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Technologies that transform: digital solutions for optimising medicines use in the NHS

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Evidence suggests that technologies that handle information on medications may improve patient safety, increase service efficiency and contribute to the provision of high-quality patient care in the National Health Service (NHS), depending on their design and configuration for use by health providers. However, these systems also have the potential to contribute to transformation of the way in which services are provided across the NHS and to enable new ways of working and new professional roles. The effective use of medicines in healthcare is dependent on the efficacy and safety of the medicines management process across the entire NHS. This would encompass prescribing, dispensing and administration of medicines in all settings, and the transfer of medicines—and information about them—across care settings. Transfers of care would include the hospital discharge process, medicines reconciliation on admission to hospital, and the complete and accurate transfer of medication-related history and recommendations at points of referral.

This article will explore the transformative potential of technologies relating to medicines and pharmacy in the NHS, focusing specifically on: (1) electronic prescribing (EP) and medicines administration, (2) robotics/automated dispensing and supply and (3) community pharmacy electronic referral systems. The article describes how the transformation these technologies enable has the potential to improve medicines optimisation in the NHS. In this context, medicines optimisation is defined as follows: medicines are used safely and appropriately across care settings by ensuring that (1) information on medicines is available in a comprehensive, accurate and unambiguous way at the point of care and (2) that the roles and skills of different health professionals are appropriately used in relation to pharmaceutical care. Due to the problems of extrapolating evidence from one healthcare context to another, the examples here are based mainly on reports of real-world experience in the UK, although this may be at the expense of extensive quantitative analysis.

A recent review of EP implementations in the UK hospitals indicated that the use of EP systems in hospitals has the potential to improve patient safety, depending on how the system is implemented in used in practice.[1] However, the authors also comment on the potential of such systems to improve quality of care through improved access to, and exchange of, clinical data to facilitate team-based care across disciplines and clinical settings. They also remark about how such systems could be used in the hospitals to actively facilitate patient/carer involvement in medicine use, something that would be an important step towards personalised care with medicines in hospitals.

While there is evidence that EP systems may increase the time taken to do some tasks,[2 3] the safety alerts and mechanisms they provide are welcomed by healthcare professionals.[2] In future, EP with closed loop medicines administration (where the medicine is verified at the point of administration) is likely to have a significant impact on reducing medicine administration errors.[4]

Even though, at present, only a minority of UK hospitals have full EP, many UK hospitals implemented EP functionality some time ago to manage the process of producing and transmitting electronic discharge summaries.[5] This enables the process of the hospital discharge to be streamlined, which enables timely discharge communications with general practitioners (GPs) and is convenient for patients and relatives. It also contributes to efficient bed management and service planning within the hospital. Another potential benefit of EP are the data on prescribing

captured by the system. If analysed appropriately, these data have the potential to contribute to evidence-based prescribing decisions and data-driven care, which could have a significant impact on health outcomes.[6]

Robotics have been long used in the retail and logistics sectors, but their adoption in the UK hospitals has enabled some transformation of the way hospital pharmacy services are provided. In 2001, the Audit Commission's report, A Spoonful of Sugar,[7] reviewed medicines management processes in the hospitals and advocated the 're-engineering' of pharmacy services to improve efficiency and safety. This led to the rapid adoption of robotics in the UK hospital pharmacies in the early years of the 21st century.[8]

Although the number of published quantitative studies of pharmacy robot implementations in the UK hospitals has been limited,[9] some benefits have been observed, such as significant reductions in dispensing errors, an improvement in dispensing process efficiency[10 11] and more efficient use of space in the pharmacy.[11 12 13] However, pharmacy robots have their most significant benefits when they are used to transform the processes of working with medicines within health provider organisations beyond the hospital pharmacy department.

