. Antimicrobial teams (consisting of medical and pharmacy staff) viewed HEPMA system data on patients with specific antibiotic prescriptions and patients with an assigned penicillin allergy with an aim of overseeing antimicrobial stewardship within their health system. Data was used to target specific patients as part of a quality improvement initiative e.g. review of patients with a penicillin allergy, or monitor targeted antibiotic prescribing within a hospital, which would assist the teams in deciding which patients to prioritise for review daily.

Tan et al. (78) described the use of HEPMA system data viewed by nursing staff in combination with laboratory, radiology and infection control alerts to allow a quick view of patient issues for prioritisation of care. A unique feature of the dashboard used in this study was the touch screen, allowing for nurse interaction to access more detailed information on displayed alerts. Display data was refreshed at one-minute intervals giving as close to real time as possible, which would be of value to nursing staff who must react quickly to patient acuity. Availability of such technology may be a barrier to some health systems in deploying a similar system and as the information is already accessible to nursing staff in separate systems, it may be difficult to justify investment and possibly a reason why there are limited studies on electronic patient prioritisation for nursing staff. Nursing staff were the only HCPs found to use HEPMA data for individual patient monitoring rather than identifying patients at the ward or hospital level for care due to the differing nature of patient care responsibility between HCPs. Combined HEPMA system data with laboratory data was also described by Diaz et al. (81) for pharmacist use to identify patients with reduced renal function and a medication prescribed that requires monitoring in this situation, showing that patient data can be manipulated to display to HCPs in the most effective way to suit the clinical aim. However, the majority of studies in this category (n=4) described the use of only HEPMA system data by HCPs for patient prioritisation.

Patient information presented to pharmacists for prioritisation differed in the three studies (Table 3.9): patients with reduced renal function in conjunction with cautioned prescribed medication; high-risk prescribed medication and missed dose administrations (service and hospital level); and hospital specialty service level metrics in conjunction with pharmacy data. Pharmacist prioritisation of patients

based on high-risk medications and low patient renal function are consistent with findings from the literature (33,36). Cresswell et al. (77) noted through interview that one UK hospital pharmacy included missed medication dose administrations as part of patient prioritisation which is not a common method used in the literature but is possible through access to HEPMA system data, which would also be of benefit to other HCPs e.g. nursing staff. One study (85) looked at pharmacy resource allocation across a health service, demonstrating that prioritisation can occur at the individual level, service level or hospital level depending on available staffing resource.

Medical staff were reported in two of the studies (79,81) as part of the study outcome measure with physician acceptance rate of antimicrobial team or pharmacist recommendation but only one study involved a medic as the HCP viewing patient data for prioritisation as part of the antimicrobial team. Low levels of medical and nursing use of patient prioritisation tools with HEPMA systems in the literature highlights that other HCPs may not be aware of the reporting potential from HEPMA data or that pharmacy staff may have an increased need for patient prioritisation. The widest range of benefits were demonstrated within this category and that is reflective of the diverse use of data to present to HCPs.

HEPMA Data Automatically Prioritised by Software

Pharmacists exclusively used this method to prioritise patients, which highlights an increased awareness of data availability and could also indicate the need in hospital pharmacy for efficiency in providing patient care. This method is the most complex and resource intensive to set up but it is the most efficient method in supporting HCPs to prioritise patients as the information is displayed to the HCP in a prioritised list on a report, dashboard or MLM software. Locally agreed clinical rules applied to electronic patient data was the most common way used to prioritise patients and the clinical rules varied between studies due to specialty use. Clinical rules used were consistent with the findings of Alshakrah et al. (36) for electronic pharmacist prioritisation tools using HEPMA data and this reinforces that there is no agreed standard for the ways in which hospital pharmacy staff prioritise patients.

MLMs were also used to automate patient prioritisation for HCPs; two studies (Table 3.7) used MLMs to predict HEPMA prescriptions that could require pharmacist

intervention but did so in different ways due to the way a MLM is trained on how to interpret data. Prediction of prescribed medicines that required pharmacist intervention through prescriber behaviour was one novel approach used by Balestra et al. (86) and highlighted that factors prior to prescribing can have an influence on error occurrence. No other studies within this review looked at human factors that could influence prescriber error e.g. time of day, grade of staff, which could complement clinical rules to identify patients after prescribing, such as those shown by Levivien et al. (82). MLMs have not been identified by previous literature reviews on HCP or pharmacist patient prioritisation tools due to the recent publication (2021 and 2022) and are a sign of the continued innovation and digital maturity of health services in managing staffing resource issues.

HCP Prioritisation using HEPMA System Functionality

The method of patient prioritisation least demonstrated within the studies was the use of functionality within the system by a HCP, likely due to the increased use of commercial systems that limit the ability of system configuration. Pharmacists were the only HCP noted to prioritise patients in this way, which may be due to system set up for differing HCP groups, but limited detail was given on how this was done within either study. Each study reported prioritisation in a different way, with McLeod et al. (68) identifying patient prioritisation and McMullen et al. (88) highlighting medication order prioritisation. There is therefore not a standard way software companies are applying prioritising functionality in system design. As one of the studies did not state the HEPMA system used, it is not possible to conclude if the Cerner™ system is the only software with this capability but as there are limited studies in the literature, it is likely that there are few systems in use by healthcare systems with this functionality. It is evident that HCPs are exploring other methods of prioritising patients as they have the available resources, demonstrated by the studies found within this review.

Benefits and HEPMA System Impact on Prioritisation

Efficiency gains for HCPs was the most frequently demonstrated HEPMA system benefit category due to the number of studies looking at pharmacist patient prioritisation methods, but it was also noted for an antimicrobial team and nursing

staff. HEPMA systems have limited functionality for HCPs to prioritise patients, but system prescribing and administration patient data can be extracted and manipulated using additional software to present data to HCPs in a variety of ways depending on clinical need; the software used to do this influences the way in which HCPs prioritise patients. Reports, dashboards and MLMs were all used for this purpose within the studies, and in this way, HEPMA systems improve the availability of patient information to HCPs.

The impact on pharmacist patient prioritisation is evident from the variation in study methods used, with published study dates reflective of the varying pace of healthcare services to adopt HEPMA systems globally. The evolution in patient prioritisation methodology is apparent in the clinical focus of the study interventions, from identification of a single clinical patient focus to a complex and multifactorial set of clinical rules to identify patients in most need of pharmaceutical care at the hospital level, which was not possible before HEPMA system adoption as time prohibitive due to manual data collection need from paper medication charts. Pharmacists are also adapting to work with HEPMA systems to innovate and review service models as demonstrated by Granko et al. (85).

HEPMA systems have facilitated other HCPs in patient prioritisation, from antimicrobial teams accessing hospital wide prescription data to identify and prioritise patients with prescribed antibiotics and allergies for improved formulary management, to nursing staff visualising patient data to assist in patient monitoring and administration of urgent medications. This increased access to data gives an early indication of the longer-term impact HEPMA systems will have as more HCPs engage with the data.

Reduction in medication errors is an inferred benefit from the studies with HEPMA data automatically prioritised by software as pharmacists will review the highest priority patients first and highlight to a prescriber as necessary if any intervention is required but none of the studies measured patient outcomes, instead focussing on prescriber acceptance rate of pharmacist intervention. MLMs are at the early stages of development but they have already demonstrated the potential for use in APP for HCPs with the ability to learn from local HEPMA system data. This facilitation emphasises the impact of increased access to electronic prescribing and administration data by HCPs and the future of patient prioritisation to increase workforce efficiency.

3.5.3 Strengths and Limitations

This is the first systematic literature review to the author's knowledge on HCP methods of patient prioritisation specifically with HEPMA systems and it is hoped that this will add to the existing HCP patient prioritisation evidence base. The scope of this search was widened to include all HCPs rather than narrow the search to pharmacists, ensuring that any identified learning could be shared across staff groups. Methods of patient prioritisation were not included in the database search terms to yield a wider literature search and were instead used as part of study eligibility criteria during search result screening, allowing a flexible approach in identifying studies with prioritisation of patient, which may not have been a study focus.

Database searches were limited to the English language, allowing for study exclusion, but as studies were retrieved from countries where English is not the first language, international representation was included. A date range was applied that limited the search to the previous 10 years, with an aim of focussing on a period where international paper and electronic patient prioritisation tools were in use. The unintended consequence of using a date range is that early HEPMA adopter countries could have been excluded. Studies conducted specifically within the critical care environment were not included within this review as specialist electronic prescribing and monitoring systems are often deployed with a high ratio of staff to patient care, therefore, some prioritisation methods by HCPs with a HEPMA system may have been excluded.

Certain studies (n=4) did not state the HEPMA system used and therefore this limited any conclusion to be made around system type and methods of prioritisation used by HCPs. Abuzour et al. (33) identified that in England alone there were a large number of pharmacy services that utilised patient prioritising tools and yet there are limited numbers of published tools in the literature, therefore there is a risk of underreporting of prioritisation methods in the literature, this review only included full text articles from peer reviewed published journals.

3.5.4 Future Directions and Recommendations

HCPs are still adapting to the new ways in which HEPMA system benefits can influence patient prioritisation, it is therefore recommended that a similar review is conducted in the future to capture future innovations and publications. As pharmacists were identified in this review as the HCP that utilised patient prioritisation methods the most, further work is necessary to measure patient outcomes for this use of prioritisation as this was not measured in any of the studies in this review.

As patient prioritisation tools are being used to assist with regular identification of patients most in need of HCP attention or care, it is necessary to understand the ethical implications of this if staff resource is not available to meet the visible demand. Criteria used for patient prioritisation has a risk of systematically disadvantaging patient groups if the underpinning selection criteria is not applied consistently as pointed out by Diner et al. (59) and none of the studies identified in this review discussed this aspect of prioritisation tool use. Workforce issues remain a challenge within hospital pharmacy and further research on the ethics of using patient prioritisation tools is necessary as pharmacists continue to innovate with HEPMA data.

It is evident from the literature that HCPs have been innovating with patient prioritisation tools over the last decade, engagement with HEPMA system software providers to highlight this need could be mutually beneficial to health services and software vendors for future system use.

3.5.5. Conclusions

This is the first systematic literature review to focus specifically on HCP prioritisation methods after HEPMA system adoption and the results are structured to provide an evidence base. A limited number of studies were identified in the literature (n=13), with pharmacists most often prioritising patients for pharmaceutical care to make efficient use of staffing due to workforce issues. Three categories of method were identified for patient prioritisation by HCPs: HCP prioritisation using HEPMA system functionality, HEPMA data presented for HCP prioritisation and HEPMA data

automatically prioritised by software. The most common method used by HCPs to prioritise patients in the literature was with HEPMA data viewed for HCP prioritisation and this was predominantly achieved via a report. MLM use was identified in more recent publications and is a developing form of patient prioritisation tool enabled by HEPMA system data that warrants further research. HEPMA systems have facilitated new methods in which HCPs can prioritise patient care after system adoption.

Chapter 4: Hospital Pharmacist Views on Professional Ethical Considerations of Using an Automated Patient Prioritisation Tool with a HEPMA System

4.1 Introduction

Ethical principles have long been established in healthcare, with Beauchamp and Childress (91) first introducing a framework in 1979 of four broad moral principles that have been widely adopted into medical teaching to guide decision making: autonomy, beneficence, non-maleficence and justice (defined in Table 4.1). (92)

Table 4.1 Beauchamp and Childress Four Moral Principles (91)

Moral Principle	Definition
Autonomy	Respect and support autonomous decisions
Beneficence	Provision of benefit, balancing benefits against risks and costs
Non-maleficence	Avoidance of harm
Justice	Distribution of benefits, risks and costs fairly

Since then, numerous frameworks on ethical clinical decision making are evident in the literature as Manson (92) and Rozemarijn (93) highlighted, with several building on and incorporating the four original principles from Beauchamp and Childress. The four topics (or quadrant) method is the most frequently cited framework from the Rozemarijn (93) review and builds on the four principles, but there is a lack of contextual factors necessary for decision making e.g. local policy and a lack of underpinning empirical evidence for the effectiveness in educational or clinical practice (92,94). This is a commonly cited limitation of published ethical frameworks (92,95), which Manson (92) sought to address in the creation of the CoRE-Values framework (Table 4.2). Manson (92) conducted a literature review on published

clinical decision making frameworks between 2008-2010, identifying 11 from 21 articles, and determined the need for a new framework incorporating contextual factors to decision making that was easy to use.

The CoRE-Values framework consists of four domains that include the necessary contextual factors for clinical decision making identified by Manson from the literature review. One of the four domains incorporates the four moral principles from Beauchamp and Childress (91) and Manson (92) added a fifth principle 'Utility'. The 'Utility' principle was included within the framework to ensure consideration is given to the healthcare cost in the clinical case, something which Manson points out is often missed from published frameworks. Evaluation of the CoRE-Values framework with medical and nursing clinical instructors and students demonstrated value as an educational tool (92).

