# Pharmacy interweaving safety within hospital health information technology

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**Abstract.** Research on the impact of hospital technology on medication safety usually focuses on prescribing and administration. Less is known about the pharmacy-related processes of reviewing, ordering and dispensing medications and how technology supports this work. We carried out a qualitative exploratory study of a hospital in England (UK) with the aim of gaining insight into processes of digitalisation. We found that hospital pharmacy staff perform safety work with technology aiming to prevent harm, such as 'scaffolding' people's thinking processes, or linking-up unintegrated systems. Their work seems to 'interweave' safety in between others' medication activities, but they do so sometimes struggling with technological deficiencies.

**Keywords.** Patient Safety, Medication Safety, Hospital Pharmacy, Technology

## Introduction

Medication safety is a thorny worldwide issue. Improvements in medication safety have been achieved by replacing paper-based systems with digital systems [1, 2]. These include systems for Electronic Prescribing and Medication Administration (EPMA), electronic discharge systems (for medicines to take out at the time the patient is leaving the hospital), and, in the pharmacy dispensary, robotic dispensing systems for picking medication. While the impact of EPMA or pharmacy robotic dispensing systems on medication safety has been widely studied as individual systems, less is known about the work *across* these systems and how this contributes to improve the reliability and safety of the supply and dispensing of drugs. Research also most often focuses on prescribing and administration tasks; less is known about the related processes of pharmacy reviewing, ordering and dispensing medications.

We carried out an exploratory study of the way technology is used in hospital for processes of supply of drugs, with the aim of capturing the complexities of hospital medication work and gain insight into processes of digitalisation and their consequences for reliability and safety. In this paper we focus on pharmacy staff work and the different medication technologies they encounter along their workflow.

## 1. Methods

### *1.1. Research design, setting and technology in use*

This study was part of a larger project investigating the digitalisation of medicines supply and use across different settings and stakeholders. The research design was exploratory, structured around the logic of tracer studies [3], and aiming to capture wide, systemic effects.

The research took place in one of the largest National Health Service (NHS) hospitals in England, its pharmacy servicing inpatients, outpatients, home care and providing advice to the local community. At the time of the study, the pharmacy had well-established use of a number of technologies, including a system for managing stock and dispensing, robotic dispensing and controlled access cabinets integrated with this, a more recent electronic ordering system to send/receive orders from wards to the dispensary, and an electronic discharge system for prescribing and ordering discharge medication. The hospital was also implementing an EPMA system with phased roll-out. EPMA included screens for pharmacy staff to review the prescription and a functionality to list and print out medicines to order from the dispensary (to be then faxed or taken to pharmacy). The EPMA was integrated with the hospital patient administration system and a hospital-wide electronic patient record (also giving access to results and primary care records) but not interfaced with the pharmacy stock management/dispensing system. Different systems for prescribing and dispensing were used for medicines to be dispensed by the pharmacy aseptic unit (e.g. oncology, parenteral nutrition).

### *1.2. Data collection methods*

Mixed data collection methods were used, including observations, interviews and documentary sources. Participants were sampled to include most aspects of hospital medicines' supply and use, including prescribing, dispensing, administration, maintaining stock, and management of pharmacy services.

Data collection took place in the period February-September 2016, with observations and interviews carried out in 8 wards (4 with EPMA in use), two dispensaries and two stock management areas (e.g. the warehouse). Participants included pharmacists, technicians, support workers, prescribers (both doctors and nurses) and nurses. Interviews lasted 15-60 minutes and were professionally transcribed. During some of the observations, the researcher shadowed a pharmacist or technician at a workstation; when possible participants were asked to 'think aloud' reporting what they were doing, and this information was recorded and transcribed.

The dataset includes field notes and transcripts of about 103 hours of observations and 38 interviews (22 from pharmacy staff, 11 nurses, 4 medical staff, 2 patients).

Approval for the study was granted by NHS Research Ethics committee and hospital R&D office. Participants were informed, gave written consent for interviews, and verbal consent during observations. Data were anonymized at the point of data collection.

### *1.3. Data analysis*

Analysis was carried out in two stages. Initially inductive coding was carried out through immersion in the data, identification and indexing of emerging themes with qualitative analysis software (NVivo v11) and annotating process maps. Themes identified at this

stage included: pharmacy key steps towards medication safety; issues of non-integrated systems; usability and cognitive work. Higher-level categories were then identified by applying the lens of medication safety as an ongoing achievement, as suggested by resilience research [4-6].

