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Digital, Data and AI Solutions in Pharmacy

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Digital, Data and AI Solutions in Pharmacy

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"There is very little that we do in life that isn't supported by a digital intervention – from the coffee we make in the morning, the pills we take for a headache, to the social spaces we travel to and frequent. More and more this ethos of scale applies to pharmacy in creating our medicines, treating patients and delivering our services. Now is the time to share what we do and learn from one another. There are excellent examples of digital solutions that allow pharmacy teams to operate efficiently and effectively to respond to patients' needs. This is why a journal special issue focusing on digital innovation is so important. We aim to create a repository of great examples of innovation in data collation, analysis, technological developments, practice enhancement and more. We know that pharmacy teams embrace digital in all its forms, so tell us what you do!"

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"With the plethora of opportunities available to exploit the use of technologies to meet demands within the pharmacy world, this journal special issue will provide readers with examples of great practice currently being undertaken as well as ideas for future implementation. Whether your area of interest is workforce education and training, service delivery or drug development, your insights on the digital landscape will certainly be valuable to share with the rest of the profession!"

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Digital transformation within the NHS continues at an exponential rate. The adoption of digital technologies within any organisation brings many benefits – efficiencies, accuracy, data access and transparency but also comes with considerations – infrastructure investment, skilled human resources, connectivity, inter-operability and so much more. Key policies e.g.,[1,2,3] argue for greater engagement with digital solutions to transform services delivering effective and personal care for patients, enhance digital literacy, design educational curricula, workforce training and development and empowering patients. Digital transformation of health and social care is a top priority for the Department of Health and Social Care (DHSC) and NHS England (NHSE) and in 2022 the government pledged £2 billion to digitise the NHS.[4] The workforce requirements for the NHS from 2020-2030 were projected in results released in 2021. The findings indicated that to deliver to the digital ambitions of the NHS, a significant increase in staffing is required, with specialists in key areas required e.g., Clinical Informatics.[5]

Our adoption of technology to support personalised care, service design and delivery, medicines access and research, indicates its value to our healthcare ecosystem and all stakeholders within. Transformation programmes throughout our NHS trusts and primary care are built on dedicated digital platforms. The introduction of technology comes at a price and with responsibility. Wanting to improve patient care and service provision must be balanced with environmental agendas (considering the contribution of technology to the NHS carbon footprint), social inclusion (ensuring that digital solutions are accessible, equitable and do not widen digital gaps) and business viability (ensuring that the service can be delivered in an efficient, safe and dependable manner on a continuous basis).

Striving to create an inclusive pharmacy professional practice is at the heart of what we do to care for patients and the public.[6] Use of NHS websites and digital applications in the UK grew substantially between 2020-2021, with 10 million more users engaging with this technology.[7] Not all groups can easily access solutions such as these with some groups at higher risk of exclusion than others.[8] Technology can support this agenda but can also undermine it if not managed effectively. Patients are more confident in the main with exploring new technologies and integrating them into their healthcare, but these digital offerings should be paired with opportunities for in-person engagement, designing services optimising technological and human capabilities.

The application of Artificial Intelligence (AI) in pharmacy practice and wider health and social care is both equally inspiring and concerning. We've seen its adoption in other walks of life e.g., the prediction of dust storms which cause economic hardships damaging farms and property, whilst simultaneously increasing cardiovascular diseases and respiratory problems.[9] How is and can it be used to inform pharmacy service design and delivery, and pharmacy practice research? Research shows that AI can be used to design an algorithm to optimise the medication review process in a *comprehensive, personalised and scalable way.*[10] Polypharmacy and patient management of their medicines can be incredibly complex and challenging for patients, so such innovative insights are a welcome addition to research and practice.

The rise of online consultations, virtual wards, and remote monitoring of patients through initiatives such as NHS @home[11] emphasise the importance for pharmacy teams to keep up to date with new technologies to provide high quality care. This has been recognised by the GPhC in their latest Initial Education and Training standards for pharmacists[12] which list the use of data and technologies as mandatory skills for pharmacists-to-be. The introduction of digital solutions to support educational delivery has also transformed how and what we teach current and aspiring professionals. This applies equally to assessment. The rapid conversion of in-person to virtual activity occurred during the COVID pandemic and fast-tracked innovation in this field. The innovative delivery of Objective Structured Clinical Examination (OSCEs) by virtual means is an excellent example of this.[13]

This collection was inspired by the need to know more about the excellent digital solutions we use in practice across the UK. We are pleased to have examples of research activity and practice innovation from hospital and primary care and opinion articles from experts in the pharmacy practice field.

We introduce our collection of works with a personal piece from Rahul Singhal, the Chief Pharmacy & Medicines Information Officer, NHS England. Rahul share's his views on the current thinking and practice of AI adoption and calls out to the profession to advance our knowledge and confidence with these technologies through research and practice agendas.

The concept of exactly what Artificial Intelligence (AI) is, what training and infrastructure is needed to support its adoption in pharmacy, and what its associated benefits and ethical challenges are, still remain more 'black box' than 'open book'. How AI can be integrated into pharmacy practice and what the antecedents should be in place to best support this are aired in articles delivered by Stephen Goundrey-Smith and Benedict Brown.

Skills development within our workforce is a must and unfortunately in times of austerity training can be overlooked. The importance of digital skills development and education for both staff and patients are outlined. In their article, Rona Honnet, Helen Barclay and Stewart Sheehan describe the development of an electronic management system for technician-led education for patients commenced on oral anticoagulants and latterly developed to encompass other high-risk medicines. Gaining qualitative insights into how digital skills development is approached and delivered within the workplace and how technology is factored into this process is presented by Angela Burgin in this collection of works.

The sharing of practice-based developments facilitated by new technologies is always of interest to the pharmacy profession and wider healthcare partners. Equally, solutions which improve clarity and quality of information at the point of discharge offers insights which are innately transferable. Such insights are provided by Rona Honnet and Helen Barclay in their article 'Impact of the Introduction of the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system on the quality of interim discharge letters at a district general hospital'. How technology can support more preventative healthcare interventions such as testing, screening and diagnosis through point of care cholesterol testing (POCT) is examined in Pei-Theng Aizlewood's article. The growth of care provision closer to home through digital remote monitoring is the focus of Reena Patel and Marsha Showman's article, showcasing the Luscii application.

How we manage the introduction and adoption of technology into healthcare settings is an area explored by Adam Sutherland and Sara Arenas-Lopez in their article, focusing on this issue from a sociotechnical perspective. In their study the authors remind us of the role technology can play in improving processes, patient safety and reduced medication administration errors.

We would like to thank the authors of these articles. Their efforts have led to the development of this useful repository. There are noticeable key areas of interest for pharmacy and healthcare professionals from a practice, research, and educational perspective. Our thanks are extended to the reviewers who supported this Special Issue sharing years of professional wisdom in their comments. Gratitude is also directed to the Pharmacy Management Healthcare Journal for agreeing to showcase this Special Issue in their journal and the editorial team for managing this process so effectively.

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AI with Medicines Data – a Personal Reflection

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I am not writing this as a subject matter expert in Artificial Intelligence or its application within healthcare, in particular pharmacy practice. Nor am I able to credibly predict all of its potential use cases within the context of the NHS. I suspect that this is true for most of the readers and what has drawn you to this special issue.

In my current role I have the responsibility for leading the adoption of the appropriate technology and the use of medicines data to improve productivity, safety, and patient experience. It is within this context that I have a growing interest in understanding the current and future applications of AI within healthcare. When I speak to professionals and policymakers about AI, there is sense of curiosity, coupled with feelings of optimism and scepticism. I think the curiosity comes from the genuine desire of individuals to continuously improve and learn and optimism because people are excited by the application of AI building on current technological innovations. The scepticism could be from a limited understanding of AI and the routes by it can safely be adopted into current ways of working. In addition, there is general 'fatigue' acknowledging the energy absorbed to digitally transform elements of the NHS.

It is important to note that the NHS has been and continues to be on a journey of digital transformation. One could argue that with continuous advancements in technology this work will never be complete – is digital transformation in the NHS a never-ending story? Over the past two decades there has been a real focus on 'levelling up', we improve the digital maturity of respective parts of the service, in order to digitise processes to improve productivity and safety. A key initiative in all of this is the implementation of Electronic Patient Records across the NHS, which can be seen as a foundation for a digital health system.

In the same period, there has been increasing digital maturity of the processes involved in managing medicines from procurement, prescribing, dispensing through to administration. This has been enabled by adoption of digital systems, but also the standardisation of medicines terminologies and standards by which medicines information should be structured in and between systems. It is this level of maturity that has been achieved over the years, which gives us an advantage in being able to consider the applications of AI, using structured medicines data in order to potentially improve care.

> "The NHS has indeed identified Artificial Intelligence (AI) as a key technology in its Long-Term Plan (2019). The NHS has already begun to implement AI in various areas, including, genomics and patient monitoring, and is exploring further applications in areas such as e-prescribing."

Some potential areas where we could see the adoption and continuity of AI using medicines data are to:

- Generate personalised medication treatment recommendations based on medical history, genomic profile, and lifestyle factors.
- Provide real-time clinical decision support to healthcare providers, including targeted drug interactions, medication adherence and clinical practice guidelines.
- Use of machine learning algorithms to analyse large volumes of patient data to, for example, predict future healthcare trends, such as disease outbreaks and population level health inequalities through medication usage patterns.
- Implement digital prescription screening in the dispensing process to review prescriptions for potential errors, and flag issues to pharmacy teams.
- AI can also be used to improve inventory management, predicting stock usage and trends through machine learning.

I suspect, because of the opportunity that could be offered by AI, that these use cases are limited and dated at the time of writing.

> "Like all technology – technology in itself has no value. The value is only derived from the considered design and application of the technology in the appropriate context."

I would encourage pharmacy professionals to engage in research and professional practice to grow the experience and knowledge base in this critical area. Over the next decade it will be important to approach this with positive curiosity. In doing so we can approach the adoption of AI in healthcare in a clinically safe, ethical, legal, and regulatory compliant manner – whilst maintaining the 'human-face' that patients value in the delivery of care.

Artificial Intelligence in Pharmacy and the Pharmaceutical Industry – Opportunities and Ethics

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Overview

Artificial intelligence (AI) has a growing role in society, with applications in many sectors, including healthcare. AI systems are able to undertake more sophisticated tasks than traditional computer systems have been able to do, and therefore have the potential to extend the use of automated systems into areas of work that have traditionally been done by human beings. Consequently, AI systems present great opportunities for automating many services in an intuitive way and improving efficiency and accuracy of processes.

In theory, AI systems in healthcare should be able to improve clinical outcomes for patients, but experience with such systems is still limited, and robust outcomes data are not yet available. Moreover, AI systems are associated with significant ethical questions, such as whether system alerts can be trusted, whether an AI system is equivalent to a human worker, and whether AI systems will ensure fair distribution of resources and equitable treatment of service users/citizens.

If AI-based systems are not implemented appropriately, there is a risk of reputational damage to the industry, as well as possible medicolegal and financial implications. There is considerable media speculation about the role of AI in society at present, and this article will describe some of the potential applications of AI in pharmacy and the pharmaceutical industry, and discuss some of the ethical issues and the risks associated with AI in the sector.

What is AI?

Simply put, artificial intelligence may be defined as 'a machine's ability to perform the cognitive functions we usually associate with human minds.'[1] AI includes *machine learning* systems that use algorithms for sophisticated data processing, where the algorithms are trained on data to make them more accurate. AI also includes *deep learning* systems that can process a range of data types (including images) and perform complex analysis using iterative processing. AI systems may be *deliberative* – they process data to make decisions – or *generative* – they generate content (for example, ChatGPT). In both cases, such systems are able to mimic human intelligence – perception, reasoning, creativity – and are capable of self-learning.

AI systems are therefore good at performing tasks that require human intelligence – rather than those that are strictly heuristic (rule-based) – but which might be boring or repetitive. AI systems therefore have the potential to transform work and culture in more profound ways than current digital systems, and this may have many positive effects.

AI in the Pharmaceutical Sector – Opportunities

The use of AI in pharmacy practice is briefly mentioned in the Royal Pharmaceutical Society report, *Pharmacy 2030: A Professional Vision.*[2] The report indicates that AI 'has potential in predicting

outcomes, targeting intervention and decision support.' Moreover, the recent ABPI report, *Evolution of an Innovation-Based Biopharmaceutical Industry: How Skill Requirements are Changing,* has highlighted the importance of AI for intuitive data analytics, and the need for people with skills in this area[3] which would be relevant for various areas of the pharmaceutical industry – drug discovery, clinical trials management and market analysis.

"However, at present although there has been much work on AI in clinical diagnostics, much of the available literature on AI applications in pharmacy and the pharmaceutical industry is either hypothetical – describing potential uses of AI, rather than actual experience – or is not specific to any one particular area of the pharmacy and pharmaceutical industry sectors. Nevertheless, there are potentially various applications for AI in the pharmaceutical sector, which will be described here."

AI systems have considerable potential for improving good practice in medicines safety and use.[4] AI is already being used in pharmacy practice, and indeed in other electronic systems in healthcare, for clinical decision support – alerting for drug interactions and contraindications, for example.[5] The beneficial effects of well-designed electronic prescribing systems on medicines error rates are well established,[6] and an AI system has a potential advantage over current systems because it is intuitive and self-learning.

With traditional rule-based (heuristic) computer systems, alerts provided are often unsophisticated and excessive in number, leading to 'warning fatigue',[7] and are based on a finite knowledge base which requires updating.[8] By contrast, a self-learning AI system can be trained on data from previous decisions, so it can make fewer, but more accurate, automated decisions for routine situations.[9] This will ensure that clinicians are presented with fewer spurious alerts, that the alerts presented are highly relevant to the clinical scenario, and will guide the clinician's professional decision-making, in order to contribute to the optimum patient outcome. In addition, Kostic et al note the capacity of AI systems to make professional decisions without subjectivity, or being affected by fatigue.[10] For this reason, these authors envisage AI systems replacing healthcare professionals in some scenarios.

In theory, AI systems have the potential to improve both treatment outcomes and overall health outcomes for patients.[11] They are likely to achieve this either by improving diagnosis rates, and therefore ensuring higher rates of appropriate therapy initiation, or by enabling more personalised care through predictive modelling. Various authors note the potential of AI systems to provide personalised care,[12] because such systems can take into account a much wider range of patient factors than clinical systems to date have been able to do. Validation studies have been conducted on the predictive capabilities of AI systems for all-cause mortality, hospital stay times, and readmission, as well as specific clinical scenarios such as sepsis, dementia, *Clostridium difficile* infection and post-chemotherapy mortality.[13] However, due to limited experience with AI systems, actual data on the impact of such systems on patient outcomes are limited.

Moreover, AI systems have potential for supporting specific pharmacy activities, such as prescribing review to reduce polypharmacy,[14] patient monitoring with biosensors,[15] disease modelling and diagnostics,[16] facilitating joined-up patient-centred services where there is collaboration between different systems and databases,[17] and provision of information/educational content for patients.[18]

The following are areas where AI could have a significant impact:

In community pharmacy:

1. Screening patient records in the community pharmacy for candidates for proactive provision of patient-focused pharmacy services (for example, vaccinations or screening).

2. Provision of support for professional decision-making within community pharmacy services – for example, patient assessment/scoring algorithms in the Pharmacy Blood Pressure Check Service or Pharmacy Contraception Service, or within the Pharmacy First clinical pathways.

In primary care:

3. Analysis of prescribing histories for specific prescribing/medicines use patterns (substitutions, dose changes etc.) to monitor good medicine use, and to ensure cost-effective use of medicines, and appropriate treatment pathways.

4. Providing automated analysis of patient monitoring results in long-term conditions – e.g. asthma and diabetes.

5. Provision of medicines adherence monitoring.

In the pharmaceutical industry:

6. In pharmaceutical marketing, provide highly differentiated and targeted promotional and marketing communications, at the same time ensuring regulatory and PMCPA compliance.

7. In clinical trials, to provide intuitive data analysis, and enable the extraction of robust, 'real-world' data from trial data to support licensing of new indications.

8. In medical affairs/medical marketing, to process a range of evidence sources of different types to develop high-quality value propositions or clinical impact assessments.

9. Generation of textual, graphic or avatar-based health education.

These possible applications could be aligned with processes that are already established for those areas of activity, which would enable greater accuracy and efficiency in these areas. Furthermore, the above list is by no means exhaustive.

AI in the Pharmaceutical Sector – Ethical Considerations

Nevertheless, the use of AI systems in pharmacy and healthcare applications is associated with various ethical issues. These include 1) the trustworthiness of the system, 2) whether the intelligent system can truly act like a human being, 3) privacy and disclosure of personal information, and 4) whether AI systems treat individual users, or data subjects, equally. These issues are discussed here.

1. Trustworthiness of the AI System

As mentioned previously, the use of computer systems for clinical decision support in healthcare is well-established and, in this scenario, it is important that the healthcare professional using the system can trust the decision support advice offered by the system. This is especially the case in healthcare because, a) the clinical decision may have life-or-death implications and, b) from a medicolegal perspective, the (human) clinician remains responsible for professional decision-making within a service, and this provides assurance to patients and service-users.

AI is already being used in community pharmacy practice for professional decision support.[19] However, as AI systems become more sophisticated, and formulate more complex clinical decisions, particularly from third party data feeds, it will be increasingly difficult to determine how the system reached its decision, and the system will become what is often referred to as 'a black box.' In future, it will therefore be more necessary for professionals to trust the decisions made by AI systems. This is an important ethical issue because the extent to which the professional trusts the AI system will determine their own decision-making, and their ability to act in the patient's best interests.