Pharmacy robots have been used to decentralise pharmacy services in some UK hospitals so that pharmacy staff can be based on wards and in other clinical settings and have significant patient-facing roles. In some cases, robots have been used to manage stock in satellite pharmacies in large hospitals, making the supply chain more efficient and enabling timely supply of specialist medicines in some settings.[14] Pharmacy robots have been used very effectively in some community pharmacies to transform service provision.[15] In community pharmacies, the automation of high-volume dispensing has freed up pharmacists' time for provision of patient-facing services on a consultation basis, such as medicines review, influenza vaccination and the new medicines service. It has also released staff time to enable development of newer, more innovative, services, such as health screening services. The economy of scale that a dispensing robot can enable has also been used to operate a supply hub for a group of hospitals,[16] and the same approach could be used in future to develop a 'hub and spoke' model of dispensing in community pharmacy. With this model, a central dispensing hub will supply medicines to client pharmacies, to enable the pharmacies to focus on patient facing professional services.[17] A recent comment piece has indicated that, by implementing pharmacy automation technologies, hospitals not only save time and space, they are developing their functions and revenue streams.[18]

The use of electronic ward cabinets to control supply and use of medicines at ward level is a natural extension to use of pharmacy robots in the supply chain. Ward cabinets provide secure individual storage for medicines used on a ward and can control and record access to medicines by ward staff.[19] Ward cabinets have been shown to provide various safety and quality of care benefits, such as reductions in the number of missed doses, delayed medicines, medication administration errors, ward stockholding and in the time taken to administer medicines (especially for controlled drugs).[20 21] However, ward cabinets may also be used to support personalised care with medicines. This might include the administration of medicines directly to a patient from a bedside or room locker, or support for patient self-administration, where the cabinet would be configured to operate with a personal identification number (PIN) or access code for each individual patient.

Both EP systems and automated ward cabinets may use bar codes for medicines administration, whereby the patient's bar code needs to be scanned and verified before administration of a medicine can take place and be recorded.[5] However, system implementers should consider that the more control the system exerts at individual patient level, the more disruptive the technology may be to current work processes. This disruption may necessitate workflow changes to enable the benefits of the system. However, it may also lead to staff developing workarounds to circumvent the system. The issue of workarounds is well recognised with closed-loop medicines administration.[22]

The third important area of digital technology in medicines and pharmacy that has considerable transformational potential is the use of electronic referral systems to refer patients into community pharmacies for the provision of pharmacy services, such as a medicines use review or a new medicine service consultation,[23] or supply of over the counter medicines. These systems also have the potential to warn community pharmacists when patients have been admitted to hospital. Community pharmacy electronic referral systems have been piloted in East Lancashire Hospitals,[24 25] with Refer-to-Pharmacy and Newcastle,[26] with PharmOutcomes. These systems are likely to become more widely available in future.

These systems provide various service efficiency and quality of care benefits. For example, they ensure that information about medicines for a patient discharged from hospital reaches the patient's community pharmacy in a timely manner, and that patients' questions about their discharge medicines at the pharmacy are pre-empted. They also help to ensure that discharge summary recommendations about medicines are actioned, that pharmacy services are provided to the most eligible people and that unnecessary dispensing is reduced to a minimum, ensuring appropriate use of the NHS resources. In the Newcastle evaluation of PharmOutcomes, referral numbers were small initially possibly due to various service and patient-related factors. However, patients who did receive community pharmacist follow-up consultation had statistically significant lower rates of readmissions and shorter hospital stays than those patients without a follow-up consultation.[26] This suggests that community pharmacy services may have a beneficial effect on patients' health in the community; a controlled study with a greater number of pharmacy referrals would

help to confirm this. In short, these community pharmacy electronic referral systems have the potential to improve the return on investment in the cost of discharge medicines. They do this by improving medicines adherence, ensuring optimum medicines use, reducing wastage and reducing the number of episodes of subsequent unscheduled care.[27]

However, what is of particular interest with community pharmacy electronic referral systems is their potential to transform health service processes and roles. These systems may ensure that a greater number of issues relating to medication discrepancies, medicine adherence and appropriate use of medicines are handled by community pharmacies, instead of GP surgeries. In some situations, these systems may, therefore, have the potential to reduce GP workload and facilitate the appropriate use of the skills of both GPs and pharmacists. These systems also have the potential to facilitate the provision of pharmacy services in settings other than the community pharmacy premises, such as in care homes and in the patient's home.

