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Sociotechnical implications for Information Technology related interventions in community medication management – a case study

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Abstract

Information Systems in the healthcare domain are seen as integral to improving quality and efficiency. However, the socio-technical nature of the healthcare domain makes it unusually difficult to successfully integrate people and information technology in such a way as to improve outcomes. During an information technology intervention to improve the process of medication management, we identified a number of sociotechnical factors relevant to our intervention, including: missing information, information granularity, the importance of information transferred by conversation, the impact of time constraints on information gathering and use, the influence of professional practice software, the nature of information technology use; and the notion of what systems should support 'experts'. Our findings support the need for information technology to support natural human processes – not necessarily requiring sophisticated technology, but rather the 'right' technology. In an area such as healthcare, characterised by complex decision-making, uncertainty and involving highly trained professionals, we believe that designing decision support tools should take these factors into account, to ensure fit with health care-related work processes.

Keywords: socio-technical, decision support, medication management, healthcare systems

1. Aims of this paper

The aim of this paper is to report on the sociotechnical observations which unfolded during a technology intervention that sought to improve medication management. The approach and results of the intervention have previously been reported [1]. We summarise our approach here for completeness but concentrate and expand on our sociotechnical observations.

2. Introduction

2.1. Information technology and health care

Healthcare professionals work in an increasingly complex area, characterised by advances in medical science and technology, increasing specialisation, ever-greater patient expectations and, above all, the sheer size and diversity of healthcare service provision [2]. The interaction space within which clinicians carry out their work is itself very complex, as individuals must execute their tasks by communicating across rich social networks [3].

Information Systems (IS) in the healthcare domain are now seen as an integral part of the healthcare process by those seeking to improve its quality [4]. However, the healthcare domain faces significant

organisational issues in successfully integrating people and technology to improve outcomes — with high failure rates in terms of system acceptance and effective uptake [5]. The socio-technical nature of the healthcare domain [6] demands that IS research approaches employ human-centric analyses of the impact of computer systems and consideration of how information technology can be designed more effectively for people [7]: the complexity of socio-technical evolution should never be underestimated [8]. When technologies become an integral part of healthcare work practices, behaviours emerge out of the socio-technical coupling unexpectedly, so that the behaviour of the overall system in any new situation can never be fully predicted from the individual social or technical components[3]. This view is supported by Ammenwerth, Iller and Mahler (2006) who based their research on the practical experience of implementing a hospital-based nursing documentation system. While these authors' FITT (Fit between Individuals, Task and Technology) framework allowed them to measure the match between attributes of: individual users (e.g. computer anxiety, motivation); technology (e.g. usability, functionality, performance); and clinical tasks and processes (e.g. organisation, task complexity),they concluded that task complexity makes it difficult (or even impossible) to evaluate the complex and interacting factors that might predict the success or failure of Information Technology (IT) projects in such socio-technical environments [9].

Health information systems, as an integral part of these complex socio-technical systems, must also cope with ongoing changes to external conditions and requirements [4]. Acceptance of this issue is evidenced in the report of the Australian National Electronic Decision Support Taskforce that referred to the need to investigate the socio-technical barriers faced by healthcare providers which were preventing the uptake of decision support systems [10, p. 90].

A review of Clinical Decision Support Systems (CDSS) in the United States (US), United Kingdom (UK) and Australia by Coiera, Westbrook and Wyatt (2006) reported that these systems can also introduce their own errors; and has provided preliminary evidence that poorly implemented CDSS can actually lead to increased mortality in some settings. Errors identified included: failure of CDSS to detect significant drug interactions; errors of omission, commission and dismissal; and errors due to user interface design. The authors concluded that it is not enough to assess Health IT by simply evaluating the usability and performance of software. Rather, this complex set of cognitive and socio-technical interactions requires a deeper understanding to design systems that are intrinsically safer and provide safer outcomes when used by busy or poorly resourced clinicians [11]. Implications are, however, not limited to direct interaction with the CDSS, as new types of errors can appear downstream of the prescribing process. Donyai *et al* suggest that clinical pharmacists in a hospital setting need to be aware of these types of errors; and may need to change the way they work to complement the benefits of electronic prescribing, as well as targeting their activities to reduce clinical risk [12].