However, the concept of trustworthiness needs to be examined closely in relation to AI systems. Jones et al note that trustworthiness is more than simply accuracy or reliability, but encompasses the relational concepts of commitment to a task, and the acknowledged competency of the decision-making agency to do it.[20] While clinicians, as scientists, are interested solely in accuracy, legal decisions on medical negligence issues are usually based on commitment and competency – whether the clinician has acted as any reasonable clinician would do. Clinicians are understandably concerned about their potential liability in relation to the accuracy of AI systems. However, unless the alert is clearly inaccurate, the clinician may be in a better position legally if they accept the alert of an AI system, rather than override it, because it is a reflection of their professional competence and commitment to use the best techniques available.

Another issue relating to the trustworthiness of the system is how controllable it is by the human user. If AI systems begin to act autonomously, rather than just provide decision support for the action of the human healthcare professional, then service managers would want to be sure that the system will act in a way that is consistent with best practice and provide the best health outcomes for service users. To assure trustworthiness of an AI system, managers would need to consider the contextual constraints of how the system is implemented, and the quality assurance procedures they would need to have in place.

2. Whether the AI system can truly act like a human being

Since Alan Turing published his seminal paper, 'Computing Machinery and Intelligence', in 1950,[21] commentators have speculated whether computers can truly resemble human beings in their 'thought' processes. It is generally accepted that AI systems are able to mimic human intelligence more closely than traditional rule-based computer systems. As well as logical reasoning, AI systems have a greater capacity for semantic perception and creativity, and can function in more indeterminate situations, Crucially, AI systems are capable of self-learning and so, in the clinical situation, are able to make decisions based on 'experience' of previous clinical data. AI systems have been demonstrated to be as accurate, if not more so, than a human clinician when used for clinical diagnosis in some specialties – for example, in radiology, where 'deep learning' processes are used to analyse images.[22]

However, while AI systems are able to resemble humans in terms of creative and logical reasoning, the flaw with such systems is in their non-deliberative communications with humans – that is, everyday discussion not related to decision-making. It is often supposed that AI systems can be used for direct patient care, in e-consultations and avatar-based care assistants. However, many philosophers and cyberneticists believe that AI systems are unable to express true empathy with a human user and that there is an element of 'cognitive vulnerability' missing. In relation to AI applications in clinical medicine, Montemayor and colleagues argue that AI empathy is either impossible or unethical.[23]

They argue that AI empathy is impossible – computers cannot generate empathy heuristically because empathy relies on an imaginative component for it to be adequate in sensitive relational situations. Moreover, they argue that artificial empathy would, in fact, be unethical in a clinical encounter because it would mislead the vulnerable patient into assuming that the AI system had true empathy. Consequently, the best ethical approach for the use of AI systems in healthcare would be to disclose to patients/service users *how* the AI system was being used to support their care. An analogous approach is being taken in education.

3. Privacy and disclosure of personal information

Under Data Protection legislation, any sensitive information about a person, which would include medical information, is regarded as personal data. In the last fifteen years, the information governance agenda has developed in healthcare to ensure that digital systems used by health services adequately safeguard personal medical information and prevent inadvertent disclosure. This is an important ethical issue because inadvertent or unauthorised disclosure of personal information constitutes a breach of confidentiality which affects the patient-professional relationship, and may also lead to disbenefits to the subject – for example, stigmatisation or increased insurance premiums.

Privacy is, of course, an issue with current rule-based computer use in healthcare, and relates to two key scenarios – appropriate access to patient information by health professionals to support care, and the use of anonymised patient data for research purposes. However, there are additional risks relating to privacy if AI systems are being used that are processing data autonomously – i.e. making decisions about the storage, use and transfer of data independently of the human operator – especially if they are connected to diffuse internet-based systems that enable wide dissemination. For example, one scenario is that a system could disclose a person's information to support their care, but in a way that did not reflect the subject's wishes. This might be a particular problem with sensitive scenarios such as, for example, HIV status or gender alignment. A second scenario would be if a person with a rare disease was inadvertently de-anonymised through an AI data analysis process for a clinical trial.

"With AI systems, privacy planning will be vital to ensure that, where applicable, subject consent covers all potential aspects of the service, and that system processes are appropriately aligned to legal requirements and professional standards of confidentiality."

4. Do AI systems treat users or subjects equally?

With the current emphasis on diversity and inclusion in western societies, it is important that all citizens receive equitable healthcare. Unfortunately, it is possible that the use of AI systems can introduce inequality between system users or data subjects. The capacity for system algorithms to lead to implicit bias has been seen with AI systems used by recruitment agencies to select people to be matched to job opportunities, and a similar situation can apply for systems providing screening for diseases or automated online healthcare services. For example, the potential for systemic racism with healthcare management systems has been noted;[24] meaning that systems may discriminate against people of colour simply because of the way their algorithms work.

It is important to note that this bias is about the process, rather than the outcomes, so it may not be transparent, and may be hard to detect from the system outcomes, or from the system's normal operation from the user's perspective. The bias is therefore implicit, rather than explicit. Furthermore, there is evidence in studies of algorithmic equity in AI systems, that true equity in healthcare is more than about just distribution of resources – Giovanola and Tirrabelli note that it also requires a socio-relational dimension.[25] I would suggest that this socio-relational dimension is needed in the healthcare context to ensure that people are treated equally, yet at the same time receive appropriately personalised care. In order to ensure that AI systems treat populations equitably, implementers need to examine the processes of the system, and the assumptions they make, and again ensure that quality assurance testing of algorithms is as robust as it can be.

Conclusion

Appropriate AI systems, which complement human professional activity rather than replace it, have potential to offer great benefits in the development and marketing of medicines, their use in the clinical setting, and can add value to medicines-related activities in a way that is not possible with current, conventional digital systems. Nevertheless, healthcare professionals remain ultimately responsible in law for all professional decisions in the pharmacy, whether they are made by AI-systems, by human actors or are composite decisions.

At present, however, a significant amount of the literature on AI systems in pharmacy and the pharmaceutical industry is hypothetical rather than empirical, although there are various studies on specific applications in clinical diagnostics. Moreover, there is no detailed guidance at present on AI in pharmacy, although the Royal Pharmaceutical

Society, the professional body for pharmacists, is doing work in this area. However, given some of the potential ethical issues with AI systems, as outlined above, this guidance is certainly needed.

As experience with AI systems in healthcare develops, stakeholders will need to conduct robust studies to demonstrate impacts on patient outcomes and the mechanisms by which those impacts are obtained. Moreover, if they are not implemented and monitored carefully, AI systems in pharmacy and the pharmaceutical industry may lead to reputational damage, if not to regulatory breaches and medicolegal cases. To prevent such issues, the following measures will be necessary:

- Relevant and contextual education and training in the benefits and risks of the use of AI systems in the pharmaceutical industry and pharmacy professional practice is needed for all personnel in the sector. Indeed, keeping up to date with the actual evidence for AI use in the sector, rather than the latest media hype, is an urgent task for all pharmacy and pharmaceutical industry professionals as the use of AI systems grows.
- The pharmaceutical industry and pharmacy bodies should work collaboratively with digital system suppliers in the development of AI functionality for medicines supply and optimisation. AI functionality should be subject to validation testing, with signal monitoring for unintended consequences, as well as analysis to ensure that benefits are realised.
- Industry and professional stakeholders should work together proactively to identify areas where AI systems might enhance and extend professional roles.[26] The aim should be to leverage the intuitive functions of AI while, at the same time, ensuring that human interpersonal skills are used effectively in the clinical setting, ensuring that services are as patient-facing and person-centred as possible.
- Users of AI systems should be transparent about their use of AI systems, and disclose to professionals, patients and the public **how** AI systems are being used to develop medicines and provide care with medicines in the clinical setting. They should also develop ways to monitor the impact of AI systems on equality of patient care and of access to services, and on diversity in local communities.

Further Reading and Resources

- The NHS AI Lab. At https://transform.england.nhs.uk/ai-lab/
- Brookings AI and Emerging Technology Resources. At https://www.brookings.edu/projects/artificial-intelligence-and-emerging-technology-initiative/
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Addressing the education gap of AI policy into practice: A pharmacy perspective

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Background

There has been an exponential increase in the interest in artificial intelligence (AI), arguably no more so than in the healthcare sector. As a result, preparation of the workforce to utilise AI has never been such a pressing issue. In the not too distant past the phrase 'artificial intelligence' would bring to mind the cutting-edge work done by university X working with super-computer X on problems that seemed to most (myself included) intellectually so far out of reach they thankfully need not be considered. Many readers may look fondly back on those times, because while the opportunities of AI are seemingly endless, the challenges are nearly as numerous. These challenges are multifaceted, whether this be in understanding of the AI algorithms the 'black box' nature, the development of skills require to utilise AI, or requirement for crucial datasets without social or ethical bias.[1]

Further to this, for many simply understanding the concept of AI is elusive. When one finally gets one's head around a particular application of AI, those industrious computer scientists find N more applications, which raises N+1 questions. With such a fast moving and uniquely complex topic, how can educators prepare the workforce to work in our predetermined AI world?

There is considerable government policy regarding AI. Since 2016 in the UK healthcare sector alone there has been at least seven policy documents, spanning nearly 600 pages. As with all policy that seeks to drive change there are recommendations. In all these policy documents the need for workforce development is identified as a key recommendation, with the take home message being education, education, education. The Topol review in 2019 illustrates this point well:

> "Educational resources should be developed to educate and train all healthcare professionals in: health data provenance, curation, integration and governance; the ethics of AI and autonomous systems/tools; critical appraisal and interpretation of AI and robotics technologies.[2,3]"

Funding

To realise the often lofty policy envisagement of how AI might revolutionise healthcare in the UK, substantial investments have been made, totalling £144 million in healthcare AI investments alone. Most recently, in June 2023 a hefty sum of £21 million was ringfenced to develop AI tools for applications in the clinic. This forms part of the estimated £10 billion spend annually by the NHS on medical technology.[4]

As with all healthcare funding, careful consideration of investment is required. In September 2020, a four-stage funding awards process was established by NHS England and the National Institute for Health and Care Research (NIHR) to guide £123 million of investment. As of

March 2023, 83 projects in the UK were awarded funding as part of this scheme over three different rounds.[5] The fourth round of award winners are expected to be announced in the coming year. The variety of projects in this funding scheme show the richness and depth of AI applications in the UK healthcare system. With so much funding and incentive, by what means should educators capitalise on this and prepare pharmacy students to work with AI?

Educational Need

Digitally literate pharmacy services are central to the digitalisation of the healthcare sector,[6] whether this be around medical records, digital prescribing, or communication to other healthcare workers and patients. This is compounded by recommendations within the NHS Long Term Plan, that put pharmacists in an increasingly clinical role.[7] The clinic setting is where many of these digital advancements are targeted to address the staggering inefficiencies that are commonplace. Therefore, it is essential that pharmacists have the digital skills required to maximise this opportunity and utilise the comprehensive clinical training that is now the cornerstone of a pharmacist's education.

A scoping review conducted in 2023 by Alowais et al. provides an excellent overview of the approaches of digital education in the pharmacy undergraduate program from a national and international perspective. This review highlighted the importance of integrating digital literacy education into the undergraduate pharmacy curriculum. It was noted that emphasis should be placed on developing fundamental knowledge along with applied teaching. Collaboration with key stakeholders using standardised guidelines in the development of a digital curriculum was also promoted. The lack of digital informatics expertise among pharmacy educators was identified as a major barrier to the successful integration of digital education in the pharmacy undergraduate program.[8] The impact of the COVID-19 pandemic was highlighted to have accelerated the need for further digital education in pharmacy.[9]

Somewhat unfortunately for educators, the use of AI in healthcare is projected to be commonplace in the not to distant future, meaning that rapid skill advancement is required. In the UK pharmacy sector AI tools are already in late stages of development. The *DynAIRx* is an AI powered tool which is designed to find patients who might benefit from targeted medicines optimisation.[10] The United States is where many AI tools are used in pharmacy, for example integrated into dispensing systems to highlight adverse drug reactions, label generation for dispensing and clinical decision support.[11,12] It is widely perceived that the US is the global leader in the integration of AI in healthcare. Therefore, close attention should be made to their education strategy and how AI tools are used in practice. Further AI tools will soon surely migrate across the pond and be ubiquitous in the UK pharmacy network.

Educational Strategy

When we consider the education of AI in healthcare, two potential strategies could be employed. A focus on the fundamentals of AI and the topic in the more general sense; or a purely applied approach, for example where students are given assignments where AI is required to complete them. In clinical practice, a successful digital intervention should require only a basic knowledge of digital fundamentals. Thus, allowing uptake across the whole workforce who invariably have a large variation in both digital literacy and the willingness to gain further understanding. Therefore, it could be argued that the focus should be purely on the application of AI in the clinic as opposed to education in the fundamentals. Counter to this, a lack of understanding in the fundamentals of AI and digital literacy may prohibit a deeper understanding of digital technology. Thus, reducing the workforce's ability to develop novel digital interventions and adapt to advancements in the field. Education of both fundamentals of AI and applied uses should therefore be developed, however, due to the already extensive curriculum in the undergraduate course, priority should be placed on applied applications.

The undergraduate education of UK pharmacists follows well-defined criteria as established by the General Pharmaceutical Council (GPhC). This comprises 55 learning outcomes that covers the four-year MPharm degree and the foundation training year, outlined in the 2021 GPhC pharmacist registration standards.[13] In these standards there is no mention of AI directly, however standard 24 states:

> **"Keep abreast of new technologies and use data and digital technologies to improve clinical outcomes and patient safety, keeping to information governance principles."**

This in essence stipulates that to become a UK registered pharmacist one must keep up to date with healthcare technological advancements, which AI would certainly fall under. A similar approach is adopted by the Royal Pharmaceutical Society (RPS), which sets out criteria for three different stages of a pharmacist's career: Foundation, Core Advanced and Consultant. Therefore, there is certainly an expectation by the regulator and professional body that pharmacists gain and maintain a degree of digital literacy, including in AI. Although there is an emphasis on the development of digital skills within the various frameworks, there is a lack of specificity around the use of AI. Considering when the GPhC standards were introduced may somewhat explain this. The latest standards were introduced in 2021, with much of the development done years in advance.

The impact the standards have on the direction of content creation in pharmacist education is an important consideration. Taking a more specific and direct approach around the wording of AI in these standards would promote the wider acceptance of AI in pharmacy education and go some way to addressing the underlying recommendation of policy. Considering the relatively slow rate of change of the GPhC pharmacists' registration standards, it is unlikely that a revision to the standards will be made in the short to medium term. This could point to the need for additional direction from regulators on the provisions required to put more emphasis on digital literacy education. This could be provided by consultation with the pharmacy schools to encourage education in healthcare AI and the utilisation of AI within assessments.

Educational Practice

A brief survey was distributed to pharmacy schools in the UK to gather current practices of AI education within the MPharm degree. Opinions on the importance of AI education were also sought. Responses highlight a gap between current education practice and the recommendations made in healthcare development policy. Nine pharmacy schools responded to the survey, the responses are outline below:

- 67% of MPharm programs surveyed stated that they have no teaching specifically on AI
- 22% of MPharm programs surveyed had assessments where students were instructed to use AI
- 89% respondents thought that AI will have an active role in patient facing interactions in the next 10 years
- All respondents from the pharmacy schools thought that the undergraduate degree was a suitable educational stage to include teaching on AI
- All respondents thought that newly qualified pharmacists have insufficient knowledge of AI

The responses indicate that AI specific education is yet to be common practice on the MPharm program. Furthermore AI used in assessments was even less common practice. The survey results indicate that little progress has been made in UK AI pharmacy education in recent years. A 2021 article, by Mantel-Teeuwisse, et al. gathered similar data, surveying 260 pharmacy students and educators from pharmacy schools across 91 countries. In this survey, 57 % of respondents stated that digital education was not taught in their pharmacy undergraduate programs.[14] Despite the inconsistences in digital education, the majority of pharmacy schools surveyed thought that AI would play a significant role in patient interactions in the medium term, the undergraduate degree stage is suitable for AI education, and more AI education is required for newly qualified pharmacists. While these results are hardly surprising - AI education in healthcare is still in its infancy and the workforce development needs are moving fast, they do illustrate the gap between policy and current educational practice.

Educational Development

While currently the gap between policy and practice is large, work is ongoing to address this, and to provide a coordinated approach to AI within pharmacy education. The Pharmacy School Council is a regular meeting of heads of each pharmacy school in the UK. AI is a topic which is of interest to the council, however much of their focus is on the use of AI in assessments and how to ensure academic integrity is maintained. This viewpoint was also highlighted in the aforementioned survey results, where one pharmacy school indicated that much of their conversation around AI is centred around academic integrity concerns. While this is an important and problematic topic, it falls outside the scope of this article. Although briefly, it does highlight the need to strike a balance between the acceptance of AI for academic purposes and scepticism around use of AI in assessments within pharmacy education. This ambiguity needs to be addressed across all higher education with clear centralised guidelines - again, outside the scope of this article.

The working group Schools of Pharmacy Digital Community of Practice (SoPDCoP) was established to inform digital education within the pharmacy undergraduate program. This group meets four times a year and have had an interest in AI for some time. NHS England has worked with the University of Manchester to develop the course *'AI for Healthcare: Equipping the Workforce for Digital Transformation'.* This is a five-week course with two hours of study time a week. Although this course is currently not running, it has had over 10,000 participants since it was established in 2020. This indicates that there is a willingness of healthcare professionals to up-skill in AI. While courses such as this provide opportunities for students and pharmacists to develop AI digital literacy, the emphasis is placed on individuals to seek out additional learning, resulting in a variation of skills across the workforce. To address this, true integration of this content is required in the compulsory education of pharmacists, which is yet to be commonplace in the UK undergraduate pharmacy education system.