Table 4.2 CoRE-Values Ethical Framework (92)

***Co*:**	=	*Co*des (i.e. codes of professional conduct)
***R*:**	=	*R*egulations (i.e. the law, and any other stringent policies that dictate appropriate action)
***E*:**	=	*E*thical Principles • Justice • Beneficence • Non-maleficence • Autonomy • Utility (i.e. needs of individual balanced with needs of many)
Values:	=	*Values* (i.e. the personal/moral/institutional values, beliefs or ideologies of the key stakeholders)

Ethical frameworks can be utilised by any HCP as part of ethical decision making and most healthcare professions have professional standards which they must adhere to as part of their registration and license to practice. In the UK, pharmacists must adhere to the General Pharmaceutical Council's (GPhC) Standards for Pharmacy Professionals, which states that professional judgement must be exercised and this may include balancing the needs of individuals with the needs of society as a whole (96). The nine standards are defined in Table 4.3.

Table 4.3 Summary of Codes (Professional) domain subthemes and standard description by the General Pharmaceutical Council (GPhC) (96)

Subtheme	GPhC Standards for Pharmacy Professionals Description
1: Effective communication	Communication can take many forms and happens in different ways. Effective communication is essential to the delivery of person-centred care and to working in partnership with others. It helps people to be involved in decisions about their health, safety and wellbeing. Communication is more than giving a person information, asking questions and listening. It is the exchange of information between people. Body language, tone of voice and the words pharmacy professionals use all contribute to effective communication.
2: Professional knowledge and skills	People receive safe and effective care when pharmacy professionals reflect on the application of their knowledge and skills and keep them up-to-date, including using evidence in their decision making. A pharmacy professional's knowledge and skills must develop over the course of their career to reflect the changing nature of healthcare, the population they provide care to and the roles they carry out.
3: Partnership working	A person's health, safety and wellbeing are dependent on pharmacy professionals working in partnership with others, where everyone is contributing towards providing the person with the care they need. This includes the person and will also include other healthcare professionals and teams. It may also include carers, relatives and professionals in other settings – such as social workers and public health officials.
4: Privacy and confidentiality	People trust that their confidentiality and privacy will be maintained by pharmacy professionals, whether in a healthcare setting – such as a hospital, primary care or community pharmacy setting – in person, or online. Maintaining confidentiality is a vital part of the relationship

	between a pharmacy professional and the person seeking care. People may be reluctant to ask for care if they believe their information may not be kept confidential. The principles of confidentiality still apply after a person's death.
5: Professional judgement	People expect pharmacy professionals to use their professional judgement so that they deliver safe and effective care. Professional judgement may include balancing the needs of individuals with the needs of society as a whole. It can also include managing complex legal and professional responsibilities and working with the person to understand and decide together what the right thing is for them – particularly if those responsibilities appear to conflict.
6: Person-centred care	Every person is an individual with their own values, needs and concerns. Person-centred care is delivered when pharmacy professionals understand what is important to the individual and then adapt the care to meet their needs – making the care of the person their first priority. All pharmacy professionals can demonstrate 'person-centredness', whether or not they provide care directly, by thinking about the impact their decisions have on people.
7: Speaking up about concerns	The quality of care that people receive is improved when pharmacy professionals learn from feedback and incidents, and challenge poor practice and behaviours. This includes speaking up when they have concerns. At the heart of this standard is the requirement to be candid with the person concerned and with colleagues and employers. This is usually called the 'duty of candour' – which means being honest when things go wrong.

During the COVID-19 pandemic, unprecedented levels of critical illness posed a significant challenge for healthcare resources. This is reflected in the literature with articles describing resource allocation ethical considerations (97), recommending that the burden of resource allocation and clinical triage criteria should, where possible, not fall to frontline staff. As highlighted in the previous systematic review (Chapter 3) on HCP patient prioritisation methods after HEPMA system implementation, hospital pharmacy departments are innovating with HEPMA system data to identify and prioritise patients that would benefit from pharmaceutical care. Studies identified in the literature review using automated prioritisation tools did not address the ethical considerations associated with regular identification of patients

at risk from prescribed medications. This finding was also reflected within elective surgical use of patient prioritisation tools (98).

A more recent study reported that patient scoring models as a means of prioritisation were rarely mentioned in ethical discussions despite use during the COVID-19 pandemic (59), highlighting a continued gap in the literature. Ethical concerns can also arise when prioritising patients without using a tool as identified in a multidisciplinary palliative care team where the tension was acknowledged between maintaining service quality versus delivery of a compromised service responding to demand (99), further strengthening the argument for more research in this area. There is limited research looking specifically at the ethical considerations of using prioritisation tools for any HCP and specifically with automated prioritisation tools, where there may not be enough staff resource to manage the provision of care to patients deemed a priority. The use of prioritisation tools to manage patient care must not compromise established ethical principles. This study aims to identify hospital pharmacists' professional ethical considerations of using automated prioritisation tools with a HEPMA system.

4.2 Aim and Objectives

Aim

To explore hospital pharmacist views on the professional ethical considerations in using an automated patient prioritisation (APP) tool with a HEPMA system.

Objectives

To ascertain and document hospital pharmacist views on professional ethical considerations in using an APP tool with a HEPMA system.

To identify and describe common themes from the hospital pharmacist views obtained using an ethical framework.

4.3 Methods

4.3.1 Study Design and Approval

An interpretive case study design was used to facilitate exploration of the study aim in eliciting pharmacist opinion and reported using the Standards for Reporting Qualitative Research (SRQR) (100). Two in person focus groups with semi-structured topic guide were conducted as a proven method in exploring HCP opinion on a specific topic (101–103). Focus group methodology was chosen in preference to semi-structured individual or group interviews to promote group discussion and debate amongst peers, allowing exploration of a shared perspective rather than individual perspectives. The Strathclyde Institute of Pharmacy and Biomedical Science (SIPBS) approved the study in May 2024 and the NHS Lothian Research and Development office approved the study in July 2024 (IRAS Project ID 345885).

4.3.2 Setting and Participants

This project was set within NHS Lothian, which has an implemented HEPMA system but does not currently use APP tools. NHS Lothian is a Scottish Health Board that provides primary, community, acute and tertiary hospital services to a population of over 850,000 across Edinburgh, Midlothian, East and West Lothian (104). The HEPMA system is implemented across 9 sites in the Health Board covering a wide range of healthcare specialties including mental health, paediatrics, medical, surgical and cancer care. The system is used across 3398 inpatient beds.

Study participants were registered hospital pharmacists with responsibility for providing inpatient pharmaceutical care and/or management responsibility for inpatient clinical pharmacy teams. Hospital pharmacists were the only profession identified in the Chapter 3 systematic literature review using APP in the defined search period and are best placed to comment on any ethical impact to their current practice with tool use. Participants were sampled by convenience through the NHS Lothian Clinical Pharmacy Group and Pharmacy Leadership Team with an aim of recruiting at least 12 pharmacists. This number was chosen to achieve a minimum of 6 pharmacists per focus group, which is reported by Onwuegbuzie et al. (105) to be an acceptable number for qualitative studies. The focus groups took place in an NHS Lothian hospital.

4.3.3 Research Materials

4.3.3.1 Participant information sheet (PIS), consent form and demographic questionnaire

A PIS and consent form (Appendix 4) were adapted from the University of Strathclyde's templates to incorporate study information for participant review and enable adequate informed consent. A participant demographic form (Appendix 5) was created to confirm participant eligibility and allow analysis of participant workforce representation. Information collected on the demographic form informed on participant gender; age; clinical care on a ward(s); job title; managerial responsibility; length of time in role, and if in a full or part time position. Documents were checked for face validity by project supervisors (MB and AW) to ensure suitability for research aim and objectives. Face validity is a check to ensure that a test appears meaningful to those taking it (106).

4.3.3.2 Clinical vignette

A clinical vignette (scenario) was developed to give context and frame participant discussion around the use of an APP tool as a proven effective way to identify and describe healthcare clinician decisions (107,108). Clinical vignettes allow for standardisation and consistency when discussing a clinical scenario, therefore limiting variables that may be introduced from an individual's experience and promoting consistent data interpretation (108). The vignette (Appendix 6) summarised what an APP tool could highlight on a given day within a hospital and was created in collaboration with AW as a pharmacist project supervisor.

4.3.3.3 Semi-structured topic guide

A focus group topic guide (Appendix 7) was created using the CoRE-Values ethical framework (92). The framework is comprised of four domains; Codes (Professional); Regulation; Ethical principles and Values (Table 4.2). Questions were developed using the domain definitions in collaboration with AW as a pharmacist project supervisor. One question was posed for three of the domains (Codes of Professional Conduct; Regulations and Values) and five questions were posed for

one of the domains (Ethical Principles) to reflect the five principles of the domain. Each question was framed around the domain or principle definition to prompt discussion on each topic in relation to APP use. This framework was chosen as it includes contextual factors for ethical decision making (Table 4.2) identified from a literature review of published clinical decision frameworks and incorporates the four established principles of medical ethics (Table 4.1). The framework has also been evaluated in a medical education context and was shown to aid the systematic identification and consideration of ethical aspects to clinical cases (92).

4.3.3.4 Documentation pilot

Document content validity was assessed through a pilot of the documentation with a lead clinical pharmacist in NHS Lothian (recruited to the study) who met the inclusion criteria and had background knowledge of the APP tool function. The lead researcher (DC) sent the PIS, demographic form and clinical vignette to the identified pharmacist for review/completion, before meeting and conducting the focus group questions to ensure the content was understood by a participant representative and could provide qualitative data to satisfy the research aim. Content validity checks the degree to which desired content theory is captured by a measure (106). Feedback was requested to ensure the topic guide questions provided the necessary information to meet the study aim. No participant documentation amendments were required after this review.

4.3.4 Participant Recruitment

Participant volunteers were requested by e-mail from the lead researcher (DC), a HEPMA specialist pharmacist employed by NHS Lothian and a student at the University of Strathclyde. An e-mail was sent to the lead clinical pharmacists for secondary care in NHS Lothian for onward distribution to all hospital clinical pharmacists. Pharmacists of all AFC bands were invited to ensure workforce representation and senior staff (Band 8) were separated from junior staff (Band 6 and 7) in the focus groups to promote participation without fear of speaking out against a senior member of staff. Three additional e-mail reminders were sent to encourage participants at 2 week intervals.

Onwuegbuzie et al. (105) advocates focus group participant number should range between 6 - 12 to promote diversity in discussion but also create an environment for participants to share thoughts, and Ahmed (109) recommends between 12 and 20 total participants for qualitative research design incorporating thematic analysis. Guest et al. (110) calculated that two to three focus groups would identify around 80% of themes on a topic, and 90% from three to six groups. Two focus groups were conducted for this study due to participant recruitment challenges. A minimum of 12 participants were recruited as the sample size, split across two 1 hour focus groups (minimum of 6 participants in each) to ensure adequate qualitative content generation (105).

Participant volunteers were invited to a 30 minute virtual briefing session (held on Microsoft Teams) and sent the PIS, consent form and demographic form for review and completion prior to focus group attendance. The briefing session (led by DC) demonstrated potential APP tool functionality and allowed participants to clarify understanding of how an APP tool could work for a hospital pharmacy service. Potential participants were given the clinical vignette at the end of the briefing session. Return of the participant consent form via e-mail to the lead researcher (DC) was mandatory prior to focus group attendance.

4.3.5 Focus Groups

In person focus groups were held one week after the briefing session to give time for informed consent. Both focus groups were conducted on the same morning and led by lead researcher (DC) alongside an assistant moderator (AR), a HEPMA pharmacist employed by NHS Lothian. The following steps were taken during the focus groups:

1. Lead researcher (DC) confirmed participants in attendance had read the PIS and clinical vignette, returned written consent, completed demographic form and were happy to participate. If any participant had not completed the documentation, they were asked to do so prior to the focus group starting. Entitlement to withdraw was reiterated with a reminder given that data cannot be removed after study inclusion. Confidentiality of focus group discussion was also highlighted.

2. Participants were given the opportunity to ask questions before audio recording was started. Audio recording device (dictaphone) was then switched on for the duration of focus group discussion.
3. Lead researcher (DC) presented the clinical vignette to the group and asked the questions outlined on the focus group topic guide (Appendix 6). The clinical vignette was displayed on a screen throughout the discussion for reference and when discussing codes of professional conduct, the lead researcher (DC) also displayed the GPhC Standards for Pharmacy Professionals (Table 4.3). Prompts were used where appropriate to promote discussion.
4. Once the group discussion was over, the audio recording was switched off and participants thanked for input. A final opportunity for participants to ask questions was given before close.

4.3.6 Data Storage and Security

Focus group audio recordings were completed with a dictaphone of 256-bit file encryption. After focus group completion, dictaphone audio recordings were transferred to a secure NHS shared drive, accessible to the lead researcher and assistant focus group moderator (AR) for transcription validation only, then deleted from the dictaphone device. Participants were given a unique identifier (number) on a participant key, stored on a password protected document in a separate folder from the focus group transcripts on the secure NHS Lothian drive. Participants were pseudo-anonymised on the focus group transcripts using the unique identifier and no participant identifiable information was used for any direct quotes in results. Pseudo-anonymised transcripts were then transferred to a secure university drive, accessible only to the lead researcher (DC) and (MAM), a University of Strathclyde research student, for coding analysis validation only. All participant identifiable data was deleted at project completion.