2.2. Medication management and the supporting role of pharmacists

Medication is a vital component in the treatment of disease, especially for the elderly and chronically ill. Ihara, Summer and Shirey (2002) note that the vast majority of adults in the US suffering from one of five common chronic conditions – diabetes, heart disease, hypertension, arthritis and cancer – use prescription drugs including, for example, 89% of people with arthritis and 98% of people with diabetes.

With increasing medication use, however, comes an increasing need to adhere carefully to medication regimens. The consequences of deficient compliance with therapy are poor healthcare outcomes and increased healthcare costs [13, 14]. Conversely, satisfactory compliance with beneficial drug therapy is associated with a decreased risk of mortality [15]; and interventions to improve compliance may have a far greater impact on health care than any improvement in specific medical treatments [13].

The disadvantage of increasing use of medication, however, is the problem of medication-related adverse events, many of which are potentially preventable [16]. The extent and cost of preventable hospital injuries, adverse drug events [16] and inpatient medication errors [17] are well known. Preventable medication-related hospital admissions account for 2.5% of all admissions, rising to 30% for individuals aged 75 years or older – and up to three-quarters of these were potentially preventable [18]. A review of high-risk people within the community also found 2.8 medication-related problems per person [19].

Medication management offers a potential solution to the problem of adverse events [20]. This term broadly describes a set of relationships and decisions by means of which healthcare practitioners and patients work together to produce specific drug therapy outcomes [21]. A satisfactory outcome is, however, contingent on better availability of patient-specific information [22] and

improved information exchange within healthcare settings via electronic communication [23]. A consumer-centred medication management role has evolved for community pharmacists, in partnership with general practitioners. The need for this role is likely to increase as the population ages and the availability of doctors and informal carer networks in the community diminishes [24]. Within this community care context, pharmacists and doctors have similar requirements for information and knowledge [24].

There is considerable, though fragmented, activity in the area of electronic decision support systems to support medical care [25], although little such activity exists for pharmacists beyond traditional pharmacy functions [26]. We believe this is an emerging issue for Australian pharmacists involved in medication management – specifically medication reviews – and this was the motivation for our project, which we describe in the next section.

3. Methods

3.1. Project Aims

The aims of our project with respect to medication reviews were twofold, to:

1. investigate the suitability of a model of medication-related information components; and
2. develop a document-oriented form of user-interaction as an intuitive way of supporting clinical documentation and as an effective mechanism to allow information communication among clinicians involved in medication management.

3.2. The information model and digital document interface

Given the lack of an existing model on which to base our research, we developed our own medication information-related model. We implemented this model using a document-oriented user-interaction approach, as this provided both an intuitive way of supporting clinical documentation and an effective mechanism for information communication between healthcare professionals [27]. Our digital document was implemented using 'XForms', an XML-based, next-generation mark-up language for defining Web-based user interfaces [28].

3.3. Research approach

Our research was driven by specific practical problems (as is the case for most healthcare developments) [2] within a sociotechnical setting, where there was a need to answer questions about human interaction with resultant complexity and subjectivity, indicating a need for a qualitative methodological approach. As (information) technology artefacts – an information model and an associated digital document – were central to our intervention, we chose Design Research as the most appropriate methodological framework. Design Research was eminently suitable, as it addresses business or problem-solving needs by constructing and applying innovative IT artefacts to understand the problem(s) addressed by the artefact [29]; and is sensitive to social context [30]. Further, Design Research addresses 'wicked problems' characteristic of healthcare such as: unstable requirements and constraints, complex interactions among subcomponents of the problem and the solution, inherent flexibility to change design processes and design artefacts; and critical dependence upon human cognitive and social abilities to produce effective solutions [29].