Many of the educational advancements in this sector are taking place within North America, for example the community pharmacists AI chatbot training course on anticoagulation at the University of Waterloo (Ontario, Canada) - as featured in the 2022 Pharmaceutical Journal article *'AI chatbots in pharmacy: a brave new world or looming threat?'*.[1] This course gives pharmacists a tangible task to apply AI tools to boost understanding, thus bridging the gap between book learning and clinical practice. The main barrier to the development of courses such as this is patient datasets. Clinical associate professor Dr Jeff Negge, who developed the course states the time investment in generating the large dataset required to facilitate this course was substantial. Therefore, it is unlikely that each pharmacy school has the time and skills required to independently develop such training. The data is readily available within the clinic, the integration of these datasets into digital education will be key to develop training on AI applied uses with pharmacy undergraduate programs.

Next Steps

Looking forward, the amount of work required to prepare pharmacy students to work with AI is vast, and will require substantial skill developments of the academic staff involved (again, myself included). On a positive note, the conversations are ongoing, and the size of the challenge is well established, an important first step in any large-scale project. The structures by which the pharmacy schools can develop this content is also well defined, the SoPDCoP and Pharmacy Schools Council for example. These working groups may bring further recommendations as to the extent that regulators, the GPhC in this case, are required to introduce further guidance on the education of AI within the undergraduate pharmacy program. At the same time, it would also be logical to extend any guidance to the career pathways outlined in a pharmacist's development issued by the professional body.

Considering the rapid emergence of AI within healthcare, educators have made significant progress to address the challenges. However, now is the time to step up efforts to ensure that momentum is transferred from policy into educational practices. Efforts should also be made to ensure that work is not duplicated, this can be achieved by each pharmacy school having an open approach, sharing issues they are facing (and will face), along with proposed solutions to develop their curriculums. To address a skill shortage amongst academic staff, inter-professional collaboration between academic sectors should be employed. For example, working closely with colleagues in computing education who already have the skills required to not only understand the nuances of AI, but also how to build this understanding in students. By working together to develop learning objectives and curriculum, academic staff within pharmacy can ensure the rapid and efficient development of AI education within the MPharm program.

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Pharmacy workforce perceptions of digital skill development across an integrated care partnership. How might pharmacy staff be better enabled and supported?

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Introduction

The *NHS Long Term Plan* sets the vision of a health and social care system that is patient-centred, equitable, accessible, safer, and manned by staff who feel better supported and enabled to do their work.[1] Digitalisation is identified as a cornerstone to successful delivery of this, but uptake and appropriate use of digital systems by healthcare staff is needed to fully realise the benefits offered by technology.[2]

The expectations of a digital-ready workforce with appropriate knowledge and skills* is outlined in national strategy and guidance.[2,3] The consequences of not addressing this include under, or poor, utilisation of technology resulting in resource waste, poorer patient outcomes, and feelings of anxiety in the workforce.[4] In response to this, organisations nationally are working to support, enable and standardise digital competency of healthcare staff through an expanding education resource and the development of digital capability frameworks.[5,6] Staff across all pharmacy sectors are reliant on technology to undertake their daily work but little is known about pharmacy workforce experiences and perceptions of developing digital skills, nor what is needed to better support and enable their use of technology in practice. This project aimed to:

1. Define the barriers and facilitators to pharmacy workforce digital skill development across an integrated care partnership (ICP) footprint.
2. Develop recommendations to better enable digital skill development of pharmacy staff, to further realise the benefits of technology.

(* Digital knowledge and skills in this article are defined as having the confidence, competence and capability to use digital systems to provide best patient care and improve outcomes.[3])

Method

Scoping work

Project scope, design and validity were informed through document review of relevant policy papers and journal articles, and conversations with key pharmacy stakeholders from Health Education England (HEE) (now NHS England Workforce, Training and Education Directorate), academia and across the West Yorkshire Integrated Care System (ICS).

Data collection

Pharmacy staff from across an ICP, from primary care, secondary care, mental health, clinical commissioning group (CCG), GP confederation and community pharmacy were invited to participate in stakeholder engagement workshops. The workshops were delivered using a semi-structured workshop facilitation guide, the design and content of which was informed by the project scoping work.

Group	Role
Group 1	Pharmacy administrator (office based clerical staff) Pharmacy support worker (dispensary or ward based) Pharmacy technician Early career pharmacist Advanced level pharmacist
Group 2	Consultant level pharmacist Senior pharmacy manager/leader (pharmacist or pharmacy technician)

Table 1: Participant role

Depending on the role (see table 1), pharmacy staff were invited to attend a workshop for either front-line workers (Group 1) or senior manager/leaders (Group 2), with others from the same pharmacy sector. Collecting data across an ICP footprint ensured that the experiences and perceptions of staff from across all pharmacy sectors were captured.

> "The workshops were delivered using MSTeams. Participants were consented, the discussions recorded and later transcribed to aid the data analysis process."

There were challenges with engaging and recruiting front-line workers (Group 1) from primary care, CCG, GP confederation and community pharmacy and so a questionnaire was designed as an alternative approach to the workshops to capture data from this cohort of staff. The questionnaire was informed by the scoping work and workshop facilitation guide, was piloted and disseminated through the local ICP primary care and CCG networks, HEE Primary Care Pharmacy Technician Network, Community Pharmacy West Yorkshire, and social media.

Data Analysis

The qualitative data from both the workshops and the free text questions in the questionnaire were analysed using thematic analysis as described by Braun and Clarke (2006).[7] The quantitative data for the questionnaire was analysed and presented using descriptive statistics.

Ethics

Using the NHS Health Research Authority decision tool, NHS ethics was not required for the project. The questionnaire was submitted and assured by HEE's Information Governance and Data Protection Impact Assessment process.

Results

Study participants

A total of 102 pharmacy staff from across all pharmacy sectors took part in the study. Workshops were attended by 27 staff members, and 75 staff members completed the online questionnaire. Workshop participants and questionnaire respondents are shown in tables 2 and 3 respectively, by role and sector.

Summary of results

From the combined data set, three recurrent themes considered to significantly impact pharmacy workforce digital skill development were:

1. Digital knowledge and skills under-recognised as a development area.
2. The impact of change as a consequence of digital implementation.
3. Poor sharing of digital learning across the wider healthcare system.

Digital knowledge and skills not recognised or explored as an area for development

Nearly all (93%) of participants stated that digital skills were not identified or discussed as a learning need at appraisal or other relevant meetings, and described feeling they were, 'Just expected to know how to use digital systems' which could lead to feeling 'overwhelmed':

	Community	Clinical Commissioning Group/ Primary Care	Secondary Care	Mental Health
Group 1 total participants	0	1	8	3
Pharmacy Administrator	0	0	1	0
Pharmacy Support Worker	0	0	1	0
Pharmacy Technician	0	0	3	1
Early Career Pharmacist	0	0	1	2
Advanced Level Pharmacist	0	1	2	0
Group 2 total participants	0	4	6	5
Consultant Level Pharmacist	0	0	3	0
Senior Pharmacy Manager/Leader	0	4	3	5

Table 2: Workshop participants by sector and role

	Community	Clinical Commissioning Group/ Primary Care	Primary care (e.g., GP practice, Care home or Primary care Network)
Group 1 total participants	13	35	27
Pharmacy Administrator	1	2	0
Pharmacy Support Worker	0	1	0
Pharmacy Technician	2	19	13
Early Career Pharmacist	0	0	0
Advanced Level Pharmacist	10	13	14

Table 3: Questionnaire respondents by sector and role (Group 1)

> *'I have never had a conversation with my manager about this in my 14-year career. … But since I have progressed, I'm expected to do things now and I haven't had any training for them, like an Excel spreadsheet. I wouldn't even know where to begin.'*
> (Hospital Pharmacy Technician, workshop participant)

Whilst a few participants described feeling confident and competent at using digital systems at work, 70% of questionnaire respondents stated that they 'Were not an expert but could do enough

to get by'. All workshop participants and 68% of questionnaire respondents stated that they wished they could use digital systems better, and 55% of questionnaire respondents worried that poor digital knowledge and skills may affect patient care. Examples included concerns about potential negative impact on clinical discussions and care decisions as a consequence of incorrect data entry and data interrogation, poor knowledge of where to document, and difficulties in finding information in electronic patient records.

A key challenge identified by over half (n=7) of community pharmacy questionnaire respondents to developing digital skills was lack of and access to resource:

> *'[we need] Access to funded training, time given by employers... and funding for backfill staff costs.'* (Community Pharmacist, questionnaire respondent)

Change described as the biggest barrier to digital skill development

Nearly all participants described the main challenge to digital skill development as the scale, pace, resistance to and fear of change. The data set for this theme is presented as a 'Found poem' (box 1) which is an arrangement of words and quotations from other sources.[8] The words arranged below were taken verbatim from workshop transcripts and questionnaire free text responses, from across all sectors of pharmacy, when asked what was considered the biggest barrier to digital skill development.

A 'found poem' about digital change

I had a member of staff who didn't have a smart phone.
She was really nervous because she doesn't like the new change.
A bit of fear, of breaking the system, of doing something wrong, of harming patients.

I don't have time. Overwhelmed.
I don't do computers. I'm a technophobe.
How will I cope?
Worried about how they are going to do their job.
Worried it was taking their job.

But then things do constantly change.
It was introduced and it's a thing that is growing all the time.
How we best use the systems changes constantly.
Processes change. Someone's job becomes more admin, more ticking boxes.
It feels like my actual role has changed.

I think it is about time and breathing space, and the ability to go through that grief cycle.

Participants identified and discussed various reasons as to why this might be. These included feelings of concern about learning new skills and processes to use digital systems, and fear of getting it wrong because they didn't want to break it or cause harm to patients. Some participants described themselves, and members of staff they managed, as having a fixed 'can't do' mindset when faced with technology which was felt to hinder progress. As staff adapted to and adopted digital systems in practice, they developed variation in practice. It was also recognised that technology created change not only to how people did their work, but to job roles and their sense of purpose.

> *'Helping people through the change. And feel empowered in the change. .... What are we now actually here for, what is that change in role and how do we support staff through that change?'* (Hospital pharmacist, workshop participant)

Digital learning is not shared across the wider healthcare system

There were participants who had experience of working in similar roles using the same digital system, across different sectors/organisations. This was described by one participant as 'Commonality in product but not in use'. Examples included the same digital system being set up (configured) differently, and/or staff being assigned different access and user rights (functionality) when they moved to a different job/organisation. Participants explained that same-system use across the ICP did not translate to a standardised skill set.

> *'People who move between job/departments then have to learn new systems. And that's just so inefficient. And even trusts that use the same systems, they don't always give the same rights and so some trusts don't give staff access or the ability to do certain things that another trust might.'* (Pharmacy Technician with experience of three pharmacy sectors, workshop participant)

Participants described having to relearn how to use the digital system, how different configuration or functionality translated to clinical practice, and how this may affect patient care and safety. This resulted in changes to core elements of their job and left participants feeling that their role had changed.

> *'Since moving, I can't [make changes in the system]... I don't want to be asking them [the doctors] constantly to prescribe this as tablets not capsules. I want to be there enhancing patient care. I want them to see me as a clinical professional not as somebody who is on at them constantly for all these technical problems.'* (Pharmacist with experience of two pharmacy sectors, workshop participant)

Participants stated that there was limited sharing of new technologies and innovative ways of working between organisations and across transitions of care. As an example, some GP practices were considered as technically advanced compared to others, and yet little was done to share the new technologies and benefits to patient care.

> *'There are a few practices in Leeds that seem to be more advanced when it comes to digital technology. They do their own things and I wish they could share it more with other practices.'* (CCG Pharmacy Technician, workshop participant)

Participants also described resource intensive projects within teams/organisations to improve processes and practice with technology, but once embedded, these changes were not shared or used more widely.

> *'... so it's [the mental health dashboard in the patient record] within our organisation but it's also across the system... We could put an alert on [there] about clozapine, but when you speak to GPs and PCN pharmacists, they don't know that a mental health tab exists.'* (Mental Health Pharmacist 3, workshop participant)

"It was considered by participants as a more efficient use of NHS resource and safer for patients to share new technologies, system configuration and end-user functionality, and new ways of working across the wider healthcare network."

Discussion

This work provides some insight into the barriers and facilitators to pharmacy workforce learning of digital skills, but what are the implications for future practice development? What follows are suggested approaches to supporting the development of digital knowledge and skills at an individual, organisational and wider healthcare system level.

Recommendation 1 - Support individual development

Embed digital knowledge and skills into staff development conversations and plans, and provide the necessary support and resource to enable staff to address identified needs and share learning.

The findings highlight the importance of recognising digital knowledge and skill development as a professional competence, and that across teams and departments staff are at varying stages of digital learning with a range of knowledge and expertise. Line managers should support pharmacy staff to identify and explore learning needs appropriate to ability, individual role, responsibilities and aspirations, to then embed digital knowledge and skills into personal development plans.

Resources such as the HEE Digital Capabilities for the Pharmacy Workforce or the wider reaching AI and Digital Healthcare Technology Capabilities Framework may offer a place to start the conversation and identify relevant learning.

Most organisations have an individual or team responsible for digital system training. Participants described that the 'best learning' occurred when the need arose, from colleagues in their own teams whom they considered 'experts'. Initial training, usually offered in the form of eLearning, is useful to orientate staff to a digital system, but staff require more accessible ways of learning in the moment, and support with translation of how to use it in practice. Ways of doing this may include providing short, easily accessible 'how to' videos around specific tasks, or enabling collaborative learning time where teams share individual best use/practice. This would socialise the concept of digital learning, enable sharing of skills, and could encourage a more uniform approach to system use and transformation of work processes. This could be further supported by formally recognising those in the team considered 'experts' as 'digital champions'.

Recommendation 2 - Support organisational change

To create the infrastructure to support pharmacy staff with the change associated with digital system implementation.

Change was cited by participants from all sectors as the greatest challenge to pharmacy workforce digital skill development. Participant descriptions of change as a consequence of technology to professional identity, role, job tasks, workflow and communication channels are echoed in the literature.[9,10] However, the change with digital is often considered as a technical change with an emphasis on kit, IT infrastructure, testing and timelines.[2] Increasingly, end-user engagement projects are included in the implementation process to improve acceptance and adoption.[11,12] Whilst important, what is often overlooked is supporting staff to understand and deal with the psychological aspects of change associated with technology and how this may impact them and their work.[13] This needs to occur prior to, during and after implementation and is supported as an approach by Greenhalgh et al (2017) in the non-adoption, abandonment, scale-up, spread, and sustainability (NASSS) framework.[14]

New approaches that use emergent change methods, described as iterative, in the moment and often unintentional, need to be employed during implementation and beyond.[15] If not, implementation of digital systems can result in variations in practice as staff learn to work with systems in their own way.[9] These are often cited as 'work arounds' in the literature which, whilst potentially creating risks with system use, can also be innovative ways of working that should inform redesign of work and system integration.[16]

Bridges and Bridges (2017; p58) describes this period during implementation as the 'Space between the old and the new', when routines are disrupted and people are more open to trying new things.[13] Examples of creating space for innovation in this way include offering staff a platform to share ideas and new ways of working, and developing a team to observe, listen to and enable improvement in response to staff challenges and opportunities with the technology.[13]

Using the tools and approach described by Bridges and Bridges (2017), it is suggested that staff would be able to let go of the old ways of being and working, are more able to embrace new ways of working and new identities, and would be better equipped to deal with future changes in the workplace.[13]

Recommendation 3 - Enable wider system collaboration

Wider pharmacy system collaboration is required to share new innovation and best practice, and enable development and transferability of staff digital skill sets and roles across care transitions.

The findings from this project suggests that poor sharing of technology and its use across transitions of care not only hinders the development and embedding of pharmacy workforce digital skills but may also have implications for patient care. Organisations across an ICS who share the same digital systems could collaborate to standardise or share learning about areas such as staff access rights, system configuration, training resource/approach, workflow processes, changes to roles and jobs, system upgrades, and best/new practice.

Resource would be needed to do this, and to understand the context and differences between working environments, but this could prove economical in the longer term to save 're-inventing' the wheel, improve work processes and system use, and to realise fully the benefits of digital systems. Collaboration in this would go some way to enabling a more transferable skill set for staff as they move between organisations.

Limitations

Recruitment of front-line staff from community and primary care sectors to workshops proved challenging despite different approaches to facilitation, timing and event advertisement. A questionnaire was designed, piloted and administered as a means of capturing data and whilst there was a good response rate from primary care pharmacy staff, there were only 13 respondents from community pharmacy. This provided a limited insight into the barriers and facilitators faced by the community pharmacy sector.

Conclusion

Digital knowledge and skill development are key to the embedding and 'good use' of digital systems in healthcare. This project highlights challenges for the pharmacy workforce across multiple sectors of pharmacy, and how staff might be better

supported to recognise and develop digital skills. It addresses the impact of digital change on staff and the step-change required to support staff through digital change in a way that would support digital skill development and enable staff to embrace technology and innovation.

It also encourages the sharing of digital learning and innovation held by individual organisations within the wider healthcare system to enable innovation, development and transferability of digital skills and staff roles across transitions of care. These suggestions may go some way to improving staff adaptability, digital system use, digital skill development, innovation and the realisation of health technology benefits.