Working together, as part of an interoperable network across the NHS, these systems are able to facilitate improved medicines optimisation, defined above as the safe and effective transfer of medicines information and recommendations across care settings, and the appropriate use of skills of health professionals. EP systems will ensure that comprehensive prescribing data are captured in secondary care; electronic discharge and e-Referral systems will disseminate that information into primary care and increase the likelihood of the correct medicines information being likely at points of referral. Pharmacy robots and ward cabinets will ensure that the correct medicines are supplied and handled against the prescribing record. The use of automation in conjunction with a well-designed EP system has the potential to ensure the skills of different healthcare professionals are used appropriately in patient-facing care, thus adding value to the care process. The use of pharmacy e-Referral systems, in particular, will ensure the professional input of community pharmacists is appropriately harnessed in the NHS medicines use process. Furthermore, the medicines-related data that could be extracted from such systems—and which therefore could be made available at different points in an interoperable network—has huge potential to enable data-driven care and use of resources, if analysed appropriately. The recent development of an England standard for interoperable medicines to deal with electronic transfer of dose information ('dose syntax') has opened up the possibility of greater interoperability of systems handling medicines information in the future and improved safety at care interfaces.[28]

However, notwithstanding the strong evidence that is available for safety and efficiency benefits of medication-related digital systems within organisations, systematic research on the ability of such systems to transform the health and care economy on a larger scale, across a healthcare economy, is still some way off. However, there are three key factors that will contribute to the transformative potential of medication-related digital technologies as part of a wider system, and these will be needed to realise the vision of high-quality medicines optimisation in the NHS. They are (1) achievement of widespread interoperability, (2) appropriate flow of information through the entire interoperable system and (3) manipulation of professional roles and boundaries by the entire system.

First, interoperability is a necessary prerequisite to a systemic approach. Drawing on a review of hospital medicines supply and use technologies, Lichtner *et al* propose that EP systems are 'repositioned as only one aspect of an important wider transformation in medicine management in hospital settings, involving, for example, procurement, dispensing, auditing, waste management, research and safety vigilance'.[29] Taking a systemic approach, they argue, will help NHS leaders understand the transformational potential of interoperable systems for all stakeholders.

The second key factor is appropriate data exchange across the interoperable system. Interoperability is important but there is then a need to ensure that the right data are transferred between health providers and care settings. In their review of the transformational potential of health information systems, Hillestad *et al* indicate that 'broad adoption of electronic medication record (EMR) systems and connectivity are necessary but not sufficient steps towards real healthcare transformation.'[30] They suggest that with routine transfer of the appropriate data, transformational benefits will emerge; first, through the availability of datasets for benchmarking and to enable data-driven care, and second, through the active use of those data to reorganise and optimise care delivery processes. In the UK, the work of the Professional Records Standards Body is ensuring that clinical record standards being developed to support electronic interoperability are consensus based, and meet the needs of clinicians, patients and citizens.[31] This will help to enable widespread interoperability where the right data are being exchanged, and this will facilitate the realisation of the first two factors.

These two factors contribute to the third important transformative factor, which is the ability of systems to manipulate the professional roles and boundaries of responsibility of their users across the entire system. A key feature of these systems is that they are sociotechnical systems—the entire system is the sum of the digital functionality and the way that human users interact with it. This sociotechnical aspect has been noted previously with EP systems, in relation to unintended consequences of these system in routine use.[32]

This ability to manipulate professional roles and boundaries has been observed with pharmacy roles within a hospital with the implementation of a pharmacy robot,[33] and also by pharmacy professionals following on from the implementation of the electronic prescription service (EPS) in community pharmacy in England.[34] Two early

reports of EP use in the UK described how the EP system streamlined the prescription review process, enabling clinical pharmacists to spend less time on prescription-related activities, and more time on patient-facing activities, such a monitoring therapy, assessing adherence and advising patients about their medicines.[35 36] This role transformation is consistent with recent proposals about how health professionals should work in a technologically enabled world in the recently published Topol Review.[37]

It is recognised that it is easier to implement systems within organisations, and that good professional leadership and cooperation is needed to implement systems across organisational boundaries,[38] which is a key factor why hospital-implemented medication technologies have been adopted sooner than those supporting medicines use in the community. However, medication-related systems that operate across localities are already in use—for example, EPS—and, with the development of clinical record standards, widespread interoperability is getting closer. At that point, the effective interoperable systems and transfer of data will be able to influence professional roles and practice significantly and release professional skills. Only then will large-scale transformation of working practices and service delivery be possible, and this will facilitate safer, more efficient and more cost-effective care with medicines in the NHS.

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