Within the overall Design Research-based case study framework, our empirical data gathering and analysis iterated through three scenarios – hospital; bench top testing; and field studies. A case study is frequently seen as an examination of a specific phenomenon such as a program, an event, a person, a process, an institution, or a social group [31]. This approach allows the researcher to investigate phenomena within their natural environment and to capture reality in considerable detail Yin [32]. Case studies can make use of multiple sources of evidence obtained from a variety of sources including people, groups, or organisations. Case studies focus on dynamic behaviour within a single setting [33] and are often used to describe relationships [34]. Kaplan and Maxwell (1994) noted that case study is a useful approach for understanding the processes of change [35].

Our triple data gathering cycle allowed us to progress the design of the information model and the digital document which evolved from that model as we moved from one scenario to the next. Each data gathering cycle thus became the basis for new theorising and a new intervention [36] within the overall Design Research framework. The scenarios each provided information to support incremental changes to the information model and digital document, based on the input from our various data sources. Pharmacists formed the primary target for this project – however, as pharmacists have close and inter-dependent relationships with medical practitioners in the practice of medication management, we clearly could not consider medication management without including the

opinions of physicians in all three data gathering scenarios – an approach which is reflected in the discussion below.

Data sources selected were broad to allow data triangulation and consisted of interviews, questionnaires, focus groups, document analysis and digital document prototype testing through the different scenarios –an approach which is described in detail elsewhere [37]. This iteration cycle enabled refinement of the artefacts to prepare them for use in the next scenario. Performance measures within the prototype bench testing and field study scenarios sought to evaluate the perceptions of the users as to how the digital document might improve their medication management process. This meta-evaluation thus ascertained the usefulness of the artefact to the users' processes, in contrast to the iterations within the scenarios which adapted the artefact to the users' processes. Our Design Research loop is shown in **Figure 1**.