Acknowledgments

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Use of the Hospital Electronic Prescribing and Medicine Administration (HEPMA) system to improve the education service for patients requiring oral anticoagulation

Rona Honnet, Helen Barclay and Stewart Sheehan.

Rona Honnet is a Principal Clinical Pharmacist at University Hospital Wishaw, providing pharmaceutical care predominantly to medical patients and collaborating to develop clinical pharmacy services across the acute site and health board. She also works as a Senior Specialist Tutor for NES Pharmacy, developing educational resources for postgraduate pharmacy staff with a focus on developing clinical decision making skills, and was recently appointed as a Visiting Lecturer at the University of Strathclyde.

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Helen Barclay started her pharmacy career at Glasgow Royal Infirmary, then moved to University Hospital Wishaw, where she is currently a Principal Clinical Pharmacist. In her current role Helen contributes to the management and development of the clinical pharmacy services locally and she is also the Lanarkshire member of the NAPS clinical group. While in her current role she co-ordinated a national online training program about medicines for all junior doctors in Scotland and has contributed to a variety of publications and presentations relating to this work including the Wyeth Education and Training Award.

Stewart Sheehan is the Lead Clinical Pharmacy Technician at University Hospital Wishaw, leading a team of six clinical pharmacy technicians across acute medical receiving, medical, surgical and orthopaedic areas. Stewart started his pharmacy career as a storeman, working his way through a variety of roles to Hospital Electronic Prescribing and Medicines Administration (HEPMA) Technician to his current role. Having worked in such a wide variety of technical posts has given Stewart the ability to understand each role and its purpose within the pharmacy team and wider multi-disciplinary team within the hospital setting.

This article describes the development of an electronic management system for technician-led education for patients commenced on oral anticoagulants and subsequently developed to encompass other high risk medicines.

- The hospital electronic prescribing system (HEPMA) is used to communicate details of patients requiring education on their new medicines, ensuring timely delivery
- Details of the education provided to patients are then communicated to primary care teams to ensure that they have the necessary prescribing information to prevent unnecessary duplicate provision
- There is a high degree of satisfaction with the system, which is being expanded to include a wider range of education topics and to include other sites within the health board
- The use of HEPMA allowed for the development of a robust and efficient system to provide high quality education consistently to patients discharged from hospital having commenced oral anticoagulants
- It allowed the service to be expanded to include other high risk medicines, better employing the skill mix within the pharmacy department, improving the quality of patient care both during admission and after discharge

Background

The use of medicines is known to be associated with significant harm to patients and is believed to be responsible for approximately 18.4% of hospital medical admissions.[1] The National Institute for Health and Care Excellence (NICE) estimates that patients fail to take up to half of all medicines for long term conditions correctly.[2] To reduce the potential for harm, patients should be provided with education, particularly for high risk medicines. Education should include highlighting particular areas of concern such as food or drug interactions, the need for regular monitoring and what to do if something goes wrong.

In our hospital it has become standard practice for the Pharmacy Department – traditionally the ward-based clinical pharmacists – to provide information to patients initiated on warfarin or other oral anticoagulants prior to discharge using a combination of written and verbal information. As the numbers of patients requiring this service has increased better use has been made of the skill mix within the department by transferring much of this work to clinical pharmacy technicians. Before providing this service, all staff who would deliver the education were trained and upskilled to deliver comprehensive, standardised education, designed to promote the safe use of oral anticoagulants (direct acting oral anticoagulants, 'DOACs', and warfarin).

The Pharmacy Department at University Hospital Wishaw consists of approximately 26.2 whole time equivalent (WTE) pharmacists, 17.8 WTE pharmacy technicians and 15.3 clerical and support workers, excluding peripatetic staff. Nine technicians (8 WTE) are trained to provide medicines education to inpatients. Clinical pharmacists provide a service to all medical (including older adults), surgical and orthopaedic inpatients. These pharmacists are supported by clinical pharmacy technicians who are involved with medication history taking, discharge planning and patient education. Further teams provide pharmaceutical care to paediatric, neonatal, maternity and mental health wards. Staff work in the dispensary or one of four clinical satellites.

"This geographical spread and the rapid turnover of patients through the hospital exacerbate challenges in identifying individuals who would benefit from education about their medicines in a timely manner. Prior to the development of this service information on newly commenced oral anticoagulants was most often provided at the time of discharge by the clinical pharmacist reviewing the interim discharge letter (IDL)."

Initially a paper referral form was created to identify patients requiring education. However, this was often not used due to the delays introduced by the need to have the form to hand when clinically reviewing the patient on the ward and then subsequently transferring it to the clinical technician team based in the dispensary. It was considered that the development of an electronic early referral system would improve the time management and work flow within the Pharmacy Department as well as improving the patient experience by making the education session less time-pressured with fewer distractions. Separation of the education session from the immediate discharge period and having a discussion earlier in the process wherever possible was seen as an additional advantage. This allows patient consent to be obtained and an assessment of their ability to take the medicines safely and reliably to be undertaken while there is still time for the multidisciplinary team to address any concerns highlighted during the inpatient stay.

In 2021 University Hospital Wishaw introduced the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system. This system is used in all adult wards with the exception of the

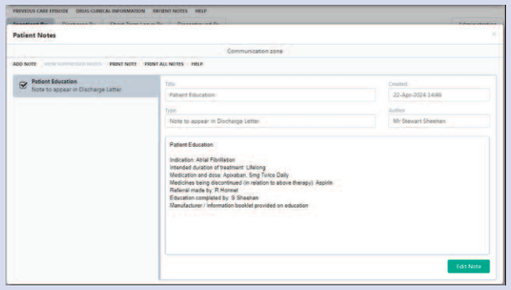
maternity unit. The introduction of the HEPMA system within our hospital presented an opportunity to improve the quality and efficiency of the pharmacy service. Inpatient medication records are accessible from any network computer in the hospital. Furthermore, the system allows us to identify patients anywhere in the hospital on specific drugs and to track their progress remotely. Pharmaceutical Care Plans can be recorded as a note on HEPMA and are visible by any healthcare professional accessing the system. Separate notes are used to record important information about medicines administration or dosing as well as highlighting patients with special requirements such as compliance aids or provision by specialist services. When the patient is discharged from hospital, the IDL is electronically delivered directly to their GP practice, avoiding the reliance on individual patients dropping a copy off in person.

It was felt that the capabilities of the electronic prescribing system could be better used to improve the speed and reliability of communication (and hence both safety and efficiency) of the education service within our hospital. Given that pharmacists and technicians working in the wards routinely access this system it was considered the most appropriate medium to communicate medication related information. This information can also easily – or automatically – be transferred to primary care teams at the time of discharge, improving the timeliness and reliability of communication across the primary-secondary care interface.

Implementation

A standardised electronic referral note based on the original paper referral form was developed. It was tested on a small number of wards and evaluated before subsequently being implemented more widely. This note on the HEPMA system was designed to gather the information necessary to provide patients with comprehensive education (see figure 1).

The clinical pharmacist completes this referral when the patient is identified and the clinical appropriateness of the prescription is confirmed. Any necessary amendments to the dose or planned duration of anticoagulant therapy are made during the initial review. The patient's existing medicines are also reviewed to ensure that medicines that are no longer appropriate (due to interactions or increased risk of bleeding, for example) are discontinued. This will be noted



GP: IM TRIAL, HEALTH CENTRE, WISHAW

Patient : DAISY FLOWERS — Hosp No: 0101501234
Address: 42 HOSPITAL STREET, WISHAW — D.O.B. 01/01/50

Admission date: 18/04/24 — Ward: 25

Discharge date: 23/04/24 — Consultant: C Brown

Allergy status: ** No known allergies** — Reaction

Diagnoses: Atrial Fibrillation

Patient aware of diagnosis: Yes

Notes transferred from inpatient chart

Indication: Atrial Fibrillation
Intended duration of treatment: Lifelong
Medication and Dose: Apixaban 5mg twice daily
Medication being discontinued (in relation to above therapy): Aspirin
Referral made by: R Honnet
Education completed by: S Sheehan
Manufacturer/ information booklet provided on education

Discharge Medication

Drug	*Dose/ route/ frequency*	*Duration*	*GP to continue*	*Quantity, strength, brand*
APIXABAN 5mg Tablets	**5mg** Oral TWICE daily at 7am	L/T	Yes	

Verified by Mrs Linda King

Figure 1 – HEPMA anticoagulation education referral note as it appears on the computer system and on the IDL sent to the primary care team.

on the referral so that the patient can be informed during the discussion.

It is possible for the lead clinical technician to identify patients remotely using a live dashboard set up on the HEPMA system; however, at our site it was preferred by both pharmacists and technicians that the patients would be handed over with a quick telephone call, allowing the pharmacist to indicate the degree of urgency (due to planned date of discharge) and communicate any other relevant information directly (such as hearing difficulties, the need for a family member to be present, etc.) Where it is not possible for a conversation to take place at the time of referral a message is sometimes sent to the relevant clinical technician using Microsoft Teams to inform them about the patient. This active communication also supports efficient time management.

When the patient education has been satisfactorily completed, this is recorded in the multidisciplinary case notes and the electronic note on HEPMA is updated to reflect this. If there are any concerns following the discussion with the patient these are documented and passed back to the clinical pharmacist caring for them. The updated patient education record is also transferred to the primary care team at discharge, allowing them to see clearly what has been done thus limiting the risk of incorrect doses or inappropriate continuation of medicines. It is also clear to the general practice clinical pharmacists (GPCPs) that education has been provided to the patient, avoiding the need for them to contact the patient soon after discharge to address this.

Evaluation

Productivity

Using the HEPMA system it is possible to gather data about prescribing habits and about care provision recorded in the clinical notes (for example, in the Pharmaceutical Care Plans). We used this facility to gather information about the provision of our established service. Over the course of a 4-month period (August to November 2023) our team of eight technicians recorded 144 anticoagulant education sessions, the majority of which related to direct oral anticoagulants (DOACs). In the same time period education was provided to thirty-two patients by clinical pharmacists and of these 20 were in acute areas where the patient would be discharged immediately after initiation of therapy.

The average time taken by the technicians to provide this education was recorded as 15 minutes. Education provided by technicians rather than pharmacists provides more time for the pharmacists to focus on other clinical duties such as medicine review and prescribing as part of the multidisciplinary team. The process is also more streamlined at discharge as the clinical pharmacist is no longer required to remember to add all of this information manually to the IDL. This saves time and also improves consistency in terms of the information that is now transferred digitally.

Improved patient-focused Care

A key advantage of using the HEPMA system to make the referral is that patients can be referred as soon as they have been commenced on a new anticoagulant. There is no delay in completing the form with all the relevant information as the pharmacist is already on the system. The quick process and timely completion improves the opportunity for patients to be educated at a convenient time for them.

> **"Due to patients being identified earlier in the process we can plan appropriate times for these sessions to be provided, avoiding peak discharging and dispensing times. As well as improving the time management within the department by supporting the dispensary workflow and subsequently patient flow within the hospital, this has the advantage of making the discussions with patients more relaxed and constructive."**

A short post-discharge survey was conducted with a small sample of ten patients who had received this service after commencing on a DOAC.[3] All of the patients confirmed that they recalled receiving written and verbal information about their anticoagulant and could explain how to take it. Seventy percent of patients could list two or more side effects of their anticoagulant to look out for and the same number were aware of medicines to avoid while taking the medication. Nine of the ten patients agreed or strongly agreed that 'anticoagulant education was delivered at the correct time' and a strong preference for face-to-face education while in hospital over a post-discharge phone call was expressed.

Improved Communication

Education sessions to patients would not be provided without clear instructions about the dose and duration of the anticoagulant as well as information about related changes to other medicines. The development of a standardised electronic referral note improved the efficiency of communication between clinical pharmacists and technicians by reducing the number of follow up calls required to gather additional information before speaking with the patient.

The automatic transfer of this information to primary care teams as a standardised summary for every patient newly commenced on an oral anticoagulant has had positive feedback from those working in the local pharmacotherapy hub where IDLs are processed. There is no longer a delay or reliance on the patient to transfer this information to the primary care team. The digital transfer ensures consistency and efficiency in communication. As one of the pharmacy support workers explained, '[It is] good to have [this information] on the IDL as [we] can see at a glance what has started, how long for and what has stopped.' The confirmation that patients have received verbal and written information during their stay has also allowed the primary care clinical pharmacists to avoid unnecessary duplication of effort in providing the same education after discharge. As one prescribing support pharmacist explained: '[This information routinely and consistently shared at the time of discharge] definitely saves time when doing IDLs as this would be something I would contact patient to clarify had this not been clear on the discharge paperwork'.

In summary this service was considered to be, 'great and really beneficial.'

Further development

Once the anticoagulation education service was firmly embedded into practice, we began expanding it to include other high risk medicines requiring education on initiation to improve safety. The list of the top ten most likely medicine groups to cause admission to hospital include diuretics (1st) and ACE-inhibitors or angiotensin-II receptor antagonists (7th).[1]

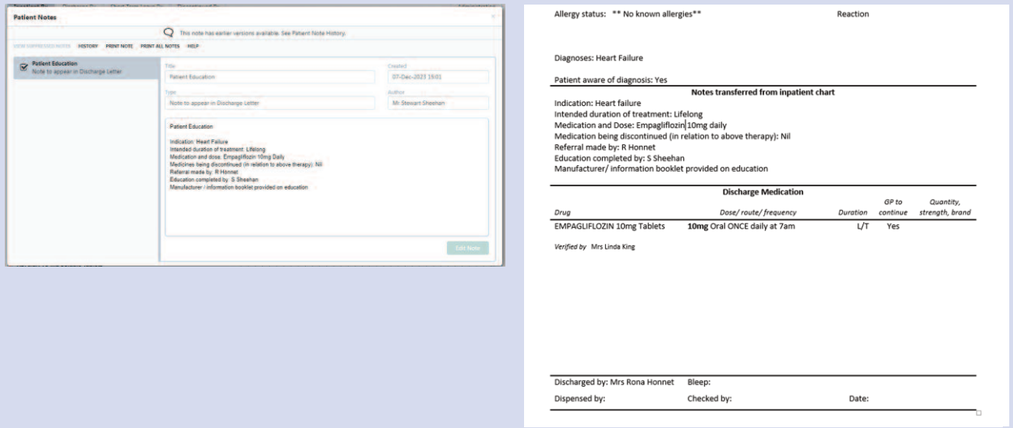


Figure 2 – HEPMA medicine education referral note (for empagliflozin) as it appears on the computer system and on the IDL sent to the primary care team.

As these are very commonly prescribed medicines where a simple intervention such as the explanation of 'sick day rules', along with provision of a Health Improvement Scotland sick day rules card,[4] may improve safety and reduce the risk of an avoidable hospital admission these were included.

A brief educational package was developed by one of our clinical pharmacists and this was completed by all of the technicians before providing supervised and then unsupervised education sessions to patients.

The engagement of the whole clinical pharmacy team in the development process has been key to the success of this service and allowed for further expansion. New topics that would be appropriate for this intervention have been identified and prioritised and several different pharmacists have been involved in developing new resources.

All clinical pharmacy technicians have now undertaken training to provide comprehensive, standardised education to promote safe use of SGLT2 inhibitors for patients with Type 2 Diabetes or heart failure in accordance with guidance.[5] With the expansion of this service, the education referral form has been adapted slightly to allow it to be used for a wider range of medicines (see figure 2).

This information will continue to be transferred to the primary care team at the time of discharge in the same way as for the anticoagulants. Further training packages are being developed so that more high quality patient education can be transferred to the clinical technician team in future.

Conclusion

The use of an electronic prescribing system (HEPMA) has allowed us to develop a robust and efficient system to provide high quality education consistently to patients discharged from hospital having commenced oral anticoagulants. Furthermore, the electronic systems put in place have allowed this service to be expanded to include other high risk medicines, making better use of the skill mix within the pharmacy department. We believe that this improves the quality of patient care both during the admission and after discharge home.

'This is great and really beneficial...'
Advanced Clinical Services Pharmacist,
NHS Lanarkshire.

Acknowledgments

Thanks to all of those who have helped and continue to help develop the educational resources for this service and special thanks to Siobhan McBride for sharing the results of her Patient Satisfaction survey.