## 2. Findings and discussion

### *2.1. Interweaving safety*

We identified seven of ten steps in the process of supplying medications involving technology, where pharmacy intervened to improve medication safety (Table 1). These included reconciling patients' medicines, reviewing prescriptions and medication orders, assisting prescribers and nurses in the use of information systems, and entering data into dispensing systems. Through this work, they add their specialist knowledge to the distributed cognitive system [7] of the clinical ward.

Through setting up medicines information in the system, and regularly checking its accuracy and appropriateness during ongoing clinical care of patients in hospital, pharmacy staff 'interweave safety' in others' medication work. This interweaving work is distributed across pharmacists, technicians, support staff and delivery teams. The work is embedded in multiple electronic medication systems.

### *2.2. Scaffolding people's thinking*

People organize and structure their work environment to facilitate cognitive work, improve efficiency and possibly reduce errors. We save telephone numbers on digital phones not to have to remember them; bartenders place different shaped glasses in a row for each drink to aid their memory [8]. Design of technology and objects in space can transform error-prone tasks such as memorizing or recalling, into pattern recognition [9]. This process is also known as cognitive 'scaffolding' [8]. We found pharmacy staff set up digital systems 'to scaffold' others' minds – they add reminders, prepare data, change text to tall-man lettering; they do this within the EPMA for prescribers, and for other pharmacists, technicians and assistants within the dispensing systems. The examples below highlight the error prevention purposes of these ongoing strategies of systems' customization.

*Pharmacy IT manager: "…it enables us to mitigate the risks, […] we do all sorts of things like using […] tall man lettering, changing the order of the text, changing the way the [drug] strength is described perhaps, making it longer, making it shorter, whatever it might be, sometimes we just put extra spaces in, so that when it prints on the label it looks better, 'cos we found errors .." (190216)*

*Pharmacy IT team: "… to save people going in and trying to prescribe and prescribing longhand, we've done some quick lists, so that it's already pre-populated for them. […] we've done all of these alendronates, because they're all given on a set day of the week, so we've set it… […] once a week. That saves them then locating the drug, putting it in, making sure they change it to weekly, putting the day in and everything else, …" (190216)*

**Table 1.** Medication processes: technology involved and pharmacy key steps for safety (EPMA in place)

| Task | Description | Technology | Pharmacy contribution to safety |
|---|---|---|---|
| [1] Medication reconciliation at admission* | Taking patient medication history, and/or reconciling drug history information across different sources, such as community pharmacies or primary care records | EPMA, patient records in primary care, NHS Summary Care Record, hospital records | Checks of safety and appropriateness of medications. Pharmacy also took over from junior doctors' the responsibility for inputting medication history information in EPMA, which then was used by doctors as a basis for their inpatient prescription. |
| [2] Inpatient prescription completed | Prescribers add medicines' information in the patient medication record | EPMA | Pharmacist advise prescribers upon request and set-up EPMA database, decision support, 'pre-set orders', to guide prescribers' decisions |
| [3] Medication review | Prescription reviewed by pharmacist, review of administration patterns [see step [8]] | EPMA, laboratory test results | Identification of any medication safety issues, discussed with prescriber and/or nurses |
| [4] Ordering medications | Order for medications sent to dispensary | EPMA, printers, faxes. Alternatively: e-ordering system and printer | By default, EPMA system prints all patients' orders processed at any one time in one single sheet; pharmacy staff pay attention to manually print each patient order in a single sheet to safeguard from errors at dispensing |
| [5] Dispensing | Medication order inputted into dispensing system, medicines picked from shelf, counted, labelled and placed in a container/bag for delivery (dispensed) | Stock Management System | Pharmacy technicians check order is complete, reasonable, for correct patient and that the medicine is available in the dispensary. Medicines picked from shelves checked and counted. Labels placed on medicines packaged with care – paying attention not to cover essential information. |
| [6] Pharmacist' check | Pharmacist compare medication dispensed with medication order for picking errors | NA – *orders printed on paper* | |
| [7] Delivery | Medications sent to the clinical ward. Delivery is tracked and signed | Tracking system devices | Pharmacy services track deliveries to check medicines are delivered to the right place/right patient |
| [8] Administration | Nurses give the medication to the patient; more rarely patient self-administer. Medication giving (or not) recorded on system | EPMA | |
| [9] Discharge* | Medication list entered in discharge screen, to be sent to: dispensary, GP system and/or home/community care systems | EPMA, GP system | Pharmacist checks TTO list includes: medicines at admission stopped during hospitalization; information on medicines stopped/started. This may involve data work to 'link' items across EPMA's different screens |
| [10] Dispensing of discharge medication* | Tasks [4-7] performed with slight process variation (e.g. labelling) | *See tasks [4-7]* | *See tasks [4-7]* |