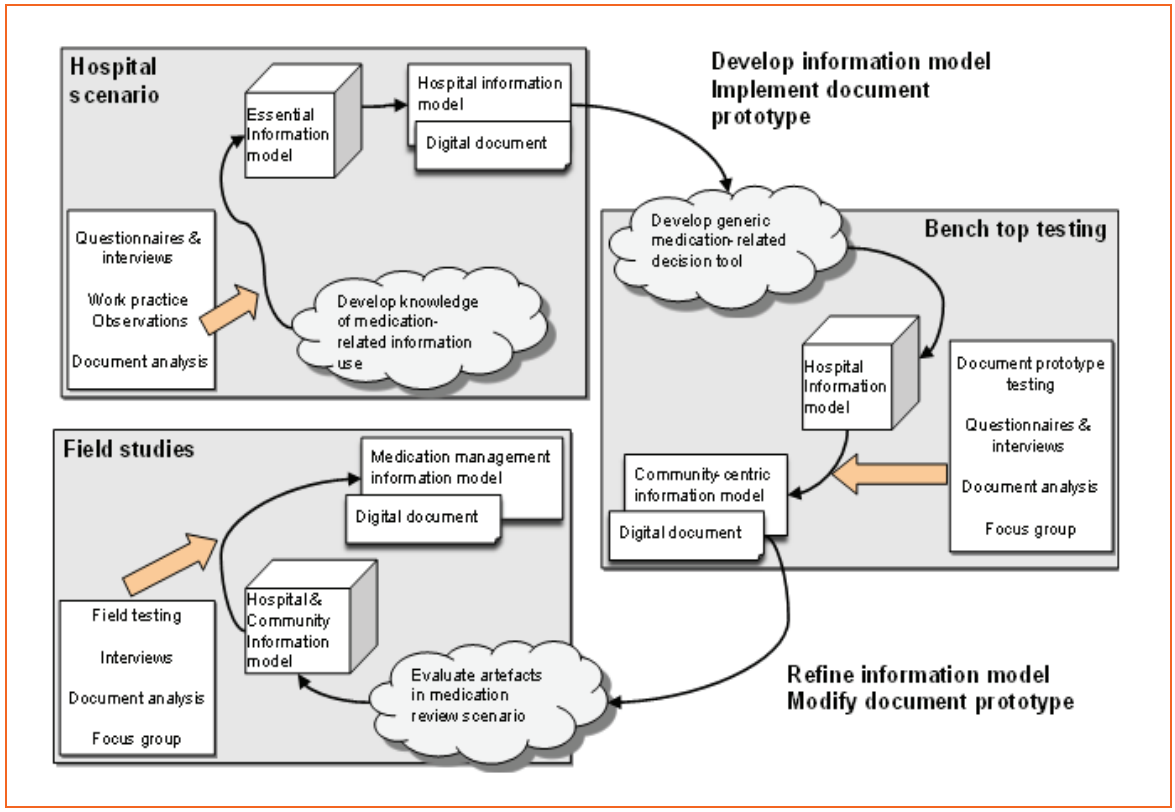

Figure 1: The design research loop

3.4. The progression of the artefacts through scenarios

The hospital scenario provided the basis for formulating the information model of medication management components, as the role of clinical pharmacists in this context is similar to the emerging medication review role of community pharmacists. In addition, the hospital environment is more 'information rich' than the community setting, allowing us to develop a more complete information model. The model formulated at the end of this phase became the basis of the digital document prototype implemented using XForms.

Once the digital document prototype was developed, it was 'bench-top tested' by pharmacists accredited to conduct home medication reviews (HMRs) in Australia. Testing evaluated the digital document's functionality and extended the information model for community use. The first consequence of testing was the addition of information elements required for the community context and some physical information about the patient which was available to hospital pharmacists from other (disparate) sources. The second consequence was the addition of some simple 'decision support' features, including calculation of the age of some measurements (e.g. how long ago a weight was measured); body mass index (BMI) and creatinine clearance (CCl).

The final scenario tested and evaluated the digital document prototype by pharmacists and General Practitioners (GPs) in a field setting. The digital document could be used online, or on a notebook computer with a simple browser developed using Visual Basic®. Patient (XML) files could be transferred between these two modes, allowing considerable flexibility. The level of involvement of GPs and pharmacists was flexible, based on their level of comfort with

the digital document; and the way(s) this might fit into (or change) their work practice. This is shown graphically in **Figure 2**.