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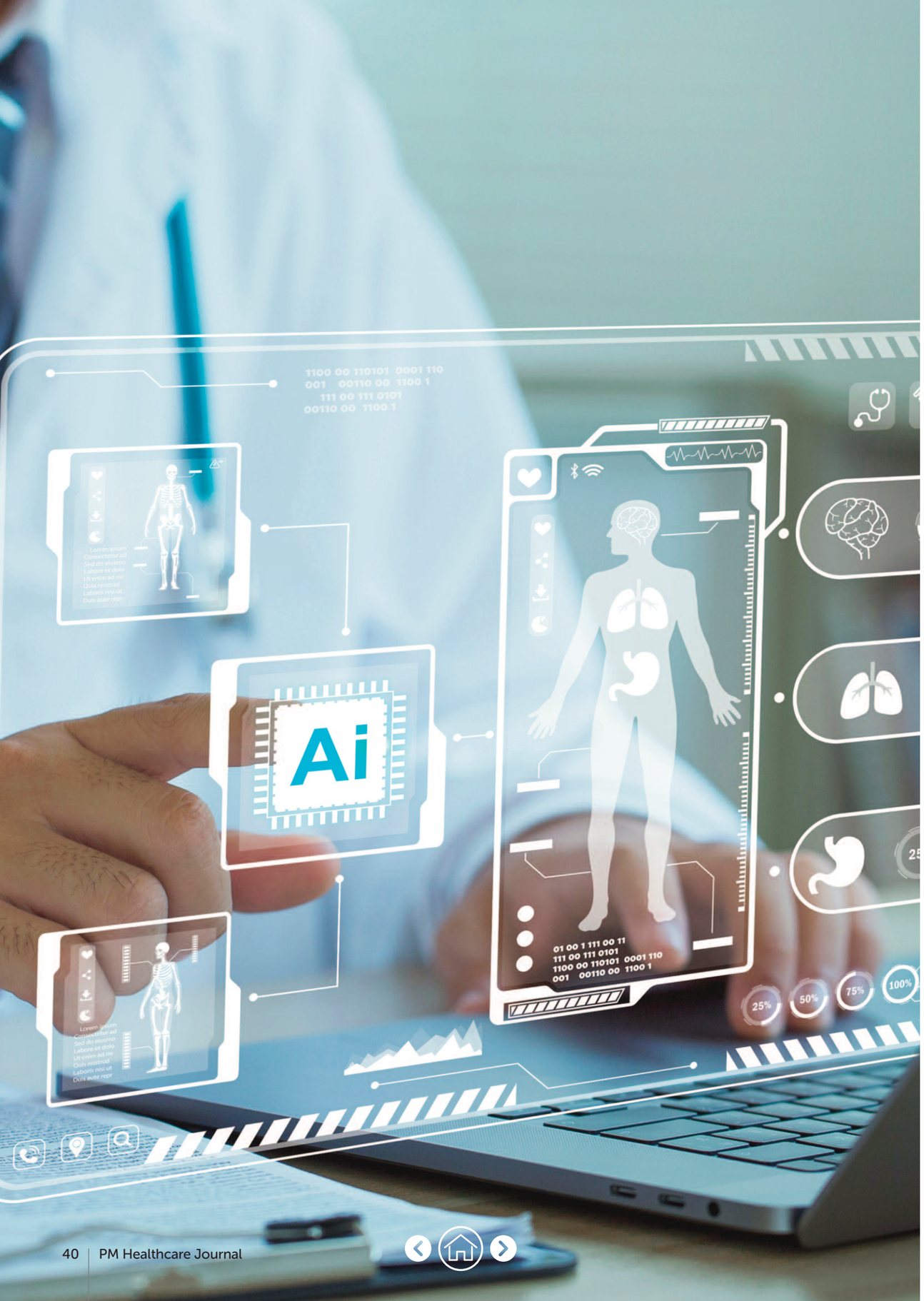

Digital Remote Monitoring: Understanding the place of digital remote monitoring in the management of long-term conditions in primary care

Reena Patel and Marsha Showman.

Reena Patel MPharm, *Principal Pharmacy Consultant, West Leeds Primary Care Network.*

Reena is a pharmacist with an extensive background in developing and leading high performing teams and capability development across ICB medicines optimisation functions, most notably, pathway development & inequalities. She is passionate and experienced in population health management approaches to tackling health inequalities to improve the lives of the poorest and most deprived faster. Reena is experienced in utilising a data-driven approach to bring together partners in tackling health inequalities and redesigning services to overcome barriers and improve patient care.

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Marsha is the Lead Clinical Pharmacist and CVD Clinical Lead for West Leeds PCN. Her role covers all aspects of CVD Prevention including Hypertension, Lipid, Heart Failure and Anticoagulation management. Marsha manages the PCN Pharmacy team and adopts a strategic approach to creating appropriate workstreams, pathways and protocols for the team. Marsha has participated in projects including the Leeds Lipid Pilot Project and the Leeds Integrated Heart Failure Pilot Project. Marsha collaborates with peers and colleagues across the system to achieve better patient outcomes and experiences.

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Background

Leeds Integrated Digital Service (supporting the Leeds office of the NHS West Yorkshire ICB and Leeds City Council) were successful in being awarded funding by NHS England in March 2023 to trial remote monitoring in a primary care setting.

People living with multimorbidity have complex health and care needs and are associated with increased total costs to the healthcare system including hospital costs, care transition costs, use of primary care, utilisation of emergency services and hospitalisations.[1] Inevitably, the complexity of these patients is placing significant strain on the system and with workforce shortages, it is necessary to ensure this population is managed appropriately to ensure best outcomes and reduce the demand on services. Digital remote monitoring can offer an alternative to monitor signs and symptoms of people living with multimorbidity and reduce the need for face-to-face appointments and therefore healthcare service utilisation.

Remote patient monitoring refers to a method of care between clinicians and patients where the patient is monitored outside of a conventional clinical setting and allows the patient to be monitored from their own home.[2] The Luscii application enables GPs and healthcare professionals to monitor and support patients safely from a distance with ad-hoc clinician support and intervention if required. This type of remote monitoring gives patients the freedom and

empowerment to manage their long-term conditions at home using the technology to aid self-care and self-management.[3]

The Luscii platform enables the remote monitoring of vital signs and initial signs of patient deterioration, and supports digital self-management and education, to improve outcomes for patients with long term conditions (LTCs). The platform gives access to specific interventions to long term conditions dependent upon the protocols and pathways developed. The functionality allows predefined supportive self-management messages and appropriate signposting to be displayed to the patients dependent upon the symptoms and measurements inputted into the app.

"The Luscii application aims to improve patient confidence and reassurance of how to manage their symptoms at home with guidance from the technology to escalate to 111 or 999 where a more acute symptom arises and allows for a lighter touch from clinicians and a less reactive way of monitoring."

Whilst this type of technology is being increasingly used in virtual wards to facilitate early discharge from hospital, it has not been fully understood in primary care. The use of digital remote monitoring technology was an ambition outlined in the NHS Long Term Plan (LTP) to support the monitoring of conditions across care settings.[4] This type of study is necessary to enable commissioners to understand the value of remote monitoring in managing people living with multimorbidity in primary care and inform clinical pathway development and redesign. Given this population tend to require multiple medicines and the need to increase and up-titrate medications to enable positive outcomes, the role of the pharmacists within this collaborative project delivery is to understand the opportunities for medicines optimisation with remote monitoring technology.

Following discussions with the Long-Term Condition (LTC) population health board at Leeds Place and discussions with primary care network (PCN) boards, it was agreed to trial the Luscii solution with patients in West Leeds PCN **(PCN A)** and Burmantofts, Harehills and Richmond Hill PCN **(PCN B)**. Both of these PCNs have large populations living with multimorbidity. All patients have a type 2 diabetes diagnosis, and at least one condition as defined in the inclusion criteria below. The project is working closely with the Leeds digital inclusion team and 100% Digital Leeds, to ensure all patients invited to take part in the pilot have access to devices, data and digital skills training so that no-one is excluded from taking part. The project is currently ongoing and monitoring will continue until the end of June, this allows for a period of 9 months of data collection. Once the project is at completion the data will be collected and a further evaluation report will be compiled. This will detail the quantitative and qualitative findings to inform future opportunities to utilise digital remote technologies by embedding the use of digital technology into current clinical pathways and to allow for the streamlining of single clinical pathways to provide a multimorbidity approach for the holistic management of patients with multiple long term conditions.

Purpose

To understand how remote monitoring can benefit primary care teams in two PCNs using different approaches. **PCN A** used an approach to identify patients who are frequent utilisers of services to assess how remote monitoring could reduce utilisation in terms of GP and other healthcare professional appointments, improve capacity, improve medication management, and to understand the barriers and challenges to implementing digital remote monitoring. **PCN A** monitored patients with multiple long-term conditions including, heart failure (HF), Type 2 diabetes and chronic obstructive pulmonary disease (COPD).

PCN B monitored patients with a mental health condition, Type 2 diabetes & COPD or HF but who are infrequent utilisers of services and have poor engagement to understand whether the technology would re-engage the patients and increase their utilisation of services.

Overall, the purpose is to implement the use of Luscii digital remote monitoring technology to help patients self-manage their long-term condition(s) and to gain a better understanding of how the use of remote monitoring could be integrated within local clinical pathways to optimise patient outcomes. The findings from the pilot could inform future use of digital remote monitoring applications at scale using a population management approach within Leeds.

Aims

1. Assess the patient experience and benefits, potential hospital avoidance, improved mental health, improved medication management and reduced requirement for interventions from healthcare professionals for patients being monitored.
2. Assess the practical acceptability and feasibility of remote monitoring technologies for LTCs from the patient perspective.
3. Describe the conditions for implementation of remote monitoring technologies for LTCs from the staff perspective.
4. Describe the benefits (including financial benefits when possible) associated with the remote monitoring of LTCs.
5. Determine which factors support the successful implementation of remote monitoring technologies for LTCs for both patients and healthcare services.

Methods

In preparation for patient onboarding, detailed discussions between clinicians, project leads and Luscii took place to ensure protocols, standard operating procedures and process flows were approved for use in Leeds. Digi Safe, a clinical safety expertise company, was chosen to support with this work.

PCN A used a group session onboarding process and **PCN B** invited patients individually for onboarding. Patient onboarding to the platform was supported by administrative staff, clinicians, Luscii staff and a member of the Leeds digital inclusion team. All members of the onboarding team supported patients on how to measure their own blood pressure, weight, and oxygen saturation, and how to report these findings using their device back to the GP practice. Individuals were encouraged to access real-time insights, receive timely notifications, and securely communicate with their GP practice. Patients who agreed to be part of the pilot were provided with the necessary equipment, skills, and training to allow them to use the product with confidence at home.

Clear inclusion and exclusion criteria were set out prior to onboarding patients into the project for both PCNs.

Inclusion Criteria

1. Diagnosis of a mental health condition, including serious mental illness (mental health register), anxiety or depression
2. Diagnosis of Type 2 Diabetes
3. Diagnosis of chronic obstructive pulmonary disease
4. Diagnosis of heart failure
5. Patient is a frequent attender (20 or more appointments in the last 12 months)
6. Patient does not engage with the service (not attended any annual NHS Health Checks)
7. Ability to use electronic device/app following training and support.

PCN A invited patients individually for onboarding. All patients should meet criteria (2, 5 and 7) and either (3 or 4).

PCN B used a group session onboarding process. All patients should meet criteria (2, 6 and 7), and either (1, 3 or 4).

> "Leeds digital inclusion team and 100% Digital Leeds ensured all patients invited to take part in the pilot have access to devices, data and digital skills training to avoid digital exclusion."

Exclusion criteria for both PCNs included patients with severe frailty, undergoing palliative care or are end of life patients with end stage heart failure, patients with severe cognitive impairment, patients with Type 1 Diabetes or insulin dependent diabetes, patients receiving care under community teams and those undergoing multiple appointments with district nurses.

Data Collection

Health Innovation Yorkshire and Humber (HIYH) have been contracted to provide the evaluation of the pilot and will be submitting their evaluation report to NHS England in August 2024. They will be evaluating if using the technology in a primary care setting:

- Improves quality of life / health and wellbeing / mental health
- Frees up GP appointment time to focus on the patients they need to see
- Improves capacity for clinicians who are delivering services
- Frees up patient time, reducing the amount of GP appointments they require
- Leads to hospital avoidances
- Enables conditions to be managed more effectively
- Improves medication management

Patient Experience

Question sets were provided to patients via the Luscii app to support the measurement of the impact of the redesigned care pathways supported by the Luscii technology on patients' health and overall wellbeing. These question sets were not mandatory and remained anonymous, therefore the results of these will need to be considered alongside other quantitative and qualitative measures that will be captured as part of the evaluation to give a full picture of the impacts and should not be taken as a standalone measure of impact.

Question sets were provided to patients 14 days after they began using Luscii, to allow time for patients to settle in to using the technology and the redesigned pathways. They were then provided on a quarterly basis throughout the duration of the pilot. The question sets are based on standardised healthcare and wellbeing evaluation frameworks: EQ-5D-5L (which includes themes of mobility, self-care, completion of usual activities, pain/discomfort and anxiety/depression) and SWEMWBS (which is a mental wellbeing scale).

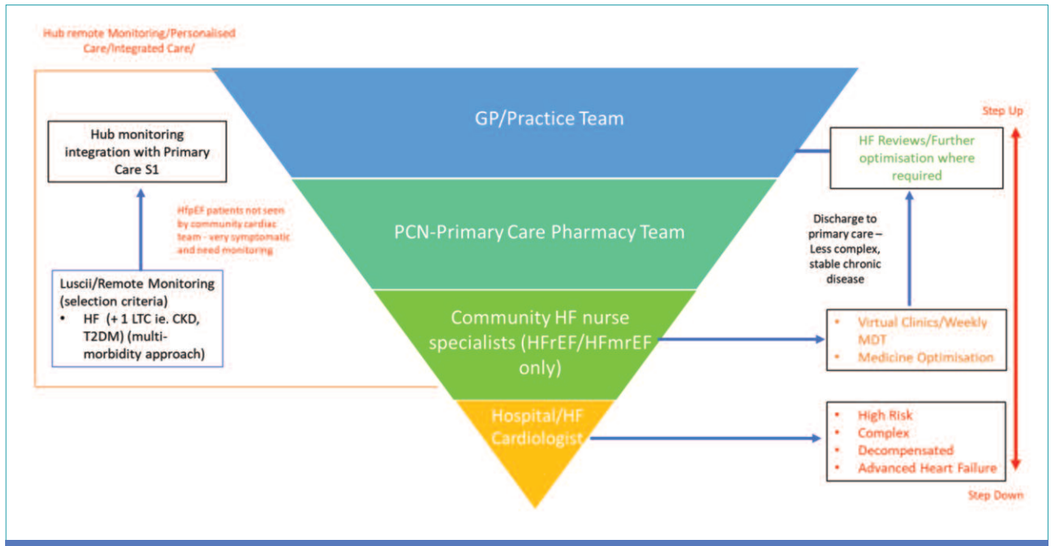

Figure 1: Model to demonstrate the potential opportunity for the use of digital remote monitoring in a primary care hub style model for the Heart Failure Pathway

Healthcare Utilisation

Data to indicate number of appointments, hospital admissions and number of patient contacts for the same time period the year before using Luscii (no digital remote monitoring) and for the time period whilst using the Luscii app will be extracted from the GP clinical system for patients taking part in the project to establish if there was a change in healthcare utilisation.

Potential Opportunities

There are multiple opportunities for improved outcomes with digital remote monitoring for medicines optimisation, figure 1 explores the opportunity within the heart failure (HF) pathway.

- HF Pathway optimisation 1 - Patients with new-onset heart failure where there is a need for rapid up-titration of medication, there may be scope for rapid up-titration service using digital remote monitoring. There is an opportunity for better outcomes for patients who can use digital remote monitoring to self-monitor BP, heart rate and symptoms and report through the app to the GP with increased efficiency for medicine up-titration. A study has shown that remote up-titrating of heart failure medication might be the solution to rapidly optimise heart failure treatment to maximal tolerated doses.[5] This demonstrates one pathway opportunity for digital remote monitoring for patients eligible for rapid up-titration of heart failure medication.
- HF Pathway optimisation 2 – Some patients discharged from virtual wards to home require daily home visits to monitor clinical signs and symptoms and observations. Introducing digital remote monitoring at the point of discharge to a hub style model would reduce the need for daily visits and increase capacity across the system.
- HF Pathway optimisation 3 – Currently all patients with a diagnosis of heart failure with preserved ejection fraction (HFpEF) are managed in primary care with no input from the community cardiac team. This group of patients are often extremely symptomatic and need input for symptom control therefore occupy a greater proportion of appointments. Introducing digital remote monitoring for some patients within this cohort would reduce the need for multiple appointments and follow ups in primary care.

Whether remote monitoring is carried out via virtual wards or using a lighter touch as trialled in

this pilot, it represents opportunities for patients to be safely monitored at home giving patients more reassurance and more information about their own health conditions which in turn provides patients with a positive experience.

Declarations

Funding for the pilot project has been awarded by NHS England and the digital remote monitoring application has been provided by Luscii.

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Improving cardiovascular disease outcomes of CORE20PLUS patient population using a digital point of care cholesterol test technology

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I am an Advanced Pharmacist in the Medicines Optimisation Team for Leeds and one of my roles is to improve access of new lipid lowering medicines to reduce patients' risk of heart disease. I led on a collaborative project with South and East Leeds GP Group called 'Healthier Cholesterol for Your Community' for the Innovation for Health Inequalities Programme (InHIP) and another system transformation project with Leeds Teaching Hospitals NHS Trust to improve lipid optimisation by upskilling the PCN workforce from the most deprived areas across West Yorkshire.