4.3.7 Data Analysis

Participant demographic information was collated in a Microsoft Excel spreadsheet and totalled for tabular reporting in results. Focus group discussions were transcribed by the lead researcher (DC) using an intelligent verbatim approach,

removing redundant or repeated words. One focus group transcript checked for validity by an NHS Lothian pharmacist (AR).

A deductive approach to initial analysis was taken due to the use of a pre-existing framework i.e. themes were derived from the framework, to guide the analysis. Deductive thematic analysis uses pre-existing theories or frameworks to structure and interpret data (111). Transcripts were analysed thematically by the lead researcher (DC) using the steps outlined by Braun and Clarke (111–113):

1. Data familiarisation with audio recording and focus group transcripts.
2. Focus group transcripts were deductively mapped to the four domains (Table 4.2) of the CoRE-Values ethical framework (92) as a pre-determined coding framework. Namely: Codes (Professional), Regulations, Ethical Principles and Values.
3. Once each transcript's text was mapped to the four framework domains, lead researcher (DC) thematically analysed the text to identify any subthemes.

- Two framework domains (Regulations and Values) were analysed for subthemes inductively through text coding and theme development using the Braun and Clarke (112) steps as they did not contain domain subthemes or have associated standards that could be applied. Inductive thematic analysis does not utilise pre-defined themes to structure data, themes are interpreted from the data (111).
- Two framework domains (Codes (Professional) and Ethical Principles) were analysed for subthemes deductively. The codes (professional) domain was analysed using the nine standards of the GPhC's Standards for Pharmacy Professionals (Table 4.3) as the regulatory body for pharmacy staff and the ethical principles domain was analysed using the five ethical principles within the domain (Table 4.2): Justice, Beneficence, Non-maleficence, Autonomy and Utility.

4. Any unmapped transcript text was reviewed and coded for exclusion.

The first focus group transcript was independently analysed by a University of Strathclyde research student (MAM) using the above steps. After independent analysis by MAM, lead researcher (DC) and research student (MAM) compared domain coding and inductively created subthemes for the first focus group transcript. Once agreement on framework deductive coding approach and inductively created subthemes was reached, lead researcher (DC) analysed the second transcript.

4.4 Results

4.4.1 Participant Demographics

A total of 12 pharmacists were recruited to the focus groups (Table 4.4 - participant demographics summary), with a mix of NHS agenda for change banding represented. Most participants were Advanced Pharmacists (n=5, 41.7%), then Specialist Pharmacists (n=3, 25%), Pharmacist Team Managers (n=2, 16.7%) and Pharmacists (n=2, 16.7%). The majority of participants worked as a clinical pharmacist in a ward environment (n=11, 91.7%) and most worked across several wards (n=8, 66.7%); only 1 participant did not work on a ward, but they managed other pharmacists who did. Half of the participants (n=6) reported they had managerial responsibility for a clinical pharmacy service. Age representation was reflective of the job titles represented; all Pharmacists and Specialist Pharmacists were aged 20-29 years. Participants had worked in their current role for a median of 2.9 years (IQR 1-3) and the majority were in full time employment (n=11, 91.7%).

Table 4.4 Participant demographics (n=12)

Demographic		**n (%)**
Gender	Female	6 (50%)
	Male	6 (50%)
Age (years)	20-29	5 (42%)
	30-39	2 (17%)
	40-49	3 (25%)
	50-59	2 (17%)
Pharmacist title and NHS banding	Pharmacist (AFC Band 6)	2 (17%)
	Specialist Pharmacist (AFC Band 7)	3 (25%)
	Advanced Pharmacist (AFC Band 8a)	5 (42%)
	Pharmacist Team Manager (AFC Band 8b)	2 (17%)
Number of wards covered by pharmacist	0	1 (8%)
	1	3 (25%)
	2	5 (42%)
	3	1 (8%)
	4	2 (17%)
Managerial responsibility for clinical service	Yes	6 (50%)
	No	6 (50%)
Employment	Full time	11 (92%)
	Part time	1 (8%)
		Median (IQR)
Years' experience	Working in current role	2.9 (1-3)

AFC – NHS Agenda for Change banding, IQR – Interquartile range

4.4.2 Summary of All Themes

The four CoRE-Values ethical framework domains (92) were used as overarching themes: Codes (Professional), Regulations, Ethical Principles and Values (Table 4.2). A summary of all the themes and subthemes is shown in Figure 4.1.

Figure 4.1 Summary of subthemes for each CoRE-Values framework domain.

4.4.3 Theme 1: Codes (Professional)

The codes (professional) domain of the CoRE-Values framework (92) is defined as guidelines for professional behaviour and responsibilities, developed by professional

organisations. For pharmacists, this is the Standards for Pharmacy Professionals as set by the GPhC (96). The seven subthemes coded from the focus groups for this domain were derived from the nine GPhC Standards for Pharmacy Professionals as defined in Table 4.3.

Subtheme 1: Effective communication

Participants felt that in using an APP tool there needed to be transparency in use with other HCPs to ensure understanding of function and reinforced the need to maintain communication for patient care referrals. It is "…*important to make sure that we communicate out to the wider team and the hospital that we are using this tool so that they are aware*" (P3, advanced pharmacist) and any practice change is communicated. The importance of pharmacy ward presence and interaction with nursing staff was highlighted as an additional way of obtaining patient risk factors which can influence priority, and the use of an automated prioritisation tool should not replace that as not all patient risk factors are included within the tool:

"*I think that's why it's important, although it's a tool, to still have effective communication with the nurses by doing morning huddles*" (P4, advanced pharmacist, Group 1)

Subtheme 2: Professional knowledge and skills

Use of automation was viewed to have potential impact on pharmacists' skills for patient prioritisation in the future, if there is an over reliance on automation:

"…pharmacists from qualification level upwards who are reliant on a patient prioritisation tool, they perhaps are not going to use their clinical judgement. That overlaps with professional judgement but also their professional knowledge and skills in the same way. So, I think that… could be presented as a risk…" (P7, advanced pharmacist, Group 1)

Risk of patient prioritisation skill loss was felt to be greatest for junior or newly qualified pharmacists, but one participant thought it would be *"…balanced by other pathways for development through RPS (Royal Pharmaceutical Society)… and that clinical professional development journey"* (P7, advanced pharmacist, Group 1).

Pharmacists are required to undertake continuous professional development and can participate in foundation to advance practice programmes to support workforce development (114).

Subtheme 3: Partnership working

Participants thought that other HCPs who work on a ward may have differing priorities for pharmacist patient review and this might conflict with patient prioritisation derived by the automated tool, impacting on partnership working:

"…*when you are on the ward you might get pulled in different directions from the nursing staff and the medics… and that might be a patient that from your tool* [APP] *would be medium risk and it wouldn't be on your high risk…"* (P11, specialist pharmacist, Group 2)

However, participants thought that an automated prioritisation tool would allow for "…*better partnership working across the clinical pharmacy team*…" (P9, specialist pharmacist) as patients that are high risk will be visible across the wards. One participant's opinion was that hospital ward pharmacy services could be "…*tailored to meeting the most high-risk patients…"* (P9, specialist pharmacist, Group 2).

Subtheme 4: Privacy and confidentiality

Need for adequate patient data protection when automatically using patient data for prioritisation was highlighted by one participant:

"…*make sure that we are using automated systems like this… in line with GDPR…"* (P9, specialist pharmacist, Group 2)

The General Data Protection Regulation (GDPR) is included within the 2018 Data Protection Act (115) in the UK and must be followed by NHS organisations. The participant thought that following local digital processes would ensure compliance with the GPhC standard.

Subtheme 5: Professional judgement

Participants acknowledged that with APP use there is risk that pharmacy staff follow the assigned patient risk score on the tool without using their clinical judgement to assess all patient risk factors and prioritise in view of these:

"*…standard 5 is using professional judgement so I guess if there's automation coming in… it's maybe taking the edge off that, doesn't allow you to use your judgement."* (P2, advanced pharmacist, Group 1)

However, this risk was felt to be mitigated through APP training by outlining the continued need for professional judgement in patient prioritisation. Participants reinforced that professional judgement is required when prioritising patients as not all of a patient's risk factors are included within APP and there is a need to prioritise between the high risk patients identified by APP, "…s*o that's where you then use your professional judgement, it has to be used on top of this* [APP] *…"* (P5, advanced pharmacist, Group 1). It was accepted that APP is "*a tool… it's not replacing your professional judgement"* (P1, pharmacist team manager, Group 1). Participants felt that a process to track when inpatients have been reviewed and indicate when they should be reviewed again by a pharmacist is required when using APP if the tool does not contain a mechanism to do this, "*the patient stays red* [high risk] *for the whole patient journey if they're still on the high-risk med…. I've already seen X number of them…. so you are constantly using your professional judgement."* (P6, pharmacist team manager, Group 1).

Subtheme 6: Person-centred care

Participants thought that APP "…*is facilitating the pharmacy team towards the high-risk patients, which with the current system we potentially miss or we do miss*" (P7, advanced pharmacist, Group 1). Automation was thought to be beneficial for a person centred approach as the patients most at risk of harm from prescribed medicines are identified but there is the risk that a pharmacist could "*miss some… individual patient factors that might affect your decision on who you will review first"* (P11, specialist pharmacist, Group 2) if not included within the automatic prioritisation rules. Overall, it was thought to be an acceptable way of identifying patients for review, "*…it's… centring you towards the right patients so there are pros and cons."* (P5, advanced pharmacist, Group 1).

Subtheme 7: Speaking up about concerns

Participants highlighted that increasing the visibility of high-risk patients in the ward and hospital might lead to pharmacists requesting additional resource for their service or the hospital if patients are in ward areas without a dedicated clinical pharmacy service:

"*…we've not got capacity, is there any way to try… and reduce the risk of harm through investment in services*" (P7, advanced pharmacist, Group 1)

4.4.4 Theme 2: Regulations

The regulations domain in the CoRE-Values framework (92) is defined as the legal obligations, such as hospital or health board policies that HCPs working within must adhere to. Four subthemes were inductively identified from participant discussion.

Subtheme 1: Equity of service

One participant highlighted that in the use of APP, high-risk patients are prioritised over low risk and could therefore be in conflict with NHS policy since low-risk patients would not routinely be reviewed by pharmacy staff:

"*Presumably, within NHS policy there is a directive that every patient is equal…we should have the same service for patients regardless of background, and if you're directing your clinical service towards this model, that's supported by automation and prioritisation, you've got a low risk* [patient] *cohort… that might not get the same quality."* (P7, advanced pharmacist, Group 1)

Another participant felt that this wasn't the case as ward pharmacists do not routinely see every patient currently:

"*I don't think it's really in… conflict… the point* [Pharmacist 7] *made, obviously that's in… an ideal situation where we can see every single patient… we know that's not going to happen ever because we're not a 24/7 service*." (P6, pharmacist team manager, Group 1)

Subtheme 2: Medical devices

One participant queried if APP tools using HEPMA system data are classed as a medical device and if so, what are the implications from medical device legislation in using within an organisation:

"*thinking about other electronic tools and registered medical devices… if you're using a tool like this* [APP]*… does that open you to a risk from an organisational perspective*" (P7, advanced pharmacist, Group 1)

Subtheme 3: Medicines reconciliation

One participant thought there could be conflict with the Scottish Government's goal of conducting 95% of medicines reconciliations (med rec) within 24hrs of patient admission:

"…*often people say that every patient should have a med rec done within 24hrs in hospital but when you are then looking at the tool* [APP] *you wouldn't be meeting that*" (P11, specialist pharmacist, Group 2)

Other participants felt that this would not be an issue as the existing system of patient prioritisation does not meet this standard:

"*I don't think using the tool* [APP] *would stop you meeting the NHS standards for… patients med rec'd in 24hrs. You need to tailor your resources to med recs that would have the most benefit in 24hrs. Which, because… at the moment, we don't… meet the standard*." (P9, specialist pharmacist, Group 2)

Subtheme 4: Realistic Medicine policy

One participant thought that APP would assist pharmacy staff by delivering care in line with the Realistic Medicine policy:

"*I think we would want to be reviewing every patient, but I don't think we need to review every patient and this tool* [APP] *would allow us to see the right patient at the right time…deliver in line with the realistic medicine policy."* (P9, specialist pharmacist, Group 2)

4.4.5 Theme 3: Ethical Principles

The ethical principles domain of the CoRE-Values framework (92) was coded using the pre-existing principles outlined in the domain: Justice, Beneficence, Non-maleficence, Autonomy and Utility. The framework ethical principles were used as subthemes and are defined in Table 4.1 and 4.2.

Subtheme 1: Justice

Participants reflected on methods of patient prioritisation without HEPMA system APP and highlighted that "…*we are prioritising at the moment, we don't see every patient… the pharmacist will make the decision that I'm going to focus on this area because in their view this is a high-risk patient*" (P6, pharmacist team manager, Group 1). Limitations to patient prioritisation without APP was discussed, *"…normally you would go onto a ward and just see who you could, and you wouldn't know about… risk…"* (P1, pharmacist team manager, Group 1).