(*) Task performed once for each period of hospitalisation. All other tasks are repeated during the period with frequency depending on the complexity of a patient treatment. Pharmacy aims to review each patient more than once per week, depending on the level of risk of medications used. TTO: To Take Out medicines. EPMA: Electronic Prescribing and Medication Administration system

### *2.3. Systems usability issues hindering 'the scaffolding' used by pharmacy staff*

Pharmacy was leading the EPMA implementation; we found pharmacy staff were generally familiar with technology and supported the use of technology for medicines. However, they expressed frustration with technology' issues that they perceived were hindering their medication safety work. First among these were speed – the system was slow to respond, and this they felt had consequences on their decision-making process:

*Ward pharmacist: "[EPMA] is slow. […] like 10 minutes sitting there. Nothing. [have been working on the patient medicines, have 'a train of thought' in mind while you wait], the order you do thing in, and have you checked this. Have you checked that. […] you have it all in your head and make a decision and then write it." (130416)*

Another example related to the visualization of medications on screen. The hope was that compared with the use of paper charts, having data on EPMA would facilitate prioritising patients' medications in need of a pharmacist' review. However, long lists of medication data were difficult to differentiate from the 'clutter' of routine prescribing.

*Ward pharmacist: "[the] Pharmacy Review function would be fantastic to help you target your workload, but the trouble is that every time a doctor prescribes a bag of routine fluids or […] paracetamol […], that goes into a list, so […] it is quite hard […] to pick [high risk prescribing] out from the clutter of routine..." (100316)*

### *2.4. Linking-up unintegrated systems*

The new EPMA system integrated the tasks of: medicines reconciliation at admission; pharmacy review; doctors' prescribing; nurses' administration; and discharge medications (although the link to discharge created difficulties in practice – this we discuss elsewhere [10]). Replacing the previous standalone e-discharge system with EPMA made the process 'more slick' and potentially safer:

*Pharmacy IT manager: "… slightly more integrated 'cos we prescribe the medications this time electronically […] and the medications get pushed into the [discharge functionality], so it becomes more slick, and less likely to error and hopefully more complete information going back to the GP [i.e. safer]" (190216)*

However, EPMA did not integrate with the hospital e-ordering system, requiring printing and faxing instead – compared to the previous e-ordering system, ordering medicines with the new EPMA was considered "*going backwards really, which is quite frustrating".* Neither EPMA nor the e-ordering system integrated with the dispensing system, requiring new data entry in the stock management system at the time of dispensing. Thus, pharmacy staff did 'the linking' across systems and workflows. In oncology, we were told, *"we compensate for the lack of joined up technology by using people".*

Lack of integration was perceived as inefficient and introducing potential risks (e.g. of erroneous transcriptions), but we found that the 'linking steps' were also opportunities for safety checks of medication orders. For example, when an order is checked before it is entered into the dispensing system - was the right drug ordered for the right patient?

*Pharmacy technician: 'That's funny [strange]. See, I've typed in that number [7654321], it looks like that is her husband, possibly. Same surname. […] But it's [male name], and this one's a [female name]. I think that might be a 2 instead of a 1. Yes. […] it might not have been spotted. This is why we just check the name at the time [of data entry] (180216)*

## 3. Conclusion

This exploratory study of a hospital in England identified shortcomings of technology common to other hospitals and other countries [11, 12]. We approached these with attention to cognitive processes and a view of safety as an ongoing achievement, rather than an end-state. Like reliability, patient safety is an ongoing distributed achievement, done through people's medication safety-oriented actions interweaved through ongoing patient care. Usability issues impact on individuals' cognitive work [13], such as prioritising, or modifying/correcting treatments' information, with potential consequences for medication safety.

Moving from paper-based medicines information to digital is a journey; systems will be initially 'slightly more integrated' and slightly more 'usable', with steps forward and backwards. It is reasonable to imagine this journey will be associated with an increasing level of automation. We should be mindful that lack of integration may introduce risks of transcription errors, but it also constitutes safe de-coupling of systems. In implementation processes, attention should be paid to the risk of tight-coupling [14] and to the potential loss of mindful human intervention.


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