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Declaration of interest: None

Introduction

Premature cardiovascular disease (CVD) mortality rate[1] and levels of poorly optimised lipids among patients with CVD[2] are higher in the most deprived areas of Leeds. According to the *NHS Long Term Plan:*

> **"CVD is the largest cause of premature mortality in deprived areas and early detection and treatment of CVD can help patients live longer, healthier lives[3]"**

Using Innovation Health Inequalities Programme (InHIP) funding, an integrated outreach multidisciplinary team (MDT) was piloted by West Yorkshire Integrated Care Board (WYICB) in partnership with South East Leeds GP Federation Group to reduce CVD risks among people from the most deprived areas in Beeston and Middleton (Leeds) with Index Multiple Deprivation Score of 1, as well as the Gypsy and Travellers' communities, where traditional access to the health system was identified as a barrier. This follows the COREPLUS5 approach to target health inequalities in the most deprived 20 per cent of the national population, ethnic minority communities as well as health inclusion group on one of the five clinical areas of focus – optimal lipid management.[4]

Beeston PCN had a higher proportion of Black and Asian communities compared to that of Leeds, and Leeds observatory intelligence reported that African, Pakistani and Indian communities were the top three ethnic minority groups with the highest percentage of CVD.[1] Average life expectancy of Gypsy and Travellers' communities was approximately 50 years of age, compared to the Leeds population of around 78 years, and many remained unregistered with GPs.[5]

The main goal of this pilot was to improve access to testing, screening and diagnostics leading to better identification and treatment of people at risk of CVD. The digital innovation introduced was using PocDoc® lipid test to perform Point of care Cholesterol Test (POCT). PocDoc® has, 'Built the first digital end-to-end CVD health check pathway that includes a quantified lab-grade 5 marker cholesterol test'.[6]

By using PocDoc® to engage the community in the outreach service, the MDT aimed to increase the target communities' awareness of their cholesterol levels and heart health. Working with PocDoc®, the Simon Broome questionnaire was integrated in their digital assessment, so everyone tested in this pilot was actively screened for Familial Hypercholesterolaemia (FH). The Simon Broome questionnaire asked for a patient's cholesterol

levels, family history and physical symptoms of high cholesterol like xanthoma; based on the answers, a score is provided to assess if the patient has definite FH, probable FH or is unlikely to have FH.[7]

Benefits of the PocDoc® lipid test are that the test user receives a copy of the digital result and its visual results displayed on the screen, which serves as a good engagement tool. It is more than a cholesterol test, it provides the ability to do a heart assessment through their integrated QRISK calculator. The MDT described a 'golden 7-minute' period while waiting for the PocDoc® test result, whereby the clinicians have protected time for full engagement with the patients to gather information about them and provide them with important diet and lifestyle advice. By identifying more people at risk of CVD and getting them appropriately treated with a statin, the pilot aimed to narrow the health inequalities gap for the targeted population.

There are some limitations with the PocDoc® digital technology. For example, it is currently not integrated with GP clinical systems, so during the outreach CVD service, clinicians had to manually enter the POCT results onto patients' GP records. There is extra cost associated with each PocDoc® lipid test, so additional funding would be required. It also requires internet access for the technology to work, but this did not pose a barrier to the outreach CVD service as mobile phone coverage allowed for tethering access to the internet. The test results had detection limits for the cholesterol markers narrower than those of venous blood test.

PocDoc® POCT does not replace the need for a full blood test because a patient who needs to start a lipid lowering therapy still requires their liver function and kidney function to be checked. However, the instantaneous lipid levels and QRISK results give the immediate and relevant context to a clinical decision and starting point for discussion with patients about their diet and lifestyle.

Method

A weekly outreach CVD service was provided by an MDT (with independent prescriber clinical pharmacist, pharmacy technician, dietitian and health and wellbeing coach) between September 2023 and February 2024. The service was offered to people aged 18+ years and included measuring blood pressure (BP) and lipids, offering diet and lifestyle advice. Where applicable, BP and lipids were optimised in accordance with NICE guidance. Three community hubs were identified for the service to be delivered in conjunction with foodbank and warm hubs. The MDT was integrated with Beeston, Middleton and Hunslet primary care networks, which allowed MDT access to GP clinical records of their patients from targeted GP practices. This digital integration facilitated the MDT to provide appropriate clinical interventions during the outreach service. Anonymised patient output data was collected by PocDoc® and the MDT.

Results

The outreach CVD service engaged 203 people in the community, of whom 16 identified as Gypsy and 74 identified as from Asian or Black ethnicities. 48% (n=97) were registered with targeted practices. Table 1 below shows the number of people tested and screened for increased CVD risk.

According to the 165 screens analysed by PocDoc®:

- 68% (n=112) were from postcodes of deprivation where CVD morbidity is high
- The average age was 48 years where 65% (n=102) were above 40 years old
- 61% (n=101) were female.[8]

Using PocDoc® digital screening, 16 people were identified with a QRISK score ≥10%, were not on a statin and never had a cholesterol check in the last five years. Nine of whom had QRISK ≥20%.[8]

"PocDoc® screening was received positively in the community, with 97% of responders (85 out of 89) saying it was more convenient than going to their doctor.[8] This means that the outreach CVD service successfully engaged diverse populations in the most deprived area, and by using PocDoc® digital innovation, people with a high risk of CVD were identified."

Screening activity	Number of people	Number (%) of those out of range
BP check	180 (132 for primary prevention, 8 for secondary prevention, 40 unknown)	66 (33%) with BP >140/90 mmHg
POCT results from PocDoc®[8]	165 (159 for primary prevention, 6 for secondary prevention)	102 (62%) with dyslipidaemia*
		43 (26%) with QRISK score ≥10%
		26 (16%) with QRISK score ≥20%

Table 1: Number of people tested and screened for CVD risk

** Dyslipidaemia defined as total cholesterol > 5mmol/L or non-high density lipoprotein cholesterol > 4mmol/L or triglycerides > 2.3 mmol/L.*

Following testing, 42 people were signposted to their GP for further blood tests and follow up, two of whom were referred for FH investigation. One patient was newly diagnosed with hypertension by their GP following referral by the outreach service. By having digital access to the GP clinical system of targeted practices in the community hubs, 36 people (18%) had in-depth clinical reviews with an MDT member. Subsequently, five patients were initiated on a statin for primary prevention of CVD and one patient restarted on BP treatment by the outreach team's pharmacist.

Discussion

The Number Needed to Treat to prevent a composite cardiovascular outcome over one to six years was 78 for statin in primary prevention of CVD in adults.[9] Due to limitations of the project period, limited time of the MDT service and the small target cohort size, we were unable to demonstrate the impact on CVD outcomes. However, the outreach CVD service showed it supplemented existing GP services with its extension into communities, and was able to positively contribute towards reducing CVD risk through lipid optimisation.

The service had been able to reach patients who would not normally visit their GPs. Some barriers included personal time constraints and cultural reluctance to see their GPs for screening.[10] This service raised awareness around CVD prevention and provided the opportunity for community members to engage with healthcare and have access to new digital innovations for POCT.

Conclusion

The outreach CVD service overcame traditional barriers and improved access of target populations to BP and cholesterol checks as well as medicines optimisation to improve CVD outcomes. There is currently a wide range in POCT device performance, and no medical device guidance is available from NICE.[11] Digital innovation using PocDoc® lipid test was useful in increasing awareness of cholesterol health in the community and helped identify those at risk of CVD for treatment. However, this does not replace venous lipid blood test and cannot be used solely to base clinical decision.

Limitations of this study included: 1) small sample size and large majority of those in primary CVD prevention cohort; 2) accuracy of information entered by participants during PocDoc® assessment and by our MDT for data collection; 3) lack of access to full GP clinical records for participants outside of targeted practices.

Given lipid optimisation is one of the five clinical conditions under the CORE20PLUS5 strategy, POCT digital technology in a CVD outreach model should be considered by our integrated care boards to help accelerate identification of those with high CVD risk and high cholesterol levels that require further clinical interventions. From this pilot, we recommend using non-medical prescribers with digital access to GP clinical systems in future CVD outreach models to enable appropriate clinical intervention to be done in a timely manner, reducing further barriers to access and loss to follow up. It would require screening larger number of targeted populations (aged 40 years and above) to realise NHS savings and improve CVD outcomes.[8]

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Impact of the Introduction of the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system on the quality of interim discharge letters at a district general hospital

Rona Honnet and Helen Barclay.

Rona Honnet is a Principal Clinical Pharmacist at University Hospital Wishaw, providing pharmaceutical care predominantly to medical patients and collaborating to develop clinical pharmacy services across the acute site and health board. She also works as a Senior Specialist Tutor for NES Pharmacy, developing educational resources for postgraduate pharmacy staff with a focus on developing clinical decision making skills, and was recently appointed as a Visiting Lecturer at the University of Strathclyde.

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Helen Barclay started her pharmacy career at Glasgow Royal Infirmary, then moved to University Hospital Wishaw, where she is currently a Principal Clinical Pharmacist. In her current role Helen contributes to the management and development of the clinical pharmacy services locally and she is also the Lanarkshire member of the NAPS clinical group. While in her current role she co-ordinated a national online training program about medicines for all junior doctors in Scotland and has contributed to a variety of publications and presentations relating to this work including the Wyeth Education and Training Award.

Introduction

In 2021 University Hospital Wishaw introduced the Hospital Electronic Prescribing and Medicines Administration (HEPMA) system. This system is used in all adult wards with the exception of the maternity unit. Since moving to the HEPMA system the process for producing and reviewing interim discharge letters (IDLs) has changed considerably and it was speculated that this may change the frequency and nature of the problems identified as reported by Maule.[1] Electronic prescribing systems have previously been found to reduce the number of drug-related errors.[2]

Patients in all areas covered by the clinical pharmacy service are reviewed on admission and periodically throughout their stay, with the frequency depending on the perceived level of need (as determined by a combination of the use of a validated electronic screening tool designed to be used with HEPMA[3] and the clinical judgement of the individual pharmacist). Wherever possible, the IDLs are clinically screened on the ward by a clinical pharmacist with access to the patient, their multidisciplinary notes and the multidisciplinary team. At the weekends, when there is no resource to provide ward-based clinical services, IDLs are screened in the dispensary using only the information available on that discharge prescription. This limits the opportunity for a robust medicine reconciliation and safety check.

Meta-analysis of 17 studies of pharmacist involvement in medicines reconciliation at the time of discharge demonstrated that this intervention improves safety, reducing the number of re-admissions to hospital and A&E attendances.[4] A wide range of prescribing errors has been reported during evaluation of the pharmacists' input, with more than a quarter of all prescriptions previewed in the dispensary requiring intervention of some kind.[1]

Previous audits of pharmacist screening of IDLs on our site have consistently shown a high rate of interventions. During the last audit at University

Hospital Wishaw in 2015 the most frequently reported errors were, in order of occurrence, 'wrong dose (including the frequency) prescribed', 'medicines missed', 'allergy not recorded' and 'illegal prescription'. These results were found to be broadly consistent with those revealed in previous years.

Traditionally, pharmacists would have to be paged by ward staff to come to the ward to review paper prescriptions. This process may then involve looking at multiple paper sources of information, including the inpatient medication chart, multidisciplinary case notes, supplementary notes and the pharmaceutical care plan. The pharmacist would check that all of the medicines were accurately transcribed from the inpatient chart and manually annotate any additional information required onto the small space available at the bottom of the IDL.

"With the introduction of an electronic system, medicines can be transferred directly from the inpatient chart to the IDL, limiting the risk of transcribing errors or accidental omissions. Medicines that were withheld on admission for clinical reasons or that required a review before discharge are also more easily identified. With dedicated fields for dispensing 'Pharmacy' notes and 'Medication changes' these details are more likely to be completed."

The aim of this investigation was to describe the nature of the pharmacist screening of HEPMA IDLs in terms of the issues identified and the time taken to resolve these issues.

The objectives were:

- To characterise the interventions made by pharmacists during screening of IDLs
- To compare the pattern of activity from the present HEPMA audit to previous results from an audit of the old paper-based system
- To determine whether the introduction of the electronic prescribing system had improved safety

Method

This investigation was conducted in October 2023, two years after the implementation of the HEPMA system at University Hospital Wishaw, a 626-bed district general hospital in Lanarkshire. It is the largest of three hospitals in the third largest health board in Scotland. The Pharmacy Department at University Hospital Wishaw consists of approximately 26.2 whole time equivalent (WTE) pharmacists, 17.8 WTE pharmacy technicians and 15.3 clerical and support workers, excluding peripatetic staff.

To reflect the move towards paperless working, an electronic data collection form was designed and piloted. This was circulated to all pharmacists working in the relevant wards or in the dispensary. For one week (7 consecutive days) pharmacists were asked to complete this electronic data collection form for all HEPMA-produced IDLs from Acute Admissions (adults only), Medical, Medicines for Older Adults, Surgical and Orthopaedic wards screened either in the wards or in the dispensary.

The results from this data collection week were compared to the findings from the same patient groups during a discharge prescription audit in 2015 conducted Monday to Friday in the same patient groups to identify any changes that may have occurred with the move from paper-based to electronic based prescribing on HEPMA.

Results

Present study using digital IDLs

One hundred and twenty four prescriptions (IDLs) were included in the audit of which 104 (83%) were screened on the wards. The majority (18/20) of the prescriptions that had a dispensary screen were

from acute receiving areas outside the main medical admissions unit that do not have regular clinical pharmacy cover (e.g. Accident and Emergency, Ambulatory Care Unit, Short Stay Ward). Two were screened at the weekend when there is no clinical pharmacy service.

Overall 62% (n=77) of prescriptions required some intervention by the pharmacist with 60% (46) of those requiring the prescribing doctor to be contacted. The average amount of time taken to screen a prescription was 10 minutes if this was done in the ward by the clinical pharmacist and 6 minutes in the dispensary, giving an overall mean of 9 minutes per prescription. Pharmacists were asked to record the actual time spent actively dealing with the prescription rather than using the time from picking it up until it was completed, not including time spent waiting for an answer from medical staff regarding prescribing concerns.

The most common intervention was to add one or more medicines that had been omitted from the prescription, either because they had been accidentally missed or because they had been suspended during the admission and not restarted. Missing medicines were reported for 20 prescriptions however several of these appeared to have multiple medicines omitted. (e.g. 'Various medicines withheld and some restarted on discharge'; 'medicines reconciliation issues not resolved and medicines added to the discharge prescription'). It was, therefore, difficult to obtain an accurate rate (occasions per prescription) of missing medicines.

The next most frequent intervention was to add or correct the intended duration of therapy, which occurred 16 times (0.13/ prescription). Examples of this included correction of antibiotic duration and addition of a course length for dual antiplatelet medicines. There were 13 medicines that had been prescribed that were removed from the IDLs (0.1/ prescription). These included rapid action insulin, amitriptyline that was no longer clinically appropriate and nebulised bronchodilators. Four additional examples of the wrong medicine having been prescribed were noted (0.03/ prescription), including one instance where the medicines prescribed were intended for a different patient.

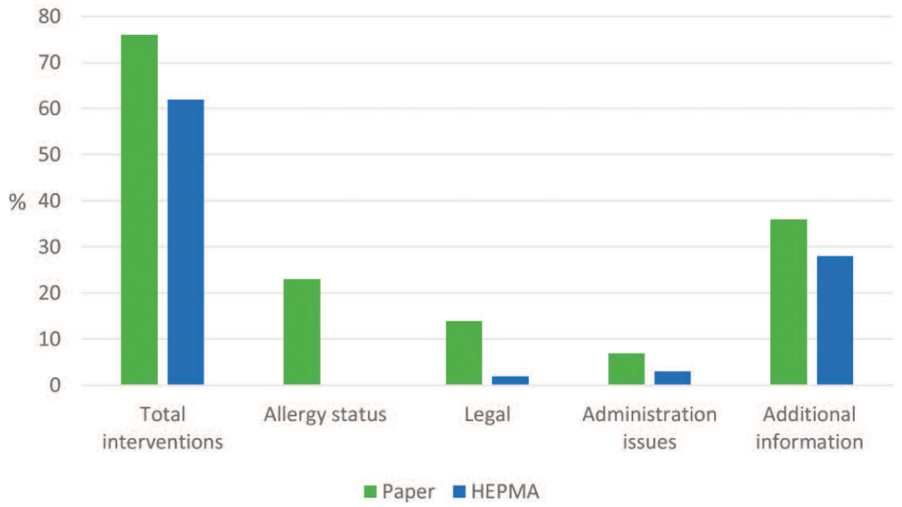

Figure 1 – HEPMA anticoagulation education referral note as it appears on the computer system and on the IDL sent to the primary care team.

Less commonly the dose or frequency of a medicine required to be changed, with four (0.03/ prescription) and three (0.02/ prescription) examples respectively being noted. On two prescriptions (approximately 2%) interventions were made to ensure compliance with the legal requirements for controlled drug prescribing.

Not all of the interventions made were to correct errors. Information was added regarding changes to medicines or monitoring required to ensure good continuity of care on 35 (28%) of the prescriptions (encompassing 73 different issues, 0.59/ prescription). Another four (3%) had information added to facilitate medicine administration at home using blister packs or medicine administration records for carers for example. There were no prescriptions requiring the allergy status to be documented to ensure safe prescribing.

All of the unnecessary medicines, incorrect medicine doses and frequencies, incorrect formulations and legal concerns were identified during clinical screening on the ward. Dispensary screening uncovered one prescription with missing medicines, one wrong medicine prescribed and one duration of therapy that required clarification.

Comparison with the previous outcomes using paper-based prescribing

Data were available for a week-long audit of discharge prescribing in 2015 as well as for a single day snapshot later the same year that showed broadly consistent results. The average time taken to screen a single prescription was the same: 9 minutes. The intervention rate was higher in both of the 2015 audits, with 76% (163 of 214) and 80% (32/40) of prescriptions being amended respectively, compared to 62% in the present audit of electronic IDLs.

The most significant change was in the recording of the allergy status, with 14.5% (31/214) and 23% (9/40) of prescriptions having had this amended. There were no recorded instances of an incomplete allergy status in the present audit. When allergy status interventions were excluded, the intervention rate was otherwise the same as for the present audit, at 62% (132/214). Amendments had to be made to 14% (n=30) and 18% (n=7) of prescriptions to make them legal using the paper based system compared to 2% using HEPMA. Figure 1 illustrates these differences.