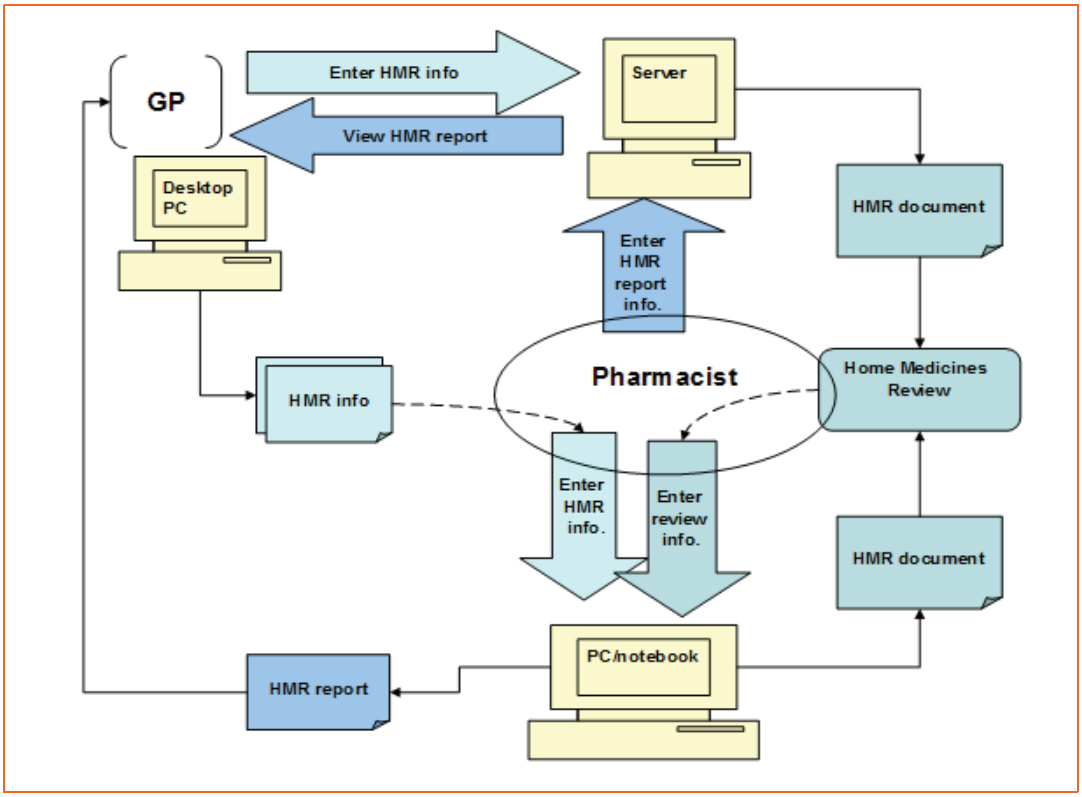

Figure 2: The community-based medication management solution

4. Results of the intervention

The results of the intervention have already been reported [1], as mentioned above, and will not be reiterated in this paper. In this paper we elaborate on previously reported and other sociotechnical factors which we observed during the empirical research and discuss possible implications.

As we noted at the start of this paper, many potential factors have been identified as being relevant to IT support for the increasingly complex process of managing patient medication – but which of these are truly significant? We observed a number potential issues resulting from our choice of information technology approach. The first set of issues was identified in the hospital setting, with additional issues being discovered in the community setting – some of which were common to both the community and the hospital settings (see **Figure 3**).