APP was thought to be "…*mimicking that current mode*l..." (P6, pharmacist team manager, Group 1) and there was acknowledgment that staff resourcing is an issue:

"Well anecdotally I'd say we… know that already… we don't cover [ward] *properly…"* (P5, advanced pharmacist, Group 1)

"we don't offer an equal service to the hospital… the way in which we approach ward cover at the moment is highly out of date, quite labour intensive as well" (P9, specialist pharmacist, Group 2)

Participants discussed how "…*we should have the same service for patients regardless of background…*" (P7, advanced pharmacist, Group 1) but "…*if you have a finite amount of resource you have to focus it on the right patients"* (P1, pharmacist team manager, Group 1). It was pointed out that staffing levels are not changing with the introduction of APP as "*you've still got the same amount of resources but you just might be able to direct them to different areas. Of course you are not going to be able to see… all of your patients… but you are going to be able to prioritise the patients that do, really really need to be seen*" (P12, pharmacist, Group 2). It was also thought increased visibility of high-risk patients in a hospital might show that "…*areas we're not covering… we didn't realise, had more high-risk*

patients than areas that we are covering" (P1, pharmacist team manager, Group 1), creating opportunity for service review by pharmacy management.

Participants thought there was some concern with the automated approach as "…*directing your clinical service towards this model… you've got a low risk cohort that's defined… that might not get the same quality*" (P7, advanced pharmacist, Group 1) of care. One participant felt there was a potential solution to this problem through staff skill mixing, "…*divvied up patients based on the professional role… with PSWs and the technicians*" (P1, pharmacist team manager, Group 1). Appropriately trained pharmacy support workers (PSWs) and pharmacy technicians that work on wards could be directed to see different levels of patient priority and escalate issues to the appropriate pharmacist as necessary.

A question was also raised with use of automated prioritisation between specialist services as they will have different requirements for clinical rules in prioritising, "*it might not equal the same fairness or equity, on seeing the correct patients on every ward, depending on the wards specialty*" (P9, specialist pharmacist, Group 2). Paediatrics in particular was highlighted as a specialty that would warrant separate prioritisation rules, otherwise the majority of paediatric patients would display as high risk.

One participant suggested that directing pharmacists to high-risk patients could be viewed negatively by lower prioritised patients as "*you might feel that that's unfair that you've not been seen but the patient next to you has been seen every day*" (P3, advanced pharmacist, Group 1). However, participants felt "we *are trying to provide equity where everybody at least has the same…risk at the end*" (P5, advanced pharmacist, Group 1).

Overall, participants thought that "…*it's actually more equitable to use something like this* [APP] *to… direct*" (P5, advanced pharmacist, Group 1) pharmacy staff to patients most at risk of harm from prescribed medications. APP would "…*increase the equity of care because you're… able to see the correct patients*" (P9, specialist pharmacist, Group 2) as "…*right now we are reviewing some patients to rule out that they don't need seen*" (P8, specialist pharmacist, Group 2).

Subtheme 2: Beneficence

Participants felt that APP was a significant benefit to assist pharmacists on the ward:

"I think it is… really beneficial to help with the clinical pharmacy service… considering the pressures on the service." (P7, pharmacist team manager, Group 1)

"*I think it would enhance the benefit and quality of care which we would provide… patients."* (P9, specialist pharmacist, Group 2)

It was thought that having patient's automatically prioritised "…*takes a bit of the subjectivity out… as a starter"* (P5, advanced pharmacist, Group 1) when assessing ward patients to review as risk level is not known until patient medications are reviewed. Automation of prioritisation "…*would target the pharmacist to the right patient"* (P1, pharmacist team manager, Group 1), particularly if staff resource is short. Highlighting patients on high-risk medicines in high turnover wards was felt to be beneficial as "…*that's where… you're likely to miss the high-risk patients…"* (P6, pharmacist team manager, Group 1) due to patient transfer through hospital.

Participants also thought reduction in time spent screening patient medication charts for high-risk medicines would result in more time spent reviewing patients on the ward as pharmacy staff "*…aren't having to spend half an hour seeing which patient they are going to go look at…"* (P12, pharmacist, Group 2). Benefit in the ability to skill mix with available pharmacy staff on the ward e.g. pharmacist and pharmacy technician was felt to be advantageous through APP as different risk levels of prescribed patient medication are displayed, "*it's actually helping us to direct ourselves to the right people, from a skill mix perspective.*" (P1, pharmacist team manager, Group 1).

Limited benefit was expressed for specialties with numerous patients on high-risk medicines "*like oncology potentially, paediatrics potentially, transplant*." (P7, advanced pharmacist, Group 1). It was thought that further work on specialist clinical rules for patient prioritisation is required.

Subtheme 3: Non-maleficence

Overall participants felt that patient prioritisation automation will support harm reduction by highlighting patients on high-risk medicines:

"…are we introducing harm…I wouldn't think that is the case" (P6, pharmacist team manager, Group 1)

"*I think harm will be reduced… because the high-risk meds is probably where the Datix* [incident reports] *are most likely to be seen*" (P4, advanced pharmacist, Group 1)

However, high-risk patient visibility and knowledge of this through automated prioritisation was felt to be "…*an informed worry*" (P12, pharmacist, Group 2) and was highlighted as a concern if an individual or team is unable to review each high-risk patient within working hours:

"*I'd be worrying… if I can see all of those* [high-risk patients] *in that amount of time*" (P10, pharmacist, Group 2)

This visibility of high-risk patients across a hospital site was felt to present "*potential harm by not seeing…*[all identified high-risk patients] *and we can't achieve this because of the current resource component that we've got within teams*" (P7, advanced pharmacist, Group 1). There was concern that patients would be visible in wards without ward pharmacist input and what the outcome of this would be, it is "*the ethical side of being aware that you have got… high-risk patients in a ward that's not got a clinical pharmacy service*" (P9, specialist pharmacist, Group 2). Patient risk visibility was also thought to be concerning for staff handover between shifts if a large proportion of high-risk patients remain to be reviewed.

Participants also discussed concerns around the data used to prioritise patients automatically as outlined in Table 4.5. It was proposed that APP tools should be used in conjunction with other sources of patient information by ward pharmacy staff when prioritising patients to ensure informed decisions are made, "*we are not going to use this tool in isolation, it's not going to be the only thing we are going to look at*" (P9, specialist pharmacist, Group 2).

Table 4.5 Participant concerns with data used to automatically prioritise patients

Concern	Description	Illustrative quote
Omitted medications	Medication not prescribed on Hospital Electronic Prescribing and Medicines Administration (HEPMA) system through omission will not be included within automated prioritisation.	*"…if a medicine has been missed off HEPMA, it* [automated patient prioritisation] *won't catch that and therefore a patient could be high risk" (P4, advanced pharmacist)*
Not all patient clinical factors are included	Patient blood results, weight or health conditions may not be included with the automated prioritisation.	*"…clinical status might change that's not picked up pharmaceutically…deteriorating renal function for instance" (P2, advanced pharmacist)*
Maintenance of prioritisation rules	Need for continued update of the rules that govern the automated prioritisation.	*"We need to continually just check it's* [automated patient prioritisation] *not missing something" (P1, pharmacist team manager)*

P - Participant

One participant also suggested it might "…*divert you away from… counselling…difficult conversations around medications, the things that you deal with in terms of sorting out compliance aids*" (P5, advanced pharmacist, Group 1).

Subtheme 4: Autonomy

Participants acknowledged that there is potential for autonomy to be taken away from ward pharmacists:

"…it does take away from your autonomy I feel… because it really directs you… you're gonna look at… red [high risk] *patients instead of… green ones* [low risk]. *So I feel it does take away your autonomy in that… sense"* (P10, pharmacist, Group 2)

One participant also wondered if autonomy could be impacted for pharmacists if they are relocated to a ward with more high-risk patients that are highlighted by APP:

"…*you could potentially lose autonomy if you're not allowed to see… your usual ward*" (P9, specialist pharmacist, Group 2)

However, APP was overall thought to supplement the information that ward pharmacists use to prioritise patients:

"*it supports, not replaces your clinical judgement of the hospital pharmacist or technician*" (P7, advanced pharmacist, Group 1)

It was thought necessary to state "… *in the induction and the rollout very clearly*" (P1, pharmacist team manager, Group 1) the continued need to use additional sources of patient information when making decisions on patient prioritisation. A process to manually adjust the priority score automatically assigned by APP was thought to be helpful if the pharmacist does not agree with the score so they can prioritise with autonomy rather than solely rely on the automated risk score as "…*you can't reassign* [the risk score] *whereas as we said, we do tinker*" (P2, advanced pharmacist, Group 1). It was suggested this could be built into APP tools during the design phase.

Subtheme 5: Utility

Participants felt that the use of APP would support the redirecting of resources to the highest risk patients:

"…*you are going to be able to prioritise the patients that do, really really need to be seen*" (P12, pharmacist, Group 2)

One participant thought it would be helpful within specialties that have several pharmacists covering multiple wards to "*…split and conquer and divide… redistribute our resources so we can see the most appropriate patients*" (P9, specialist pharmacist, Group 2).

Participants acknowledged that this will likely result in decreased review of lower risk patients "…*because in reality… we wouldn't get to the medium or low risks* [patients]" (P4, advanced pharmacist, Group 1). There was also felt to be a risk in not seeing all visible high-risk patients, with suggested need for "…*something worse than a red* [high-risk patient]*… a high high risk for patients that you would see"* (P12, pharmacist, Group 2). It was thought that transparency of the automated prioritisation score would help in patient prioritising when capacity is limited within the working day:

"*Can we actually have a score so that you can say, that patient's 200, that one's red* [high risk] *but they're only 11. So I'm going to go for the 200 first… I think a lot of*

patients we are going to find will… be red… with nothing to validate against." (P5, advanced pharmacist, Group 1)

Participants also discussed how APP could be used to transform a ward pharmacy service model to utilise resources effectively:

"*Currently our model is… specialty based… ward based…do we start to think… actually it's more fluid. Where pharmacists are going to the areas where this tool* [APP] *is helping to identify high-risk patients*" (P6, pharmacist team manager, Group 1)

4.4.6. Theme 4: Values

The values domain in the CoRE-Values framework (92) is defined as the values/beliefs/ideology of: the patient; the involved health professional/s; other stakeholders in the outcome, such as the patient's family, the hospital, the health system, health care funding organisations, the government or other employers of the health professional. One subtheme was inductively derived from the discussion. Values were only coded if related to the hospital pharmacy service.

Subtheme 1: Organisation values

One participant thought that use of automation in patient prioritisation would align with "*the pharmacy strategy and… strategic plan…our values as a Board and organisation*" (P7, advanced pharmacist, Group 1) as it is an innovation to support patient care.

4.4.7. Additional Theme

An additional theme was identified from a focus group transcript that was not related to the CORE-Values framework.

Education

One participant felt that APP use would make it easier to identify patients for educational purposes when training pharmacy staff:

"*…experiential learning students… will probably get a lot more…learning if they are looking at high risk medicines…rather than seeing a patient…low risk but at the moment we have not got a quick and easy way to look at patients at a glance.*" (P9, specialist pharmacist, Group 2)

4.5 Discussion

This study aimed to explore hospital pharmacists' views on the professional ethical considerations in using an automated patient prioritisation (APP) tool with a HEPMA system. Studies in the literature identified in Chapter 3 highlighted that although there is demonstrable use of HEPMA data for patient prioritisation by pharmacists, there is not any documented consideration around potential ethical impact. Pharmacist opinion was ascertained through focus groups conducted using a clinical vignette to demonstrate a potential scenario with APP for context. Two focus groups were conducted with 12 pharmacists of varying banding, with questions structured and analysed using the four domains of the CoRE-Values framework (92): Codes (Professional), Regulations, Ethical Principles, and Values (see Table 4.2). Subthemes were derived inductively from domains without predetermined subthemes: regulations and values.

4.5.1 Summary of Key Findings

Participants highlighted ethical considerations that should be considered when implementing and using an APP tool. In order for pharmacists to comply with the GPhC Standards for Pharmacy Professionals (96) in the UK, it was suggested that the use of APP by hospital pharmacy staff should be communicated with other HCPs to ensure awareness of use and reinforce need for continued communication and patient referral to minimise any impact on partnership working. It was felt that there should not be an overreliance on automation so that staff retain the skills to prioritise patients, and that a process is required for pharmacists to track which patients have been reviewed and when they should be reviewed again to enable continued professional judgement. Removal of staff autonomy was highlighted as a potential concern if other patient clinical information, which informs the wider clinical

picture, is not used as part of prioritisation. It was felt that this should be made clear to pharmacy staff during training so that they continue to review all necessary patient clinical information when prioritising patients.

High-risk patient visibility across a hospital could result in pharmacy teams expressing concern if existing staff resource is inadequate to permit the review of each individual patient but this could lead to opportunity for service model review, particularly for wards that do not have a dedicated pharmacy resource. The increased awareness of high-risk patient numbers could also impact on pharmacy staff wellbeing i.e. moral distress if capacity does not allow all identified patients to be reviewed within working hours.