The frequency of occurrence of other prescribing interventions is shown in figure 2. The greatest changes were seen in the rate of intervention to correct the dose and frequency of prescribed medicines with the rate falling from 0.19 and 0.08 per prescription to 0.03 and 0.02 per prescription respectively. The rate of changes to the prescribed duration and formulation were also noticeably lower. The rate of identification of the wrong medicine being prescribed was unchanged although it should be noted that prescribing of medicines that were no longer necessary or appropriate was not recorded in previous audits.

There was little change in the proportion of prescriptions where documentation of additional information was recorded with 36% (78/214) in the earlier audit compared to 28% (35/124) in the present study of the electronic prescribing system. The occurrence rates for the identification and correction of medicines that had been missed from the IDL are not included in figure 2 as it was difficult to determine an accurate figure in the recent audit with which to compare the previous audits, which also had widely differing rates. There were 42 medicines missed in the 2015 week-long audit, a rate of 0.2 per prescription. In the later one-day snapshot this rate increased to 0.58/ prescription. With the incomplete documentation on data collection forms for the electronic prescribing system, the range is estimated to be 0.24-0.32 missing medicines per prescription based on a range of 2-4 medicines missed where "various medicines" were indicated.

Discussion

The introduction of an electronic prescribing system would be expected to improve the quality and safety of prescribing in hospital and at discharge. It is impossible to prescribe any medicines for any patient before the allergy status has been documented and interactions are highlighted when individual medicines are prescribed. The system also offers dose prompts and can be set to a specific duration of therapy for example. While it is possible for the wrong item to be selected from the drop down list of medicines, the need for interpretation of the prescriber's hasty handwriting is eliminated. It is substantially quicker for the prescriber to complete the IDL using HEPMA as medicines can simply be transferred from the inpatient chart to the discharge with a few clicks.

As well as saving time in transcribing the medicines this also vastly reduces the likelihood of transcribing errors such as the wrong patient details being transferred, medicines being missed or incorrect dosing information being prescribed. It should be noted, however, that there was one instance of medicines being electronically prescribed for the wrong patient, highlighting the need to check that the correct electronic record is being accessed. The time saved on transcription of medicines is used to provide a much more

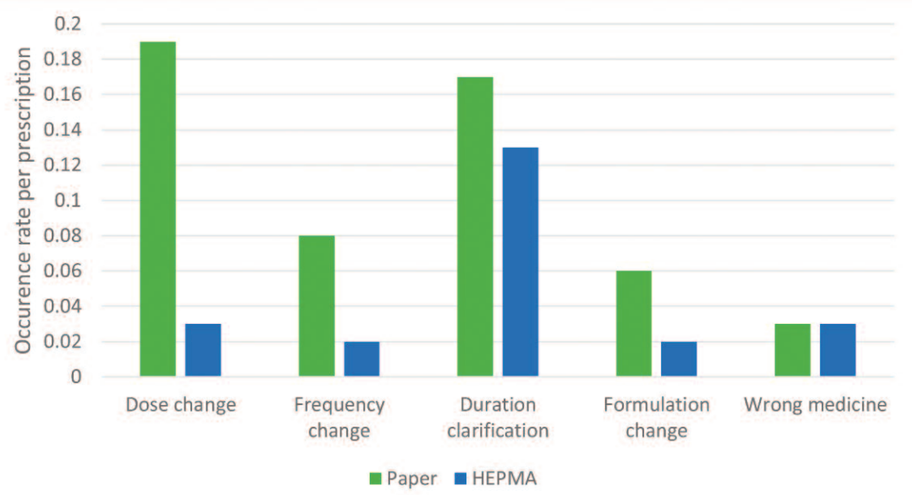

Figure 2 – rates of specific prescribing interventions recorded with the paper-based vs electronic IDLs

Discharge screening typically will involve consideration of the following:

- If medicines have been stopped, was it deliberate and permanent?
- Are new medicines intended to be continued on discharge? If so, for how long?
- Are plans in place for appropriate monitoring and has this been communicated?
- Is the patient able to take their medicines effectively at home? Is help needed?

Box 1 – Brief summary of some of the considerations made during clinical screening

comprehensive letter to the GP, with a brief clinical progress being written where only a single line diagnosis was given before. Similarly, the ease of transferring the medicines from the inpatient chart to the IDL does not mean that the clinical pharmacists' screening process is quicker as each drug has to be individually 'verified' by the pharmacist. It is, however, easier to see which medicines have and have not been transferred and to identify medicines that had been temporarily withheld ('suspended') during the admission and review the longer term plan for those.

In the present audit the average time taken to screen the IDL was found to be similar to that recorded previously (mean of 9 minutes in both cases). There was, however, disparity between those IDLs screened on the ward vs the dispensary (mean 10 minutes on the ward vs 6 minutes in the dispensary). This would explain the much higher rate of intervention for clinically screened prescriptions, both in the identification of prescribing errors and more proactive improvement in the quality of care such as reviewing the need for specific medicines to continue, amending the formulation to something more appropriate to facilitate administration, or specifying the duration of therapy to continue in primary care.

Overall the percentage of prescriptions requiring intervention by the pharmacist dropped from 76% for the original audit of the paper-based system to 62% in the present audit using HEPMA. As it is impossible to prescribe any medicines on HEPMA until the allergy status has been documented, it is unsurprising that the incidence of incomplete recording of allergy status dropped from 23% in the original audit to zero in the present. This accounts for the difference in the intervention rate.

There was also a lower incidence of technical interventions as the controlled drug legal requirements are automatically printed on the IDL for all necessary medicines and the prescriber only needs to sign the printed copy of the HEPMA prescription for the supply to be made. Pharmacists are now able to focus more on clinical interventions (see box 1). Figure 3 indicates typical changes that may be made as a result of this process.

The ability to transfer medicines directly from the inpatient chart to the IDL also significantly reduces the risk of transcription errors for the dose and frequency of medicines and dramatic improvements were seen in both of these when comparing the two audits. None of the changes made to dose or frequency were transcription issues on the electronic system: three were incorrectly prescribed on the inpatient chart already (enoxaparin, furosemide and levomepromazine) and three were changes to analgesic dosing based on requirements at the time of discharge. Similarly, if the appropriate formulation or device (for example, insulin pens as opposed to cartridges or the correct inhaler) has been prescribed on the inpatient chart, then it is very unlikely that it will be incorrectly prescribed on the IDL. Previously the information on the IDL was often incorrect or incomplete. For the present audit of electronic IDLs, a small number of medicines were changed at discharge because the clinical pharmacist was made aware that the nursing staff had been administering liquids to the patient due to swallowing difficulties.

A similar improvement might have been expected to be seen for the duration of the medicines as it is

DISCHARGE LETTER AND PRESCRIPTION

GP: IM TRIAL, HEALTH CENTRE, WISHAW

Patient : DAISY FLOWERS
Address: 42 HOSPITAL STREET, WISHAW

Hosp No: 0101501234
D.O.B. 01/01/50

Admission date: 18/12/23
Ward: 25

Discharge date: 23/12/23
Consultant: C Brown

Allergy status: ** recorded allergies**
Trimethoprim
sulfamethoxazole

Reaction
Rash – Major
Rash - Major

Diagnoses: Chest sepsis + AKI

Patient aware of diagnosis: Yes

Discharge Letter Notes

Pharmacy

Medication Changes

Discharge Medication

Drug	*Dose/ route/ frequency*	*Duration*	*GP to continue*	*Quantity, strength, brand*
AMOXICILLIN 500mg Capsules	**500mg** Oral THREE times daily – 7am; 1pm; 10pm	7	No	
Verified by				
AMITRIPTYLINE 10mg Tablets	**10mg** Oral ONCE daily at 10pm	L/T	Yes	
Verified by				
ASPIRIN 75mg Soluble Tablets	**75mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by				
ATORVASTATIN 40mg Tablets	**40mg** Oral ONCE daily at 10pm	L/T	Yes	
Verified by				
BISOPROLOL 5mg Tablets	**5mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by				
CLARITHROMYCIN 500mg Tablets	**500mg** Oral TWICE daily – 7am; 10pm	7	No	
Verified by				
FUROSEMIDE 40mg Tablets	**40mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by				
SALBUTAMOL 5mg in 5mL Nebules	**5mg** Inhalation FOUR times daily – 7am;1pm;6pm;10pm PRN For breathlessness/ wheeze	L/T	Yes	
Verified by				

DISCHARGE LETTER AND PRESCRIPTION

GP: IM TRIAL, HEALTH CENTRE, WISHAW

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sulfamethoxazole

Reaction
Rash – Major
Rash - Major

Diagnoses: Chest sepsis + AKI

Patient aware of diagnosis: Yes

Discharge Letter Notes

Pharmacy Please supply MAR Chart
Usual supplier: ABC Pharmacy, Wishaw Road. Tel 01698 112233. Contacted on discharge.
Medicine times rationalised to fit care package.

Medication Changes Furosemide, sacubatril/valsartan and spironolactone were withheld during admission but restarted on discharge after AKI resolved. Please recheck U&Es in one week.
Amoxicillin and clarithromycin for 2 further days to complete the course.
Amitriptyline discontinued (prolonged QT interval).

Discharge Medication

Drug	*Dose/ route/ frequency*	*Duration*	*GP to continue*	*Quantity, strength, brand*
AMOXICILLIN 500mg Capsules	**500mg** Oral THREE times daily – 7am; 1pm; 10pm	2	No	
Verified by Mrs Rona Honnet				
ASPIRIN 75mg Soluble Tablets	**75mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by Mrs Rona Honnet				
ATORVASTATIN 40mg Tablets	**40mg** Oral ONCE daily at 10pm	L/T	Yes	
Verified by Mrs Rona Honnet				
BISOPROLOL 5mg Tablets	**5mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by Mrs Rona Honnet				
CLARITHROMYCIN 500mg Tablets	**500mg** Oral TWICE daily – 7am; 10pm	2	No	
Verified by Mrs Rona Honnet				
FUROSEMIDE 40mg Tablets	**40mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by Mrs Rona Honnet				
SACUBITRIL/VALSARTAN 49/51mg Tablets	**49/51mg** Oral TWICE daily – 7am; 10pm	L/T	Yes	
Verified by Mrs Rona Honnet				
SPIRONOLACTONE 50mg Tablets	**50mg** Oral ONCE daily at 7am	L/T	Yes	
Verified by Mrs Rona Honnet				

Figure 3 – Example of a sample electronically produced IDL before and after screening by a pharmacist

also possible to specify the required duration of therapy at the time of prescribing, which can help to ensure that the course length is not unnecessarily prolonged. In the original audit of the paper-based system, interventions relating to the duration of therapy were typically to state (or amend) the course length of antibiotic or high dose steroid therapy. If this feature of the HEPMA system was being effectively utilised there ought to have been no interventions for these medicines, however, there were 8 medicines prescribed for the wrong duration (including antibiotics, potassium supplements, steroids and an anticoagulant loading dose) where the short course completion date could have been set in advance, but it was not.

Some work has already been done successfully to encourage prescribers to make better use of the "protocol" prescription facility on HEPMA at this site.[5] This feature allows a fixed term, reducing dose or complex regime to be prescribed according to the approved hospital protocol as a single action, reducing the risk of errors and inadvertent continuation of therapy.

Potential for error is also introduced when the default setting is for a "long term" prescription with "GP to continue" (see figure 3). Care must be taken to select the appropriate response when medicines are transferred from the inpatient chart. Several interventions were made to correct the course length for antiplatelets after a stroke or myocardial infarction, anticoagulants, folic acid and analgesics to avoid incorrect information being transmitted to the primary care team. The importance of these corrections, particularly when augmented by the additional communication to the primary care team should not be underestimated in terms of patient safety. A recent systematic review found that the rate of unintentional medication discrepancies or errors in adult patients after discharge was around 50%.[6] The drug classes most commonly implicated in adverse drug events were antibiotics, antidiabetics, analgesics and cardiovascular drugs, which were all included among the interventions made during this study.

Similar rates of intervention to provide additional information about the prescribed medicines and in

particular changes to the prescribed medicines were seen although it is difficult to ascertain exactly how much information was imparted in either study from the data collected. The present electronic system does prompt the original prescriber and the screening pharmacist to add additional information and the space to do so is far less limited than it was on the paper prescription, encouraging useful sharing of details (see figure 3). In addition, this information is electronically transferred automatically to primary care teams when the patient is discharged.

Another area where there was a significant input from the clinical pharmacist was in the identification of incorrect medicines or medicines that were no longer required to be prescribed. The rate of identification of wrong medicines on the IDL was unchanged by the introduction of electronic prescribing. This may be due to the fact that the medicines were often not erroneously prescribed but had simply not been clinically reviewed until discharge. The later study included a separate category: unnecessary medicines that were "not for discharge". These medicines were considered to be correct for the patient at the time of prescribing but were no longer clinically appropriate at the time of discharge. While the system cannot be set up to prevent unnecessary continuation, the use of the Pharmacy Care Plan note on HEPMA to prompt this review by the clinical pharmacist may have facilitated this review.

Consistently the most common discharge intervention by the clinical pharmacist was to prevent necessary medicines from being missed at the time of discharge. It is hard to ascertain whether the number of missing medicines detected has increased or decreased with the introduction of the HEPMA system. It may have been expected that the number of missed medicines would decrease because of the significant reduction in the risk of transcription errors in line with the reduction in dosing errors but, in fact, the opposite may be observed. Using paper inpatient medication charts, often only the medicines that were immediately appropriate were prescribed to avoid temporarily inappropriate medicines being inadvertently administered. Current best practice in our hospital is considered to be that all current medicines are prescribed on HEPMA at admission and then those that are not suitable, e.g. because of drug interactions, temporary contraindications or changes in the patient's ability to clear them, are suspended. These suspended medicines are clearly visible but unable to be administered by nursing staff. At discharge the clinical pharmacists routinely review the suspended medicine, prompting appropriate medicines to be restarted. It is possible that a proportion of unintentionally discontinued medicines were undetected previously using the old system but there is no way to verify this.

While there do appear to be clear improvements in prescribing on IDLs that can be attributed to the introduction of an electronic prescribing system there are other factors that may have contributed to the improvements that warrant further investigation.

Key benefits of the introduction of electronic prescribing systems for the IDLs noted

- Automatic recording of allergy status
- Reduced risks of accidental ommissions or transcribing errors of dosing
- Increased awareness of medicines that were temporarily withheld on admission
- Improved communication of the clinical particulars of the admission
- Improved communication of changes to medicines and ongoing requirements
- Improved reliability of communication to primary care
- Automatic completion of controlled drug handwriting requirements.

Box 2 – Key benefits of the introduction of electronic prescribing system for IDLs

It was assumed that, as repeated audits previously had shown similar results in terms of the rate and types of interventions made, the different cohort of prescribing doctors would not have a significant effect on the outcomes. It is possible that changes to management and training within the hospital may also have had some influence on the findings. Additionally, the number of active pharmacist and other non-medical prescribers providing inpatient care may have influenced the quality of the initial prescriptions that were then transferred to the IDL. Further work will be done to look at ways to improve the education and training of all prescribers using the system to optimise the safety and efficiency of inpatient prescribing and to try to remove some of these clinical decisions from the immediate discharge period towards earlier consideration and resolution.

Conclusion

This study demonstrates that the introduction of an electronic prescribing system has significantly improved certain aspects of prescribing on IDLs at our hospital. It also emphasises that the pharmacists make significant clinical contribution to the safety of the medicines provided on discharge as well as the accuracy and quality of the information transferred to the primary care team on the IDL. Multiple features of the electronic prescribing system facilitate these contributions and promote best practice. This study did not take into account the additional contributions made at the time of discharge such as patient education or liaison with primary care teams regarding specialist supplies which contribute further to patient care.

Acknowledgments

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The governance challenges associated with technology to improve medicines safety: a sociotechnical perspective

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Conflict of Interest Statement

AS and SA have received honoraria from BD(UK) Ltd, a manufacturer of infusion devices. AS has also received unrestricted educational funding from BD(UK) Ltd to support some of the research reported here. AS is funded by the National Institute for Health and Care Research (NIHR/HEE ICA Clinical Doctoral Research Fellowship 2017-003-024). The views expressed in this publication are those of the authors and not necessarily those of NIHR, NHS England or the UK Department of Health and Social Care.

Introduction

Avoidable healthcare associated harm is a persistent problem of which a quarter is associated with medication.[1,2] The World Health Organisation lists reduction of medication-associated harm by 50% within five years as one of its patient safety strategies.[3] In England, there are almost 280 million medication errors every year, 80 million of them in hospital care settings, contributing to at least 1700 deaths and costing £168m in excess treatment costs.[4]

Technology is then attractive to policy makers and practitioners to improve safety. Medication systems are unrecognisable today compared to 20 years ago. Electronic prescribing and health records are now standard of care and tools for the administration of intravenous medicines have evolved from gravity fed infusions to automated infusion devices.[5,6] These digital administration systems generate data that can be used to explore practice and events, and can be used to support learning through linking events to patient outcomes.[7,8] Most interventions to reduce the prevalence of medication administration errors (MAEs) are administrative controls, modifying behaviours and attitudes of operators. Examples include education, policies and guidelines and distraction mitigations.[9,10] Technological

interventions for MAEs involve Drug Error Reduction Software (DERS) and Barcode Administration systems (BCMA). Administrative controls are theoretically less effective than technological interventions.[11,12]

DERS involves software-driven infusion devices that are preconfigured with a drug library populated with concentrations and thresholds for minimum and maximum doses. An alert is generated when these thresholds are breached, and where a maximum dose is exceeded, the device will not allow infusion of the medication. Parameters are grouped into 'profiles' which reflect practice in different sites within an organisation to provide a suite of safeguards that are relevant to the needs of patients in different care contexts. An inherent risk in the software systems is that they perpetuate variation in practice across complex healthcare systems, which has been identified as a causative factor in serious adverse drug events.[13,14]

BCMA is designed to mitigate wrong drug-wrong patient MAEs. Medication orders are linked to a barcode on the medication package and linked to the patient with an identifier barcode usually on a wrist band. By scanning these barcodes, it is possible to reconcile medication with patient. BCMA has been in regular use in North America since the early 2000s as a tool to satisfy assurance targets set by state healthcare funders. It has achieved reductions in MAEs of around 50% which appears to be the 'best' it can achieve even when 'bundled' with electronic prescribing and DERS.[15,16]

We have seen that technology all too often introduced new risks, and may not have the expected impact in MAE reduction.[9,17,18] This is because they're all implemented in different ways.[19] Healthcare systems are complex and dynamic and these tools are not designed or implemented with an understanding of how people work in real life, or their impact on workflows.[20,21]

We intend to explore the governance issues associated with technology for medicines safety, which healthcare systems need to take account of. We will use two case studies – one of DERS and the other of BCMA - to examine the organisational and professional implications of these systems and propose some priorities and considerations that healthcare leaders need to be mindful of when commissioning these systems.