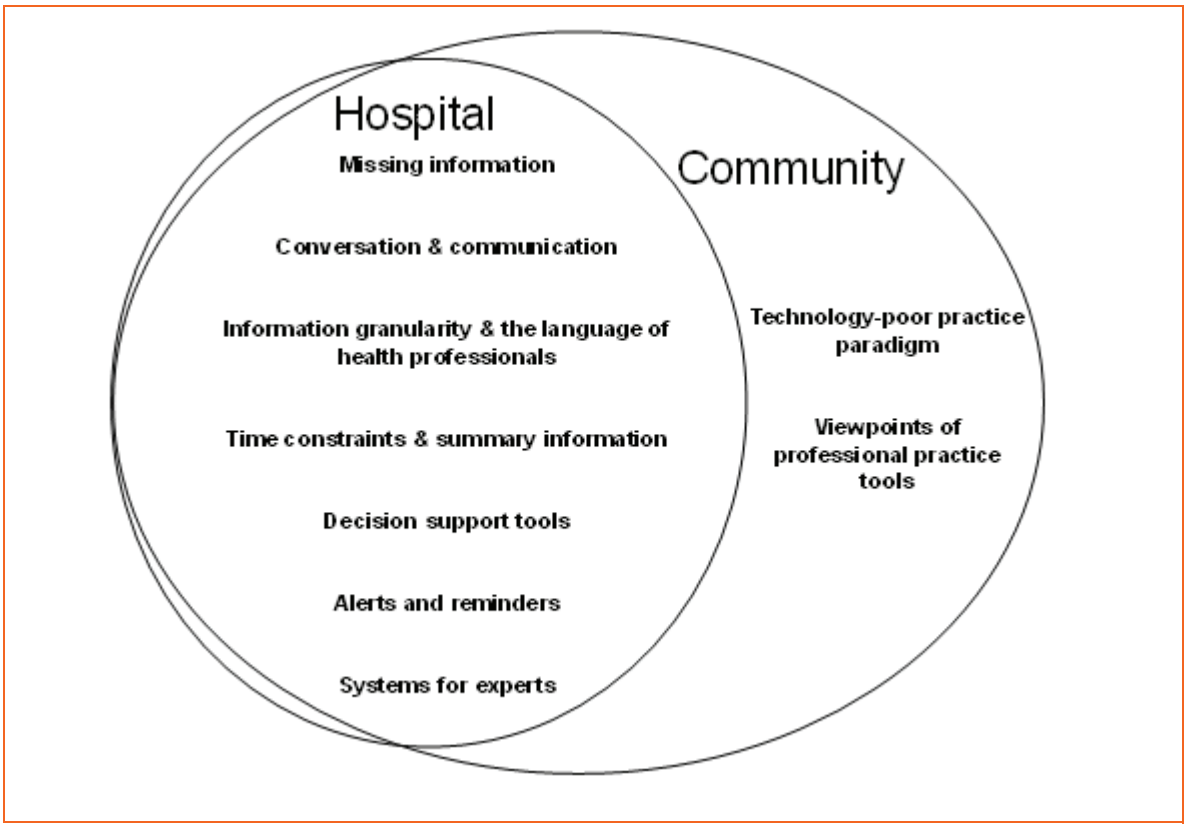

Figure 3: Information technology-related issues for medication management

4.1. Missing information

The widespread problem of missing information evident in the literature was immediately confirmed in the hospital scenario. Missing information in our context related to information which was not available in a location at the time it was needed for decision-making. This frequently occurred because the information had never been recorded, or had been recorded (elsewhere) but was not available as and when required for decision-making. The most common omission – and that of most consequence to this project – was medication-related information. Missing information was also a significant problem identified by community pharmacists during benchtop testing: and this fact was confirmed during field tests. The problem of missing information was more critical for HMR pharmacists in the community than for hospital pharmacists, as they had fewer information sources on which to rely. Field studies showed that a wide range of information could be missing, although an immediate impact on the patient was less likely in the community than in a hospital, because the focus of care in the community was on chronic disease management rather than on acute situations, as in hospital. Pharmacists could obtain information during patient interviews, but this ability was limited in both hospital and community scenarios because patients were not always reliable sources of information. Although hospital pharmacists were able to elicit some missing information from other healthcare professionals, HMR pharmacists had only themselves to rely on and would often press on with a medication review despite a lack of information – merely suggesting to the GP that the HMR might be of limited value.

4.2. Information granularity

One important aspect of information for both doctors and pharmacists was the varying levels of granularity of information elements, which became evident, during information modelling. In the hospital environment the nature of information ranged from patient case-notes to specific data items such as a laboratory value, i.e. from aggregate to atomic levels of information. The level of the information sought was driven by the requirements of the healthcare professional, for example, if they knew little about the current situation and required aggregated information such as a patient's case notes; or if a pharmacist simply needed a specific data item on which to base a decision. Participants mentioned during interviews that they wanted 'everything' but conceded that a more useful day-to-day form of information would be a concise summary, representing important issues for the patient.

The changes to the hospital-based information model for the community context also confirmed the need for elements at different levels of granularity – additions included aggregated items (e.g. a field for patient indica-

tions) as well as atomic elements (e.g. a serum creatinine value). It appeared that community pharmacists and GPs had a greater need for aggregate data items than was the case in the hospital scenario.

4.3. Conversation and communication

Conversation was revealed as a very important information pathway for hospital pharmacists: primarily to chase missing information, but also as an efficient way of obtaining contextual information about the patient, even when other sources were available. There are also many occasions when tacit knowledge[1] held by other healthcare professionals would not otherwise be available to the pharmacist. Conversation has other important roles, e.g. social roles and allows opportunistic interventions for the education of other healthcare professionals; and these cannot be usurped by decision support tools.