Participants thought that use of APP was a fair and pragmatic way to manage pharmacy resource by targeting patients most at risk of harm from their prescribed medicines. All participants agreed that pharmacy staff would be directed to, and focus on, high-risk patients first as defined by a specific tool, which would result in less time for low and medium risk patient review, but automated presentation of data would release more staff time to care. This change in practice could potentially conflict with any existing NHS policy that promotes patient equity of care and need for timely medicines reconciliation verified by a pharmacist after hospital admission. It was suggested that utilising different staffing could be a way to support wider patient review beyond those identified as high risk i.e. pharmacy technicians routinely review low to medium risk patient medication charts and escalate any missing or locally defined high-risk medications to pharmacists and pharmacists routinely review high-risk patients. This approach would require adequate governance and training for pharmacy technicians for standardisation in what pharmaceutical care issues would require escalation to a pharmacist if not already in place. Participants also questioned how patients would potentially perceive pharmacy use of the tool and suggested consideration around this prior to use.

In relation to the HEPMA system data used to prioritise patients, it was highlighted that an omitted medicine for a patient when medicines are being prescribed at hospital admission could compromise APP scoring. It was also pointed out that the clinical rules used to create the APP score must be maintained to ensure appropriate patient clinical information included. Use within specialist areas e.g. paediatrics was highlighted as an issue as some of the scoring rules used within generalised APP may not be applicable because they were created for use with

adult patients. It was also felt that any medical device legislative requirements should be considered by organisations prior to the use of and after modification of APP tools.

Data presentation in section 4.4 was structured around the four domains of the CoRE-Values (92) ethical framework but due to overlap and interrelation, themes were combined and have been presented under two headings: Codes (Professional) and Ethical Principles, and Regulations and Values.

4.5.2 Codes (Professional) and Ethical Principles

Continued need for pharmacist professional judgement and autonomy when using an APP tool were key subthemes of the Codes (Professional) and Ethical Principles domains. The requirement to use APP alongside other patient information sources to assess patient risk when prioritising for pharmaceutical review was identified as necessary in this study as APP using solely HEPMA system data may not contain all of the clinical information required by pharmacists to prioritise patients. This is dependent on the clinical rules created for APP and software available locally, reinforcing the importance of the tool design and development. Alshakrah et al. (36) identified the variation in criteria used for patient prioritisation tools by pharmacists through a systematic literature review in 2019 and therefore pharmacists must ensure they are checking patient risk factors not included within the locally agreed APP clinical rules to maintain safe clinical practice.

This finding is consistent with Gibson et al. (116) who explored staff perceptions on hospital pharmacy prioritisation practices by conducting a survey across 11 NHS Trusts in England in 2016. Gibson et al. concluded that pharmacy workload prioritisation is best managed through patient prioritisation tool use with pharmacy staff applying their judgement to the displayed information for interpretation of risk in clinical context. Similarly, Clarke et al. (117) who developed an electronic patient prioritisation tool without automation i.e. pharmacists calculated and entered the patient's priority score, identified through clinical pharmacist survey that the prioritisation criteria used were multifactorial and cannot be fully captured within an electronic tool. Clarke et al. emphasised that prioritisation tools should be used to support rather than replace clinical expertise when assessing patients for

pharmaceutical review. APP is therefore currently recognised as a support to patient prioritisation and pharmacy staff should continue to exercise their own professional judgement and autonomy when undertaking this task. As HEPMA systems and reporting software evolve, there is potential for APP tools to contain more diverse and complex clinical rules, which should be monitored by hospital pharmacy services to ensure supporting procedures and staff training for APP are in alignment.

Suggested benefit in a pharmacist adjusting the automated prioritisation score on an APP tool if they do not agree with the scoring was not discussed in the literature review by Alshakrah et al. (36) for tools that used HEPMA data or the qualitative study conducted by Abuzour et al. (33). Abuzour explored approaches by hospital pharmacy services in the UK to prioritise patients in 2020 through survey and interviews, some of which utilised APP tools. The ability to alter the automated patient priority score was suggested as necessary by participants in this study since APP tools can continue to score patients as high priority even though they have been reviewed by a pharmacist. Manually adjusted scoring could be managed through APP tool design and would address the concern that APP tools may not contain all of the clinical information used for patient prioritisation, as well as the concern for loss of autonomy and patient prioritisation skills with an overreliance on automation. Onatade et al. (118) who conducted a small pilot study using an automated hospital pharmacy patient prioritisation tool in a London Trust noted pharmacist use of clinical judgement to override APP priority scores and recommended that staff should have their prioritisation expertise assessed appropriately if APP tool priority scores are altered routinely. If manual APP score alteration is built into APP tools, there should therefore be appropriate mechanisms to assess staff competence locally but score alterations should also be monitored as an increase in this may point to an issue with APP tool design. Hospital pharmacy services therefore have to review the governance of the pharmacy patient prioritisation and review processes to provide clarity for staff when adopting APP to ensure they are adequate for staff and patient needs.

High-risk patient visibility through APP tool use was another key consideration that was evident in the Codes (Professional) subthemes of Partnership working, Professional judgement, Person-centred care, and Speaking up about concerns, in addition to the Ethical Principles subthemes of Justice, Beneficence, Non-

maleficence and Utility. By automatically assigning a priority score to every patient in a hospital, the number of high-risk patients identified could be too large for the existing pharmacy resource to review within working hours as identified in the Speaking up about concerns, Justice, Non-maleficence and Utility subthemes. This unintended consequence of automated prioritisation isn't addressed in the literature and is an ethical concern with tool use as highlighted by this study. Hospital pharmacy services must consider this aspect of automation prior to implementation as it may highlight high-risk patients in areas with little or no pharmacy cover leading to requests for increased resource or modified service delivery models. Staff wellbeing could also be impacted if all identified high-risk patients across the pharmacist's assigned ward(s) cannot be reviewed during the working shift or day, individuals may be subject to moral distress. As highlighted in the focus groups however, pharmacy staff state they do not currently see every patient in ward areas or hospital without APP use and therefore it is not currently known what impact that has on staff in terms of wellbeing through unknown risk. Literature is lacking on hospital pharmacist moral distress, focussing more on community pharmacists as highlighted by Alvarez et al. (119) who argued in a 2023 journal article that further research is needed through the American College of Clinical Pharmacy to characterise and understand the impact of moral distress in other practice settings and beyond those studies conducted during the COVID-19 pandemic.

However, APP high-risk patient visibility could bring opportunity to transform a hospital pharmacy service model as indicated in the Partnership working, Justice and Utility subthemes. Traditional UK hospital pharmacy service models are based around ward or specialty cover (120,121), with one or more pharmacists and clinical pharmacy technicians assigned to cover one or more wards, but use of APP could change that by directing pharmacy resource to the high-risk patients across a specialty or hospital rather than within defined ward(s) as described by Cottrell et al. (53). Cottrell implemented an APP tool in an acute hospital in 2013 and evaluated the time taken from prescription to pharmacist verification of high-risk medicines, indicating improvement after APP implementation although this was not statistically verified. Cottrell et al. recognised the potential for APP to change a hospital pharmacy service through targeted pharmacy resource and recommended future work on this. By changing the focus from ward allocation to a centralised model, pharmacy resource could be deployed in a different way, which study participants felt should be considered as identified high-risk patients are most at risk from their

prescribed medicines. Improved team working without changing service models is an identified benefit from patient prioritisation use. Taking a skill mix approach to managing the different patient priority levels of APP (low, medium and high risk) through skill utilisation of the clinical pharmacy technician for lower priority patient review as suggested in this study was reported by Abuzour et al. (33). A Delphi study conducted by Alshakrah et al. (120) in 2021 to develop a patient prioritisation tool using consensus methods also reported expert comment on low risk patient review by clinical pharmacy technicians as well as junior pharmacists. Clarke et al. (117) further noted junior pharmacists could be directed to the lower priority patients and senior pharmacists to the high-risk patients. Hospital pharmacy services therefore need to be clear on the roles and responsibilities of staff when implementing and utilising APP tools.

Targeting pharmacy resource to high-risk patients through patient prioritisation tool use is acknowledged as a pragmatic approach to improving staff efficiency and patient safety as identified in this study under Person-centred care, Justice, Beneficence and Utility subthemes. The systematic literature review conducted by Alshakrah et al. (36) and the qualitative UK survey by Abuzour et al. (33) both reported the benefits of patient prioritisation tool use for pharmacy services with improvement for patient care, but patient outcomes have so far not been formally assessed with tools used. Increasing the chance that high-risk inpatients are reviewed by pharmacists through APP identification was felt to be a service improvement in this study. Less time spent by pharmacy staff reviewing low to medium risk patients was a likely consequence of APP highlighted in this study, which is inferred by Alshakrah et al. (36). Time released to care through automated data presentation to pharmacy staff, which is a recognised benefit of electronic prioritisation reported by Alshakrah et al. (36), could partially balance this impact since it would create capacity to review more patients due to the removal of the time taken to identify and prioritise patients manually. The need of differing clinical rules for specialties e.g. paediatrics is something that was also identified by Abuzour et al. (33) as prioritisation tools can lack the specificity needed in these areas. Bespoke specialty prioritisation tool use is emerging in the literature, evidencing the need in these specialist areas. Spencer et al. (122) created paediatric patient prioritisation criteria for pharmacist use in 2020, to be used in either paper or electronic systems, recognising that most pharmacy prioritisation tools are created for use with adult patients. In 2023, Alshaikhmubarak et al. (123) reported that pharmacists were

using patient prioritisation methods in 21 UK mental health trusts/boards, nine of which used a prioritisation tool, one being APP.

Risk in solely using HEPMA data for APP as noted in the Non-maleficence subtheme is concurrent with the findings of Cottrell et al (53) who reported that patient co-morbidities, deranged blood results and absent prescribing from a HEPMA system were limitations with the tool they implemented. Quintens et al. (83) also noted the constraints of creating clinical rules for APP when implementing a report to identify patients for pharmaceutical review as some patient characteristics are not electronically documented e.g. weight or clinical symptoms. APP limitations will depend on the clinical rules that define the prioritisation of the algorithm but there will always be the risk that a prescriber omits a medication from a HEPMA system when prescribing a patient's medications upon hospital admission. Any omitted patient medication will not be included within APP scoring and therefore the assigned risk score could be incorrect if this occurs. Similarly, there will always be a need for ongoing clinical rule update to ensure new high risk medicines are included. Inclusion of further patient clinical factors within APP e.g. blood results could develop as tools and systems evolve over time. The need for continued tool management to keep up to date with recommended practice was recognised by Levivien et al. (82) who implemented a machine learning model to prioritise electronic prescriptions likely to have a drug related problem for pharmacist review in a French hospital. A need for pharmacy staff to see and understand how APP calculated a patient risk score to assist with prioritisation within risk categories e.g. high risk, as suggested in this study is not something that is noted in the literature but would be beneficial if the number of high-risk patients is too large for a pharmacy resource to review within working hours.

4.5.3 Regulations and Values

Equity of a hospital pharmacy service was raised in the Equity of service subtheme, which touched on a traditional service model and one using APP. The NHS Constitution for England outlines the guiding NHS principles and states that 'a comprehensive service should be available to all' (124), which could potentially be in conflict with a pharmacy service that does not offer pharmaceutical care to every

patient. However, context is given within another principle in providing best value for money and recognising that services must be effective, fair with sustainable use of finite resources (124). NHS Scotland further clarifies that patients should be offered care according to clinical priority, with the most urgent seen first (125). The concern that APP use could be in conflict with NHS policy is therefore mitigated through efficient use of resources by targeting patients most in need of pharmaceutical care or with a high pharmaceutical acuity. A recent piece of work to define pharmaceutical acuity by Lewis et al. (126) in conjunction with the European Association of Hospital Pharmacists (EAHP) highlights the growing interest in this area. Lewis acknowledged patient prioritisation tool use by pharmacy services to manage limited healthcare resources and points out that even though there are multiple tools or processes to manage prioritisation, there is variation in terminology. The definition to allow for shared understanding and future research was agreed as:

“Pharmaceutical acuity is an attribute of a patient, determined by an assessment of the likely requirement for pharmacy services, and used to direct and prioritise pharmacy workflow and workforce to ensure the right patient is seen by the right pharmacy professional at the right time - an approach that seeks to reduce medication-related problems and ensure person-centred care.”

Resource efficiency as suggested in the Realistic Medicine policy subtheme is in alignment with the Realistic Medicine publication from the Scottish Government, which states that failure to deliver the right care, where and when it is needed contributes to low value healthcare as opportunities are missed to improve patient outcomes (127).

Medicines reconciliation is the process of ensuring an accurate list of a patient’s current medicines, taking into account the current health of the patient with any long-standing conditions (128) and can be conducted by a doctor, nurse, pharmacist or accredited pharmacy technician (129). The goal of reaching 95% compliance for medicines reconciliation of admitted patients within 24hrs was set in 2013 for NHS Scotland (130). The participant’s concern identified in the Medicines reconciliation subtheme that APP use could lead to an organisation not meeting this goal due to APP directing pharmacy staff to high-risk patients is unfounded if a healthcare organisation does not mandate that pharmacists must complete medicines reconciliation since other HCPs can complete this task.