Methods

This paper will report relevant data from two self-contained studies that have been previously published elsewhere.[22,23] Both studies were conducted with appropriate ethical approvals or waivers.

"BCMA has achieved reductions in MAEs of around 50% which appears to be the best it can achieve even when bundled with electronic prescribing and DERS."

Study 1 was a retrospective quantitative data analysis of DERS data from two large multi-hospital NHS trusts in a 12-month and reported adherence with DERS as a prevalence per 1000 administrations, and explored potentially harmful events that were avoided with DERS using a validated post-hoc severity scoring tool.2[4] We have identified specific cases in the data that suggest limitations of implementation.

Study 2 was a multicentre ethnographic study in acute paediatric wards in three English NHS trusts. The study explored medication safety processes associated with medicines in in-patient wards. A single researcher observed prescribing, preparation and administration of medicines. Further depth to these observations was added with on-site ethnographic interviews and in depth semi-structured interviews with nursing, medical and pharmacy staff, and parents and carers. One site used a proprietary BCMA system linked to computerised physician order entry (CPOE). This paper will focus on that site only and observations of the BCMA system.

We have analysed and presented the data from both studies together to provide a mixed-methods exploration of the potential governance considerations involved with technology for reducing MAEs. We have used sociotechnical theory (STT) as our lens.[25] STT is a theoretical model of complex systems, which view people as a component of the system alongside the tasks, tools, teams, organisational situation and environment. The proposition is that people are

autonomous within these systems, but are influenced by and adapt to these other factors around them.[26] This model is the underpinning theoretical approach within the NHS Patient Safety Strategy therefore will ensure generalisability into wider NHS practice.[27]

Results

In Study 1, NHS Trusts provided data for over 1.4m infusions from a 12-month period selected for database stability (i.e. no major changes to drug profiles). After removal of non-eligible infusions, around 745,000 were analysed. In Study 2, the BCMA system had been in situ for around a year and was intended to be part of routine medication administration. Multiple operations of this system were observed over the course of 90 hours observation, and interviews with nursing staff, medicines safety officers and pharmacists were conducted. Through the analysis of both studies together, several systemic issues were identified.

Tool impacts on task workflows

BCMA required the use of laptops and barcode scanners to scan medication labels and patient wristbands. In early observations, these scanners were in fixed spaces at nursing stations, requiring work to be brought to the station. It was expected that nursing staff would then use CPOE equipment to scan the patient's identity but there was insufficient equipment which were poorly suited to the task.

Two nurses park workstation outside cubicle. Logged in. Take the barcode scanner from carriage and stretch the cable as far as they could to the lower foot end of the patient's bed. Couldn't reach any further. Nurses decided to abandon BCMA and sign off prescription manually. (Fieldnote observation)

The hospital used multiple identifiers attached to wrist bands, which were meant to change during the patients journey but this often wasn't done because of inoperative printers.

'I swear I'm like IT support some days, with having to fix these bloody printers.' (Observation conversation, Nurse.)

Study 1 identified 745,170 infusions administered over 644,052 patient bed days. Only 338,263 (45.3%) were administered using DERS implying that workers operated without DERS most of the time. Thus while the devices were configured and available, there were still a large number of infusions administered without safeguards.

In later observations, the BCMA equipment had been located to a smaller specific workstation, allowing nursing staff to use them at the bedside. However, these were often sequestered by other members of the clinical team for other tasks.

'*They gave us these dedicated laptops and more barcode scanners, but you have to lock them down because the doctors still whip them away, or … the battery is flat.*' (Fieldnote conversation, Nurse)

> **"Over half of all infusions were administered without DERS safeguards in place, and many barcodes were corrupted, illegible, or not identified in the wider hospital system because patient-own-medicine use was commonplace."**

A nurse is scanning a bottle of Kay-Cee-L [potassium chloride] oral liquid, but the label is stained and faded by medicine residue. The nurse wipes the label with a wet wipe which fades the label even more.

'Right, this isn't going to scan, so I'm just going to manually sign it off…' (Fieldnote observation)

Where DERS was used, it prevented potentially harmful MAEs. There were 6067 occasions where maximum dose limits were exceeded – a rate of 17.9 events per 1000 administrations (95%CI 17.5-18.4). 668 (1.97/1000 administrations) of these events were rated to have moderate to severe potential for harm. Patterns of potential severity were explored associated with drug categories. Antiepileptics featured highly (20.86/1000) which was surprising and stimulated further analysis. These were all (64/3068 administrations) related to the administration of phenytoin over five minutes rather than 20 minutes. We explored this with the contributing sites and identified that these alerts were triggered by a legitimate change in practice to administer phenytoin quicker than referenced in established texts that was not reflected in the pump programming.

Individual and tool limitations as a driver of adaptation

Thus because of that limitation in the phenytoin programming, operators would likely engage the device to administer the medication, and in the face of the alert be prevented from administering the medicine. They would then likely either disengage DERS to allow administration at the desired rate or would administer the phenytoin by hand.

Similar limitations were observed with BCMA.

> **"Nursing staff felt that they could not deliver the care they needed to because of the inadequate equipment, and 'worked around' it."**

This was particularly evident around time-critical medicines, or in situations where nursing staff were busy and were trying to manage their tasks.

Observing a nurse preparing five oral medicines for administration. Two are in amber bottles with only a community pharmacy label on them. 'Those two don't have a barcode and it's going to take too long to do two manually and three by BCMA, so I'm just going to sign them all off manually. Get it all done in one go…' (Fieldnote observation)

There was a focus on 'on time' medication administration and it was observed that BCMA sometimes got in the way of that goal so again nurses would work around the system to meet their other priorities.

A nurse preparing an oral dose of amoxicillin. Tries to scan the barcode and an error message is presented. 'Yeah, this is going to delay patient care.' They decide to bypass the BCMA… (Fieldnote observation)

The packaging of medicines often did not provide barcodes on the final medication containers so nursing staff would scan the outer packaging. Some nurses worried that this created errors because of confirmation bias.

'So if you scan the box and it tells you the drug is correct, it could be anything, but they won't look at the bottle because they've checked the box…' (Interview 2, Nurse)

BCMA also created situations where adherence to one policy led to violation of another. Nursing staff were empowered to make formulation choices to meet patient needs, but then would have to override BCMA to meet that requirement.

'…so you've got paracetamol 120 in 5 and 250 in 5… so even though it's the right drug and you're giving the right dose, it comes up with a warning that it's the wrong dose.' (Interview 2, Nurse)

Organisational aspects and managerial assumptions

Study 1 precluded such exploration at a managerial level, however there was a strong suggestion that the BCMA system was being used by ward managers to monitor and enforce second-checking policies.

'…so the chief nurse has suggested that if it's not being used, we should just decommission it but the ward managers … say they want it for the data…' (Fieldnote conversation, Pharmacist)

Nursing staff also complained about the lack of responsiveness at a managerial level to their concerns.

'…we're the ones getting [told off] because we're not using it, but it slows us down, it doesn't work…' (Fieldnote conversation, Nurse)

Those with responsibility for medicines safety in the organisation reported compliance with BCMA as being around 4% in the study ward but acknowledged that nurses were overstretched and managing multiple priorities. However, there was still a consideration that bypassing BCMA was a sign of 'complacency' and a 'bad habit' and if nursing staff just took some more time around their work, they would be more likely to comply and make fewer errors.

'…they're giving slow-release morphine instead of regular morphine… they're meant to use [BCMA] but… they're in a rush…' (Interview 11, Medicines Safety Officer)

'Honestly, if they would just follow the procedures and guidelines… it would be so much safer' (Interview 6, Pharmacist)

Discussion

These two case studies demonstrate many of the systemic factors that affect implementation of technology, and how healthcare staff may not interact with it as expected. When dealing with complex technologies such as DERS and BCMA there is a need for an understanding of how humans interact with their surroundings, so as to understand the challenges that these systems present to healthcare workers and patients.

Work-as-Imagined versus Work-as-Done

Work-as-Imagined (WAI) represents our policies and guidelines and is rooted in an abstract understanding of how tasks are conducted. However WAI is essentially a fantasy, and does not reflect real-world activity.[28] Healthcare is dynamic and complex, and people work in an open system – they are influenced and impacted by events around them. Work-as-Done (WAD) reflects the impacts of these influences and gives insight into the routine adaptations that workers use to undertake to manage their conflicting tasks and priorities. Studies in operating theatres have identified that deviating from policies and procedures is sometimes essential to deal with specific tasks and problems and to follow them uncritically can lead to patient safety events.[29] Further, there is a wealth of evidence to suggest that policies and guidelines developed with WAD in mind are more likely to be effective interventions for safety.[20,30]

'Violation' or 'Adaptation'?

In both case studies, high bypass rates supported the conclusion that operators 'violated' DERS and BCMA because it may not have allowed them to practice appropriately. Compliance with these systems is variable in the real world. For DERS compliance estimates are between 40 and 80%, but only in the context of clinical trials.[31] For BCMA these estimates are harder to locate. A recent systematic review of 10 empirical studies did not consider compliance with the intervention.[32] It was anecdotally reported in our study that compliance with BCMA was less than 10%.

The term 'violation' has been used to describe deviation from recommended or expected action.[33-35] The term is almost 35 years old and in consideration of modern complex systems, we saw that many of these 'violations' are more likely 'adaptations' to situations where if policy and procedure is followed the correct outcome may not be achieved.[36-38] We posit that these adaptations can help service leaders understand and improve their systems. In both our case studies we have shown that practitioners bypass these systems to get the job done (in the case of phenytoin) or to ensure that appropriate medication is administered.

The BCMA case study also sheds light on the resource gaps that affect adherence.

> "Technology changes the way people work in ways that are unexpected, and staff at the sharp end felt that there was an assumption by managers that these systems would 'slot in' to existing processes. Not only was there a limited understanding of WAD at an organisational level, but there was insufficient resourcing for the systems which further rendered them unfit for purpose. This is not unique to BCMA or DERS, but these case studies exemplify the challenge. There is a need to study and understand WAD, identify the potential pinch points, and design your processes and procedures for implementation thus supporting successful implementation."

Our case studies have shown that individual operators adapt to manage their workload, accounting for patient acuity, and ensure that medicines given are on time. These 'efficiency thoroughness trade-offs' (ETTO) are natural adaptations by workers to ensure that tasks are completed, and involve a subjective assessment of the risks (to time and completeness) of a process, trading off some of the risks of non-completion with the benefits of delivery.[39] These were evidenced throughout the systems, through bypassing of DERS and BCMA because their workflows required taking additional time to complete the tasks (or in the case of DERS may not be able to complete them at all). Previous empirical research in Norway has suggested that non-compliance with BCMA can be as high as 50%.[40] Yet in our interviews, there was a prevailing sense that adherence to procedure increased risk. This was manifested by sharp end workers expressing their concern that if they followed procedure, they couldn't achieve their goals, while at the same time if they adapted to deliver their responsibilities, they placed themselves in jeopardy.

Accountability and responsibility

These technologies raise important questions around how the data from these devices is used. Both DERS and BCMA generate large quantities of contemporaneous data around medication administration. This data can support identification of trends in events across drugs, clinical areas and times of day or night.[41,42] However, there is concern that the data from these systems could be used to attribute responsibility for events to individual staff.[43-45] The case of RaDonda Vaught crystalises these concerns.[46]

Vaught was convicted of negligent manslaughter after administering a muscle relaxant instead of a sedative. She was supposed to have used an array of technologies including BCMA that were designed to prevent this, but they were all inoperative and the culture in the department she worked in meant that workarounds were the standard way of dealing with these deficiencies. She was exonerated on appeal after a court accepted those systemic contributory factors, but there is a risk of this being repeated in the NHS. There was evidence in our qualitative study of a culture that if people just followed the rules, then everything would be okay, but our data demonstrates that just isn't possible. It was also interpreted that the technology had value as a behavioural management tool which may create suspicion among the end users.

These systems must not be used to determine responsibility for specific events as they provide no contextual information. They are tools to guide organisational learning. Recommendations exhorting pooling and sharing of data across organisations to enable higher learning have yet to be actioned.[13,47,48] These devices will also provide good quality real world data on the prevalence and nature of MAEs across healthcare systems.[4,22,49] Leveraging this aggregate data will support understanding of organisational safety and feed directly into the Patient Safety Incident Reporting Framework (PSIRF).[5,27,50] Further we should capitalise on the potential benefits of machine learning and artificial intelligence by curating and analysing these data on a grand scale, to identify emerging and novel insights into patient safety.[51,52] Yet there are still insufficient resources allocated to these devices.

New governance challenges

Despite the NHS moving towards a more systems-focussed view of safety, we continue to procure technological devices to support safety without consideration of how those tasks are done and the impact of those devices on that work. With DERS we identified considerable variation in the way these systems are set up and used even at a local level, with variable nomenclature for ubiquitous medicines such as morphine that reflects a hyperlocal approach to medicines management. Both staff and devices move around organisations so localised configurations create an error-prone environment.

There are two important strategies to support these systems in improving patient safety:

1. Simplify and standardise practice.[53] Health services are not special, and there is a clear need to harmonise and standardise practice system-wide. There are standard doses for most medicines in the British National Formulary but there is variation in how these are operationalised in DERS databases. Similarly, there are frameworks for standard concentrations of common infusions (e.g. dopamine, adrenaline) in adult and paediatric settings that are still not adopted universally.[54-56]

2. Creation of a governance framework at a system level that supports this harmonisation work, considers and incorporates reflections on WAD into the deployment of these devices, and collates and curates their data.

Both these interventions have been recommended by the Health Services Safety Investigation Board (HSSIB) and the National Association of Medical Device Trainers (NAMDET) as important to improving the safety of DERS systems, and it would be reasonable to acknowledge these standards for BCMA systems as well.[13,57]

Both previous empirical studies and HSSIB suggest that systems do not take a strategic view of this work.[47] Consequently, organisations repeat configuration work. As well as being wasteful, this perpetuates systemic variation in practice and continues to place patients and staff in jeopardy. There are examples in the United States and the Republic of Ireland where a strategic approach to DERS definitions at supra-organisational levels has led to safety and efficiency gains.[58,59] Both the initial work to develop and deliver the systems, and to subsequently manage their data needs to be adequately funded. Using centralised drug libraries and BCMA standards can realise economies of scale across healthcare systems and thus may be cost-neutral.[47,60] Further, this data should be pooled and shared across organisations to support higher system-level learning.

Limitations

This paper is limited by its use of data previously collected and analysed for other purposes. While it has provided some insights into the governance and implementation challenges of these devices, further study using specific observational methods is required to fully appreciate and explore the barriers and opportunities of these devices. An additional limitation from the methods utilised in these studies is the lack of observed adverse events. In Study 1, DERS events were used as a surrogate for actual MAEs, and in study 2 no actual MAEs were observed. Therefore no causative inference can be derived from this paper, however our observations and insights are supported by the wider literature. The perspectives of managers and policy makers are excluded using datasets that are largely focussed on frontline work. Finally, there is a lack of robust study regarding BCMA in the UK context, with most study being undertaken in North American systems that are not generalisable.

Conclusions

Technology has a place in mitigating MAEs, but we have demonstrated that these systems are implemented with reference only to WAI. This leads to unexpected impacts on WAD. Workers avoided using these systems for simple reasons: BCMA was characterised by inadequate equipment, and DERS was not systematically updated. There may be a lack of organisational governance and strategic ownership of these assets, and their data. Training may be another part of it with some participants not being aware of the justification for the interventions.

> "Implementation is not a simple exercise, and these devices require ongoing human resource and expertise to maintain."

Implementation needs to be managed collaboratively owned at board level. End-users should also be involved in the implementation of these systems, to provide real-world perspectives.

If WAD is studied and plans adapted to account for it, implementation may be more effective. Furthermore, there is clear evidence that end users of these devices must adapt practice to accommodate these deficiencies and there are risks that the data from these systems may be used to lay responsibility for events on individuals, which are well supported.

We are clear that the data from these devices must NOT be used to support local investigation into single events. They provide an overall view of system performance and 'health' and are not a behavioural enforcement tool. Data should be used to support exploration and monitoring of the incidence, prevalence and nature of adverse drug events at an organisational and service level, to foster an organisation that is responsive to system conditions, and proactive system change.

If we don't take these steps, we risk wasting scarce healthcare resources and we squander opportunities for improvement.

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