Use of software and applications in healthcare is a growing area of digital health and they are subject to the Medicines & Healthcare products Regulatory Agency (MHRA) medical device regulations in the UK to ensure acceptability and safety in use (131). A medical device is an instrument, apparatus, appliance, software or material intended for human use to perform a medical purpose (132). Not all software and applications used in healthcare are classified as a medical device, the MHRA have outlined guidance to assist in assessment (131). There is no reference in the existing literature to APP classification as a medical device, which is why this query was raised in the medical devices subtheme, and this is likely due to individual interpretation of the regulatory guidance and variation of APP use. In this study, APP as displayed in the clinical vignette is a decision support algorithm and MHRA guidance states that algorithms are usually classed as a medical device. However, decision support software is not considered a medical device if it exists only to provide reference information from which a HCP can make a clinical decision and the HCP reviews the raw data as part of that assessment (131), which would be done in the case of APP when a patient is reviewed. Furthermore, APP using HEPMA system data does not fit within the current MHRA definition of a device with a medical purpose. Organisations should however consider the potential for APP to evolve over time and regularly review regulatory guidance with any change to ensure compliance.

The Royal Pharmaceutical Society in the UK have set out their vision for 2030 and use of data, digital technology and innovation is listed as a key element of an infrastructure to underpin this (133). APP use in hospital pharmacy is therefore aligned with a future vision for pharmacy in the UK as suggested by one participant around organisational values.

4.5.4 Strengths and Limitations

Ethical consideration of APP use in hospital pharmacy has not been published prior to this study to the author's knowledge. Use of an ethical framework that incorporates the Beauchamp and Childress ethical principles (91) adopted in medicine with contextual factors to frame the focus group questions and subsequent analysis was a strength of this study as framework use increases the robustness of

the methodology and reduces the risk of confirmation bias. A limitation of the CoRE-Values framework was that it was evaluated in a teaching context only with nursing and medical students and instructors. This framework has therefore not been used in a hospital environment and has not been evaluated with pharmacy staff. However, Manson demonstrated that the framework was felt to link ethical theory with clinical practice and is a useful educational tool (92).

A range of pharmacist bandings were recruited to the study, allowing for a wide scope of opinion, but with challenges in recruiting due to low volunteer number, the pharmacist that completed the content validity in the documentation pilot was recruited to a focus group. This was necessary to achieve a participant number of 12, which was the minimum number outlined in the method. Pharmacy technicians were not recruited to this study but were referenced in the focus groups, this may have therefore been a limitation as not all staff types who may use APP in pharmacy were included. As the lead researcher was the focus group moderator there was the possibility of interview bias as a subject matter expert posing the questions to participants. Focus group methodology promoted discussion and debate amongst peers to maximise qualitative data output but it can also allow for strong voices to dominate the conversation, resulting in a biased view on group opinion. Senior and junior pharmacists were separated between the two focus groups to promote discussion and all participants contributed however, this was not quantified. Use of a clinical vignette was a strength of this study as it focussed discussion on a standardised scenario for consistency of data interpretation, rather than individual's experiences based on varied clinical pharmacy staffing models.

Data saturation is the point at which no further insights are identified from the data and repetition occurs, indicating that further data collection is redundant (134). Two focus groups would not have achieved data saturation on this topic, evident as different inductive subthemes were derived from each focus group for Regulations and Values. However, two focus groups can be expected to identify 80% of themes on a topic (110). Due to participant recruitment challenges, focus group number is a limitation of this study.

A deductive approach to the focus group analysis (except from the subthemes of the Regulation and Values domains) resulted in the exclusion of one potential subtheme of Education as it did not correlate with a domain of the CoRE-Values framework. As the subtheme was in relation to pharmacy education and not professional ethics, it

was not relevant in the context of this study. Conversely, the inductive approach to analysing the Regulation and Values domains for subthemes allowed for interpretation of new ideas that are not pre-defined but this can lead to issues in replicability between researchers. However, as the first focus group transcript was validated and analysed by another researcher to ensure standardisation, this lessens that risk since agreement was achieved on the subthemes. Only one researcher transcribed and analysed the second focus group. This study was conducted within one Health Board in NHS Scotland and may therefore limit generalisability.

4.5.5 Future Directions and Recommendations

This study was conducted in an organisation that had not yet implemented APP in the hospital pharmacy service to support the implementation by addressing any identified concerns prior to use. Future work on ethical considerations could be conducted with an organisation that had APP established however, it was noted that two of the participants in this study had previous experience of APP use. Pharmacy technicians were also not included within this study which focussed on pharmacist opinion for ethical use of APP. APP impact to pharmacy technicians was referenced throughout the focus group discussions, indicating further work should be undertaken around this.

As APP use continues to emerge in the literature and evolve over time, further research is necessary around tool validation and assessing patient outcomes; a limitation noted with the literature (117). A key theme from the study analysis showed that the visibility of high-risk patients through APP use could facilitate pharmacy service model review but it also has potential to cause moral distress for pharmacists if unable to review all high-risk patients within working hours. Further work on transformational change as a result of APP use and any identified staff wellbeing impact is warranted to fully understand the post implementation impact of APP with HEPMA system data.

4.5.6 Conclusions

Study results highlighted that APP use in hospital pharmacy has potential to cause some ethical conflict if not managed at the outset of implementation. Aspects of APP use that were felt to be a potential issue were centred around the number of high-risk patients that would become visible if there is a local staff resource issue, the need for pharmacists to use APP as part of the patient prioritisation process as not all patient clinical information is included, and the need to ensure APP algorithms are maintained for appropriate HEPMA data inclusion and governance.

Overall, pharmacist participants thought that APP use was a positive innovation and would benefit patient safety through better management of staff resources. APP use was felt to bring opportunity by facilitating transformational change of a hospital pharmacy service model through a more centralised approach and assignment of available staff i.e. pharmacists and pharmacy technicians to patient priority levels.

Chapter 5: Discussion

Due to the recent uptake in HEPMA system implementation across NHS Scotland, and with continued workforce challenges across the NHS, this research sought to explore innovative methods of prioritising hospital inpatients for pharmaceutical care by pharmacists. The research aim (Chapter 2) was to identify and describe any new methods used to prioritise hospital inpatients for medication review by hospital pharmacists after HEPMA system implementation, and to explore ethical considerations from automated patient prioritisation (APP) tool use within this process. Research objectives (Chapter 2) were conducted in two stages: in Stage 1 a systematic review of the literature was undertaken to identify, summarise and describe methods of inpatient prioritisation used by HCPs after the implementation of a HEPMA system. The literature review scope was widened, encompassing all HCPs rather than focussing solely on pharmacists to support the evidence base and allow for shared learning between professions. An evidence gap was identified in the literature around the ethical use of automated patient prioritisation with HEPMA system data, leading to Stage 2, which sought to ascertain and describe hospital pharmacist views on professional ethical considerations of automated patient prioritisation (APP) tool use within a hospital pharmacy service using an ethical decision-making framework.

5.1 Overview of Key Findings

With an emerging interest in the use of patient prioritisation tools in the UK and beyond by hospital pharmacists to assist in managing the continued workforce pressure and resource issues (33,36), this systematic literature review was conducted to identify the methods used for patient prioritisation with the adoption of HEPMA systems. The review identified 13 studies conducted between 2012 and 2022, where HCPs were prioritising inpatients with a HEPMA system; the majority of studies originated from Europe and identified pharmacists as the HCP most commonly engaging with patient prioritisation methods. This is consistent with the use of paper and electronic patient prioritisation tools across Europe during this time period as highlighted by the literature review of Alshakrah et al. (36) and reflective of

the workforce pressure on hospital pharmacy services. Machine learning models (MLMs) were an innovation for inpatient prioritisation methodology as previous literature reviews had not reported these (33,36).

Hospital pharmacist use of patient prioritisation is evident in the literature (33,36) and through the literature search in this study, which highlights innovations in methods used to prioritise patients now emerging through HEPMA system enablement. Research exploring ethical decision making in the hospital pharmacy context that is not specific to patient prioritisation or HEPMA is limited as described by So et al. who conducted interviews with hospital pharmacists in Australia in 2021 (135). This is further supported by the 5 studies identified in the literature review using APP with HEPMA data which do not address the professional ethics of patient prioritisation by this method. In this thesis, focus groups were conducted with pharmacists to explore the ethical concerns with APP use in hospital pharmacy using the CoRE-Values ethical decision-making framework (Table 4.2). A summary of themes and subthemes from the focus group analysis are displayed in Fig 4.1. Participants agreed that use of APP is a fair and pragmatic approach to managing daily workload by directing pharmacy staff to the patients most at risk but also highlighted ethical concerns that organisations should consider prior to adoption.

5.2 Interpretation of Findings

HCPs are engaging with HEPMA system data to prioritise patients with the aim to improve care. Previous literature reviews have highlighted hospital pharmacist use of patient prioritisation tools across Europe and the UK, with some incorporating HEPMA data (33,36). The literature review in this study adds to the evidence base by specifically examining and reporting the methods used by HCPs to prioritise patients using HEPMA systems. Additionally, the review findings confirm that hospital pharmacists are the HCP group most commonly reported to be using patient prioritisation tools with HEPMA data in response to an increased workload and staff resource issues. Variation in the methods used to prioritise patients with HEPMA systems (Table 3.5) from the 13 studies in the literature review showed that HCPs are not only engaging with HEPMA systems for this purpose, but they are doing so in different ways with the software available to them.

Commercially available HEPMA systems differ in functionality (136) and as some HCPs were not prioritising patients with HEPMA system functionality in the Stage 1 literature review, it stands to reason that not all systems have the functionality to do this method of patient prioritisation. Those systems that do have the functionality offer HCPs potentially more efficient methods of patient prioritisation. For HEPMA systems that do not have patient prioritisation capabilities, HCPs can access the electronic patient data they create, which was previously time prohibitive to collect due to paper-based prescribing and administration records (33). The studies identified in this review show a variety of ways in which HCPs can extract and engage with HEPMA system data to improve staff efficiency at a ward, specialty or hospital level. However, it's critical that HCPs have an awareness and understanding of the system data and software available to them in an organisation and the limitations, in order to safely and effectively engage with new methods of patient prioritisation. Despite the small number of published studies in the literature during the search period, it is evident the HEPMA system implementation enables HCPs to prioritise patients in new and innovative ways. For pharmacists, the continued evolution from paper patient prioritisation methods continues as use of MLMs now begin to emerge, which have be trained to predict the likelihood of errors and drug related problems (82,86), increasing the accuracy of APP.

A lack of ethical discussion around HCP innovations with HEPMA data to prioritise patients was identified. Despite increased reporting of the ethical issues arising in relation to resource allocation during the COVID-19 pandemic (59), the ethics of prioritising patients is rarely mentioned in the literature (59). Exploration of the ethical considerations for hospital pharmacist use of APP in this study adds to this limited evidence base. Several findings from this study supported the current evidence base on APP tool use by hospital pharmacists (Section 4.5.2). The participants agreed that APP tools are beneficial to the hospital pharmacy service. Pharmacists must ensure they check patient risk factors not included within locally agreed APP clinical rules, a finding supported by Gibson et al. (116) and Clarke et al. (117). APP tool use will support the direction of pharmacy staff to high risk patients and could lead to a change in service model as described by Cottrell et al. (53). Enhancing skill mix to provide pharmaceutical care to the patients categorised by APP as low risk from prescribed medicines through clinical pharmacy technician review was discussed by Abuzour et al. (33) and Alshakrah et al. (120). As pharmacy technician scope of practice is currently being assessed in Scotland to

support the creation of advanced level competencies relevant to role (137), use of APP should be considered as part of this. Participants agreed that staff time would be released to care through APP use due to the time saved in gathering patient information as acknowledged by Alshakrah et al. (36) and need for bespoke APP clinical rules for use in specialities e.g. paediatrics was noted by Abuzour et al. (33).

However, additional ethical considerations were identified from this study that have not previously been described in the literature that require mitigation in order to ethically implement APP tools. Organisations planning for implementation of APP need to consider the capacity of pharmacy services to meet the potential demand or the provision of pharmaceutical care to high-risk patients identified by a tool and how staff could be supported if they are unable to review all high-risk patients within core working hours. Prior to APP use, pharmacy services would not routinely see every admitted inpatient and would therefore not know the risk category of each individual patient in a hospital. Testing APP tools prior to implementation could identify the number of high-risk patients across a hospital and allow service managers to make informed decisions on staff resource allocation. If situations arise where all high-risk patients cannot be reviewed in a working day, then organisational procedures should be put in place to outline what staff should to do in those situations so that the risk of not reviewing a high-risk patient does not sit with an individual.

Organisations must also consider how to maintain pharmacy staff autonomy when using APP by developing the tool to allow pharmacists to see the underpinning calculation of each patient assigned score on APP and to manually adjust the APP score using their professional judgement after wider consideration of additional risk factors. If APP tool score adjustment is not technically possible then a process to indicate pharmacist allocated priority score in the patient clinical notes or care plan could be implemented to achieve the same outcome. If pharmacists are found to be routinely adjusting APP scores then staff competence in patient prioritisation and APP tool algorithm appropriateness should be reviewed. Lastly, organisations must ensure they are compliant with medical device regulations as APP tools develop over time, any enhancement to an APP tool should be checked against the regulatory guidance.

5.3 Strengths and Limitations

This thesis is the first to the author's knowledge researching both HCP methods of patient prioritisation with HEPMA system data and the ethical considerations of APP use by hospital pharmacists. It is expected that this thesis will add to the evidence base of patient prioritisation tools by describing the types of methods used by HCPs to prioritise patients with HEPMA system data and the ethics of using automated patient prioritisation tools in a hospital pharmacy service.

Conducting a systematic literature review first allowed for a robust review of the existing literature by HCPs on methods of patient prioritisation with HEPMA system data alongside comment on study quality. Widening the search to include all HCPs gave an overview within the date range to highlight innovations for shared learning and not limit to hospital pharmacists, which existing systematic reviews focussed on (33,36). The systematic literature review allowed comment on the overall thesis aim (Chapter 2) as methods used by pharmacists to prioritise patients with HEPMA systems were evidenced in the review.

As none of the included studies in the systematic literature review addressed any ethical considerations with automated patient prioritisation tool use, there was a lack of existing literature for qualitative results comparison, which was a limitation. The focus group participants were recruited from one Scottish Health Board that did not yet use APP in the hospital pharmacy service to inform implementation. Wider inclusion of pharmacists from other Health Boards that use APP would have allowed for a broader perspective and this is a study limitation.

5.4 Future Research

The literature review in this study highlighted that HCPs are engaging with HEPMA system data to prioritise inpatients, and hospital pharmacists are innovating with automation in this process, including MLMs. Future systematic literature reviews using the same search terms as used in this study are recommended to monitor the methods in which HCPs continue to prioritise patients with HEPMA system data. None of the studies identified in the literature review measured patient outcomes from patient prioritisation tool use, which is a common issue identified from literature

reviews on published prioritisation tools (33,36). Creation of an outcomes framework, allowing measurement of patient outcomes when APP is used by hospital pharmacy services would enable evaluation of effectiveness to give assurance to healthcare organisations, practitioners and patients.

High-risk patient visibility through APP use was identified in this study as beneficial through targeted staff resource but also as a concern if resource does not have capacity to meet the workload demand. Pharmacist opinion was explored in a service that does not yet use APP to capture any ethical concerns prior to implementation. It would be beneficial to qualitatively explore the outcomes of APP in a hospital pharmacy service with an established APP tool to investigate if capacity concerns occur and how they are managed as well as any resultant transformational service change enabled by implementation. Service outcomes could be encompassed within the aforementioned framework in addition to patient outcomes to enable a wider evaluation of APP.

5.5 Conclusions

The continued implementation of HEPMA systems globally has enabled further evolution in methods used to prioritise hospital inpatients by pharmacists in an effort to manage workload, patient safety risk and resources efficiently within healthcare systems. HEPMA systems can influence methods of patient prioritisation if they contain functionality specific for this purpose or by creating large scale electronic data sets with which HCPs can engage, which would not have been accessible prior to implementation. Evidence of HCP engagement with HEPMA data for patient prioritisation is evident in the literature and pharmacists in particular are noted to be innovating with patient prioritisation automation and machine learning. Ethical considerations in using APP within a hospital pharmacy service are not addressed by the literature and although APP use is considered to be a pragmatic solution to target available pharmacy resource to the patients with highest pharmaceutical acuity, this study has identified ethical considerations for hospital pharmacy services to consider when implementing APP. Ethical issues with APP arise if pharmacy staff resource does not have capacity to provide pharmaceutical care to all identified high risk patients within working hours, if pharmacists use APP to prioritise patients

without professional judgement there is risk that other pertinent clinical information will not be reviewed, and staff may lose autonomy, and if APP tools are not updated to reflect current practice.

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Appendices

Appendix 1 - PROSPERO Systematic Review Submission

1. * Review title.

The impact of electronic prescribing systems with administration on healthcare professional patient prioritisation and triaging in secondary care healthcare settings: a systematic review

2. Original language title.

For reviews in languages other than English, give the title in the original language. This will be displayed with the English language title.

3. * Anticipated or actual start date.

20/03/2022

4. * Anticipated completion date.

30/04/2022

5. * Stage of review at time of this submission.

The review has not yet started: Yes

6. * Named contact.

David Clifford

Email salutation (e.g. "Dr Smith" or "Joanne") for correspondence:

Mr Clifford

7. * Named contact email.

david.clifford@strath.ac.uk

8. Named contact address

Strathclyde Institute of Pharmacy and Biomedical Sciences (Sipbs)

161 Cathedral St

Glasgow

G4 0RE

9. Named contact phone number.

Give the telephone number for the named contact, including international dialling code.

10. * Organisational affiliation of the review.

University of Strathclyde

11. * Review team members and their organisational affiliations.

Mr David Clifford. University of Strathclyde

Mr Duncan Hill. University of Strathclyde

12. * Funding sources/sponsors.

NHS Lothian and University of Strathclyde

13. * Conflicts of interest.

None

14. Collaborators.

Give the name and affiliation of any individuals or organisations who are working on the review but who are not listed as review team members. NOTE: email and country must be completed for each person, unless you are amending a published record.

15. * Review question.

What impact does electronic prescribing systems with administration have on healthcare professional patient prioritisation and triaging in secondary healthcare settings?

16. * Searches.

Searches will be completed in MEDLINE, Embase, CINAHL and The Cochrane Library for the last 10 years.

Unpublished studies will be reviewed through NHS ERD and Strathclyde SUPrimo.

No restrictions will be applied to study designs.

Both randomised control trials and observational studies will be included.

English language and full text articles will be included.

17. URL to search strategy.

Upload a file with your search strategy, or an example of a search strategy for a specific database, (including the keywords) in pdf or word format. In doing so you are consenting to the file being made publicly accessible.

Or provide a URL or link to the strategy. Do NOT provide links to your search results.

Do not make this file publicly available until the review is complete

18. * Condition or domain being studied.

Healthcare professional patient prioritisation and triaging in hospital setting.

19. * Participants/population.

The participants/population has no restriction but must be within the hospital setting.

• Inclusion: hospital setting (e.g. acute, emergency, outpatient, trauma), any stakeholder (e.g. doctor, nurse, pharmacist, manager, patient).

• Exclusion: primary care setting, community setting, care homes, home care.

20. * Intervention(s), exposure(s).

Electronic prescribing systems (with administration) implementation is the reported intervention. All types of electronic

prescribing system studies will be reviewed.

21. * Comparator(s)/control.

Studies that look at healthcare patient prioritisation and triaging based on paper medication charts or any system other than electronic prescribing with administration in the hospital setting.

22. * Types of study to be included.

No restrictions will be applied to study designs.

Both randomised control trials and observational studies will be included.

English language and full text articles will be included.

23. Context.

Studies in any hospital setting.

24. * Main outcome(s).

Studies assessing or observing the clinical and economic impact of electronic prescribing systems with administration on patient prioritisation and triaging.

25. * Additional outcome(s).

What electronic prescribing data is used to change the way in which patients are prioritised or triaged.

26. * Data extraction (selection and coding).

The studies retrieved during the searches will be screened for relevance, and those meeting the eligibility criteria will be selected for use in the review.

A second reviewer will independently assess 10% of returned articles for screening and data extraction, and if there are any conflicts between the two reviewer appraisals then a third reviewer will assess.

The following data will then be extracted from the selected studies: year, author, country, title, study aim, study design, setting, sample size, duration of study, electronic system used, comparator, population, outcome measures/main findings, limitation(s) of study.

27. * Risk of bias (quality) assessment.

A second reviewer will independently assess 10% of returned articles for screening, data extraction and quality assessment. If there are any conflicts between the two reviewer appraisals then a third reviewer will assess.

The Cochrane Collaboration’s Risk of Bias Tool (ROBINS-I) will be used to assess bias for RCTs and Newcastle-Ottawa Scale for observational studies as appropriate.

28. * Strategy for data synthesis. [3 changes]

Data for narrative synthesis review will be generated through literature database searches. Agreed search terms will be used for MEDLINE, Embase, CINAHL and The Cochrane Library. Each database will be searched for articles published in the last 10 years. Results of each database search will be combined in the Covidence platform to form a single list with any duplicate articles removed. Title and abstract of each article will be reviewed and any not applicable to the research question will be removed with reason(s) documented. Full text review will then take place and again any studies that do not fall within the inclusion criteria will be removed with reason(s) documented to form a finalised list to start formal narrative synthesis of findings. Common themes of study outcomes will be grouped and heterogeneity of studies will be assessed by an appropriate tool based on study design for quality.

29. * Analysis of subgroups or subsets.

None planned.

30. * Type and method of review.

Type of review:

Narrative synthesis

Service delivery

Systematic review

Health area of review:

Service delivery

31. Language.

English

32. * Country.

Scotland

33. Other registration details.

Name any other organisation where the systematic review title or protocol is registered (e.g. Campbell, or The Joanna Briggs Institute) together with any unique identification number assigned by them.

If extracted data will be stored and made available through a repository such as the Systematic Review Data Repository (SRDR), details and a link should be included here. If none, leave blank.

34. Reference and/or URL for published protocol.

Do not make this file publicly available until the review is complete.

35. Dissemination plans.

Do you intend to publish the review on completion?

Yes

36. Keywords.

Electronic prescribing

HEPMA

EPMA

EPA

Patient prioritisation

Patient triage

37. Details of any existing review of the same topic by the same authors.

If you are registering an update of an existing review give details of the earlier versions and include a full bibliographic reference, if available.

38. * Current review status.

Ongoing

39. Any additional information.

Provide any other information relevant to the registration of this review.

40. Details of final report/publication(s) or preprints if available.

Leave empty until publication details are available OR you have a link to a preprint (NOTE: this field is not editable for initial submission).

Appendix 2 - Search Terms

Medline	Embase	CINAHL	Cochrane
Electronic Prescribing			
electronic prescri*.mp.	electronic prescri*.mp.	(MM “Electronic Order Entry”)	e*prescrib*
e*prescri*.mp.	e*prescri*.mp.	(MM "Patient Record Systems")	electronic N0 prescrib*
CPOE.mp.	CPOE.mp.	(MM "Medical Orders"	CPOE
EPMA.mp.	EPMA.mp.	(MM "Electronic Health Records")	EPMA
HEPMA.mp.	HEPMA.mp.	e*prescri*	HEPMA
ePA.mp.	ePA.mp.	electronic prescri*	EPA
medical order entry system*.mp.	medical order entry system*.mp.	CPOE	medical N0 order N0 entry N0 system*
(electronic prescri* and medic* administration system).mp.	(electronic prescri* and medic* administration system).mp.	EPMA	computeri*ed N0 physician N0 order N0 entr*
		HEPMA	electronic N0 prescr* N0 and N0 medic* N0 administration N0
		ePA	

		Medical order entry system	
		computeri*ed physician order entr*	
		electronic prescri* and medic* administration system	
Healthcare Professional			
healthcare professional*.mp.	healthcare professional*.mp.	(MH "Health Personnel")	healthcare N1 professional*
health professional*.mp.	health professional*.mp.	healthcare professional*	health N1 professional*
healthcare personnel.mp.	healthcare personnel.mp.	health professional*	healthcare N1 personnel
health personnel.mp. or Health Personnel/	health personnel.mp. or Health Personnel/	healthcare personnel	health N1 personnel
pharmacist*.mp.	pharmacist*.mp.	health personnel	pharmacist*
Pharmacy/	Pharmacy/	pharmacist*	pharmacy N1 doctor*
doctor*.mp.	doctor*.mp.	pharmacy	clinician*
clinician*.mp.	clinician*.mp.	doctor*	physician*
physician*.mp.	physician*.mp.	clinician*	hospital N1 medical N1 staff
Medical Staff, Hospital/	Medical Staff, Hospital/	physician*	nurs*

nurs*.mp.	nurs*.mp.	hospital medical staff	hospital N1 nursing N1 staff
Nursing Staff, Hospital/	Nursing Staff, Hospital/	Nurs*	registered N0 nurse*
Registered nurse*	Registered nurse*	hospital nursing staff	
		registered nurse*	
Healthcare Setting			
inpatient*.mp.	inpatient*.mp.	(MH "Inpatients")	inpatient*
hospitalised patient*.mp.	hospitalised patient*.mp.	inpatient*	hospitali*ed N2 patient*
hospital patient.mp.	hospital patient.mp.	hospitali*ed patient*	hospital N2 patient
hospital.mp	hospital.mp	hospital patient*	hospital
infirmary.mp.	infirmary.mp.	hospital	infirmary
secondary care.mp	secondary care.mp	infirmary	secondary N0 care
(accident and emergency).mp.	(accident and emergency).mp.	Secondary care	accident N0 and N0 emergency
emergency room.mp.	emergency room.mp.	(accident and emergency)	emergency N0 room
		Emergency room	

Appendix 3 - Methodological Quality Criteria

Part I: Mixed Methods Appraisal Tool (MMAT), version 2018

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
	Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5 Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				
	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

Reporting the results of the MMAT (version 2018)

In the version 2018, we advised not to present an overall score. This decision was made from the literature that discouraged to use metrics because it is not informative. By presenting a single number, it is not possible to know what aspects of studies are problematic. We often see people presenting a global score and nothing else in the results or discussion or description of included studies. This often raises the question of why quality appraisal was performed.

This suggestion is, however, problematic for reporting the results of the MMAT. Several MMAT users have contacted us for advice to report their results. If there is a need to report an overall score, here is a suggestion based on the previous version of the MMAT:

For each retained study, an overall quality score may not be informative (in comparison to a descriptive summary using MMAT criteria), but might be calculated using the MMAT. Since there are only a few criteria for each domain, the score can be presented using descriptors such as stars (*) or %:

5***** or 100% quality criteria met
4 **** or 80% quality criteria met
3 *** or 60% quality criteria met
2 ** or 40% quality criteria met
1 * or 20% quality criteria met

For mixed methods studies, since there are 15 criteria to rate (instead of 5), the premise is that the overall quality of a combination cannot exceed the quality of its weakest component. Thus, the overall quality score is the lowest score of the study components. The score is 20% (*) when QUAL=1 or QUAN=1 or MM=1; it is 40% (**) when QUAL=2 or QUAN=2 or MM=2; it is 60% (***) when QUAL=3 or QUAN=3 or MM=3; it is 80% (****) when QUAL=4 and QUAN=4 and MM=4, and it is 100% (*****) when QUAL=5 or QUAN=5 or MM=5; (QUAL being the score of the qualitative component; QUAN the score of the quantitative component; and MM the score of the mixed methods component).

Regarding questions on cut off value, we have not studied values that could characterize low, medium or high quality studies. The categories are arbitrary, but useful for performing qualitative or quantitative sensitivity analysis. We have seen some papers with 2 categories (lower vs higher quality) or 3 categories (e.g., low, medium, and high). What is important is to clearly describe how the results of the appraisal were interpreted and used in the review (transparency).

Appendix 4 - Focus Group Participant Information Sheet

Participant Information Sheet for Focus Group

Name of department: NHS Lothian Pharmacy and Medicines Service
Title of the study: Hospital pharmacist views on the professional ethical considerations of using automated patient prioritisation tools with a HEPMA system

IRAS Project ID: 345885

Introduction
This project is part of a postgraduate MPhil qualification, sponsored by the University of Strathclyde. In addition to my NHS contact details, I can be contacted via university-mail at david.clifford@strath.ac.uk.

What is the purpose of this research?
To explore pharmacist opinion on the professional ethical considerations of using an automated patient prioritisation tool in a hospital pharmacy service and describe what these are.

Do you have to take part?
No. Participation in this project is voluntary, it is your decision if you would like to take part. Refusal to participate or withdrawal is your right if you wish to do so without detriment. Please note that data cannot be withdrawn after pseudo-anonymisation.

What will you do in the project?
If you consent to take part in this project you will be invited to attend a 30 minute (Microsoft teams) briefing session on an automated patient prioritisation tool in which you can clarify your understanding of function, followed by a separate 1 hour (in person) focus group within an NHS Lothian Edinburgh location. Briefing session will be held one week prior to the focus group. During the focus group of up to 6 people, you will be asked to give your views and opinions on the questions posed to the group and resulting discussion points.

Why have you been invited to take part?
You have been chosen to participate in this project in your capacity as a hospital pharmacist with responsibility for providing inpatient pharmaceutical care and/or management responsibility for inpatient clinical pharmacy teams.

What information is being collected in the project?
Basic participant demographic information will be collected for all focus group attendees to inform result analysis; any information you do not wish to provide can be omitted. Focus group discussion will be audio recorded, transcribed and analysed for themes. The audio recording transcription will be carried out by the focus group facilitator (David Clifford) with transcription checking by the second

focus group moderator. Participants will be numbered within the transcript so they cannot be identified, any direct quote used in the project write up will be anonymous.

What are the possible disadvantages of taking part?
Time commitment to attend both the briefing session and focus group. Focus group discussion may result in personal experiences being shared so there is therefore risk of psychological harm.

Who will have access to the information?
All participant information will be electronically stored securely and pseudo-anonymised. Potentially identifiable data disclosed during the focus group will not be transcribed. Only the focus group moderator and assistant moderator will have access to the focus group recording data.

Where will the information be stored and how long will it be kept for?
Project forms and data will be electronically stored on a secured NHS shared drive with access limited to the focus group facilitator (David Clifford) and second moderator for validation. After data transcription, pseudo-anonymised focus group transcripts will be deleted from the NHS shared drive and transferred to a secure University of Strathclyde drive with access limited to David Clifford. Upon project completion, all project data will be deleted from secure drives and pseudo-anonymised transcripts will be uploaded to the University of Strathclyde research data repository.

Thank you for reading this information – please ask any questions if you are unsure about what is written here.

What happens next?
If after reading you would like to participate in this project then please contact the project lead at david.clifford@nhslothian.scot.nhs.uk. The project lead will get in touch and ask you to complete a consent form before inviting you to attend a focus group. Prior to focus group attendance you will be provided with a clinical vignette (clinical scenario) on the proposed automated patient prioritisation tool for use in NHS Lothian. A copy of the final project write up can be provided upon request and the aim is to publish results.

If you do not wish to participate in this project, thank you for the time and consideration in reading.

Researcher contact details:
David Clifford david.clifford@strath.ac.uk

Chief Investigator details:
Marion Bennie marion.bennie@strath.ac.uk

This research was granted ethical approval by the SIPBS Ethics Committee.

If you have any questions/concerns, during or after the research, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the SIPBS Department Ethics Committee
University of Strathclyde
161 Cathedral Street
Glasgow
G4 0RE

Telephone: 0141 548 2125
Email: sipbs-ethics@strath.ac.uk

Consent Form for Focus Group

Name of department: NHS Lothian Pharmacy and Medicines Service
Title of the study: Hospital pharmacist views on professional ethical considerations of using automated patient prioritisation tools with a HEPMA system

- I confirm that I have read and understood the Participant Information Sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, up to the point of completion, without having to give a reason and without any consequences.
- I understand that I can request the withdrawal of my basic demographic information from the study and that whenever possible researchers will comply with my request.
- I understand that pseudo-anonymised data (i.e. data that do not identify me personally) cannot be withdrawn once they have been included in the study.
- I understand that any information discussed in the focus groups recorded in the research will remain confidential and no information that identifies me will be made publicly available.
- I understand that I must not share any of the focus group discussion with anyone that was not a participant.
- I consent to being a participant in the project.
- I consent to being audio recorded as part of the project.

(PRINT NAME)	
Signature of Participant:	Date:

Appendix 5 - Focus Group Participant Demographic Information

Focus Group Participant Demographic Information

1. What is your gender?
    - Female ☐
    - Male ☐
    - Other ☐ _____
    - Prefer not to say ☐

2. What is your age?
    - 20-29yrs ☐
    - 30-39yrs ☐
    - 40-49yrs ☐
    - 50-59yrs ☐
    - >60yrs ☐

3. Do you provide clinical care to inpatients on a hospital ward?
    - Yes ☐
    - No ☐

4. If you answered yes to the above, how many wards do you provide a clinical pharmacy service to in a day?

5. What is your NHS job band?

    - 6 ☐
    - 7 ☐
    - 8a ☐
    - 8b ☐
    - 8c ☐

6. Do you have managerial responsibility for a clinical pharmacy service?

    - Yes ☐
    - No ☐

7. How long (in years) have you been in your current role?

8. Are you in a full time or part time position?

    - Full time ☐
    - Part time ☐

Appendix 6 - Focus Group Clinical Vignette

Clinical Vignette

This clinical scenario is to be read in advance of focus group attendance. During the focus group, you will be asked questions based on the CoRE-Values ethical framework to prompt discussion around the use of automated patient prioritisation tool use with a Hospital Electronic Prescribing and Medicines Administration (HEPMA) system as described in the scenario below.

The CoRE-Values framework comprises of four domains:

***Co*:**	=	*Co*des (i.e. codes of professional conduct)
***R*:**	=	*R*egulations (i.e. the law, and any other stringent policies that dictate appropriate action)
***E*:**	=	*E*thical Principles
Values:	=	*Values* (i.e. the personal/moral/institutional values, beliefs or ideologies of the key stakeholders)

Please familiarise yourself with the GPhC Standards for Pharmacy Professionals prior to the focus group, which can be found here: standards_for_pharmacy_professionals_may_2017_0.pdf (pharmacyregulation.org).

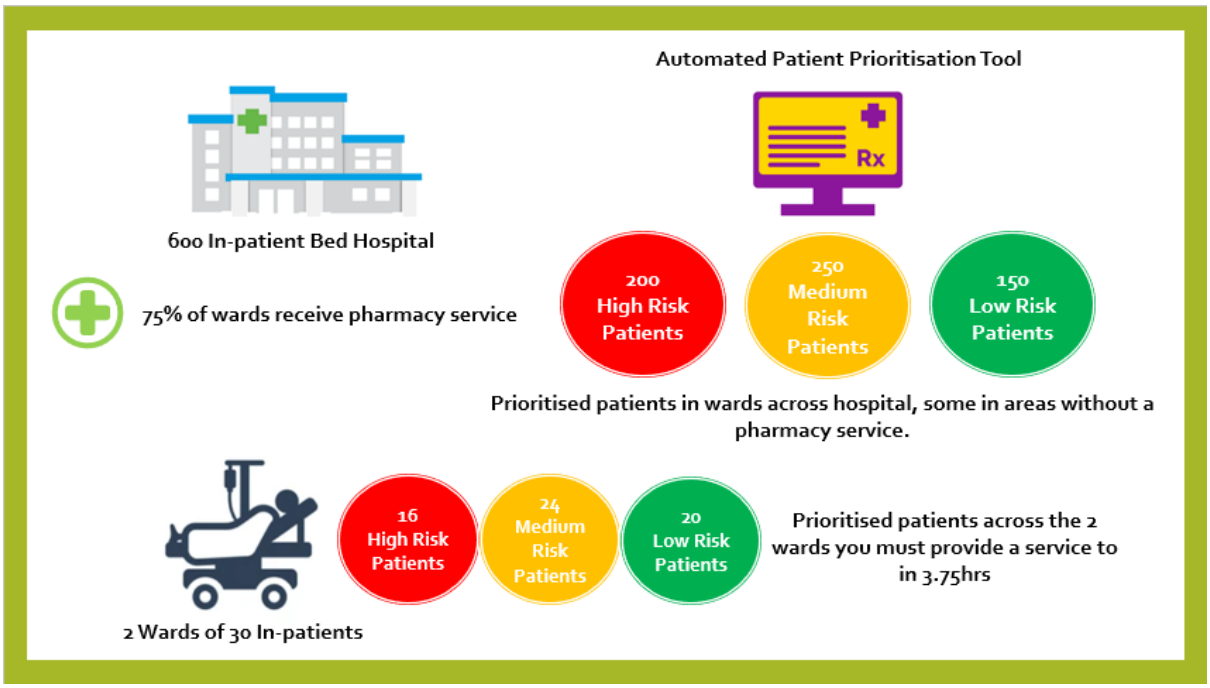
The automated patient prioritisation tool included within this scenario is described in the briefing session.

Scenario

- It is a Monday morning, the pharmacy patient prioritisation tool is automatically updated for a hospital of 600 inpatients. In this hospital, 75% of inpatient wards receive a routine clinical pharmacy service.

- The patient prioritisation tool displays 200 high-risk patients across the hospital, some in wards without a clinical pharmacy service. The tool also highlights 250 medium risk patients and 150 low risk patients.

- As a ward pharmacist, you have 1 session (3.75hrs) to cover two wards of 30 inpatients that have 16 high-risk patients identified, 24 medium risk and 20 low risk.



Appendix 7 - Focus Group Topic Guide

Focus Group Topic Guide

Lead investigator to confirm all participants attended mandatory briefing session as well as completing the consent and demographic forms prior to focus group.

The aim of this focus group is to explore your views on ethical considerations in using an automated patient prioritisation tool with a HEPMA system.

Thank you for agreeing to participate in this focus group today. Please be aware that after this meeting, participant data will not be able to be withdrawn but all data will be anonymised.

Is everyone still happy to proceed?

Today's focus group will be audio recorded. Does anyone have any questions before we begin the recording?

Activity	Time (mins)
Introduction	**5**
• Introduce self. • Brief rationale for focus group: part of MPhil project. • Ask participants to introduce themselves by providing their first names and clinical practice area.	
Focus Group Agreements	**2.5**
• No right or wrong answers. • Feel free to confidently speak your thoughts, listen to others with attention and please be respectful of each other. • This is a safe space to provide your opinions. Anything you say within the focus group will be treated confidentially.	
Questions for Discussion	**50**
CoRE-Values Framework	

Domain 1 **Co**des of Professional Conduct • What are the potential concerns (if any) in using automated patient prioritisation as described in the vignette with respect to the General Pharmaceutical Council (GPhC) Standards for Pharmacy Professionals? Domain 2 **R**egulations • What (if any) conflicts are there with law or NHS policy in using the automated patient prioritisation tool? Domain 3 **E**thical Principles • Justice – What is the impact of using an automated patient prioritisation tool on the fairness and equity of the delivery of pharmaceutical care. • Beneficence – How do you think provision of benefit is applied by using automated prioritisation in the vignette. • Non-maleficence – How would harm be avoided by using automated patient prioritisation in the vignette? • Autonomy – What impact does automated patient prioritisation have on the ability of hospital pharmacists to make reasoned choices? • Utility – How do you think automated patient prioritisation balances the needs of high risk to low risk patients in the vignette? Domain 4 **Values** • What are your personal concerns (if any) as a health professional in using an automated patient prioritisation tool as described in the vignette?	
Closing	
• Thank everyone for participating in focus group. • Explain that participants can contact the lead investigator for any updates.	**2.5**