HMR pharmacists' conversation opportunities were essentially limited to the GP, although field studies observed the general practice nurse as a 'front-line' to GPs. Although conversations with GPs occurred infrequently – even when information was missing – pharmacists valued good relationships with GPs. The importance of good communication was also supported by the fact that pharmacists believed the digital document could provide common ground between pharmacists and GPs to assist communication and perhaps even improve relationships.

4.4. Time constraints and summary information

Time, or its absence, is a constant influence on the healthcare process as reported in the literature. [39] In hospitals, we found that the time to find, assimilate and interpret information was a significant issue for pharmacists – and even more so for Medical Officers (MOs). Despite pharmacists' and MOs' desire to have all patient-related information available to aid in their decision-making, the concept of an artefact with summarised, relevant, patient-related information was seen as a practical solution. Participants acknowledged that a trade-off between displaying essential and all information would be difficult to achieve.

In the community, time was mainly an issue for GPs, affecting the quality of the HMR referral initially sent to the pharmacist; as well as their ability to deal with HMR reports sent back to them by pharmacists. Pharmacists' awareness of these issues meant that they endeavoured to produce summarised reports that would minimise the time impact and maximise report impact on GPs. Many GPs wanted a 'one-button' approach to generating HMR referrals; and expected reports from pharmacists to be short and to the point.

4.5. Alerts and reminders

Within the hospital setting, alerts and reminders were seen as the most positive features of a decision support system – an avenue to promote good prescribing practice. However, the value of alerts and reminders to decision-making was qualified by their ability to perform within an appropriate patient context. Alerts were considered to be of value in areas relating to toxicity (e.g. previous ADRs for a patient); in unfamiliar areas (e.g. drug contraindications in pregnancy); or in the case of issues requiring immediate attention. However, it was felt that even these serious reminders would become a nuisance if they occurred too often; and the threshold at which they became an irritation could (and probably would) vary for each individual doctor. Even if alerts were supported by reference information (why they were important), it was their relevance that was the most critical issue for acceptance by healthcare professionals. The introduction of reference information would also introduce an extra level of reading and inconvenience, limiting its usefulness.

The possibility of personalising such a system, so that more experienced MOs could control the number and frequency of alerts, was not discussed by participants and should form the subject of future research.

Although the concept of alerts and reminders was supported in the hospital setting, this was not the case in the community. HMR pharmacists suggested that alerts and reminders provided in the digital document would be of limited use; and this view was confirmed during the field studies, where it became apparent that the information required to trigger alerts was often missing in the digital document – either because it had not been included in the original HMR referral from the GP, or because the pharmacist did not react to the alert (by entering the missing information). This latter issue, of pharmacists' information management practices, did not permit the evaluation of alerts and reminders in this project – so that the usefulness of even the simple alerts and reminders implemented in the digital document remains unclear. Clearly, this issue needs to be confirmed by larger studies.

4.6. Decision support tools

All hospital participants had some exposure to decision support tools, although many of these were simple information retrieval or laboratory reporting systems, reflecting day-to-day activities. In addition to having greater experience or exposure in this area, pharmacists offered more opinions, particularly relating to the lack of success or usefulness of the systems they had encountered – hampered by poor training or understanding of how the systems functioned.

HMR pharmacists' experience with decision support tools also reflected their work environment: the availability of technology-based tools in the community was significantly less than in the hospital setting, with HMR pharmacists being exposed only to a small range of paper-based

1. Tacit knowledge represents the clinical experiences of healthcare practitioners [38]

and electronic drug information resources. The main support for the HMR role witnessed in this research was a word processor.

Interestingly, pharmacists in both settings failed to distinguish between technology-based and other sources of decision support, which could also be paper-based, telephone-based, or occur through interaction with other healthcare professionals. What information a decision support system should provide – and whether this would be possible – were areas of considerable discussion.

In the hospital, many MOs and pharmacists saw patient summaries as useful output from a decision support system, with the added ability that the system could provide links to more detailed patient information if needed: although some also believed that all information should be presented, on the basis that it was better to determine the value of the information for oneself, than to allow a system designer or programmer to make that decision. This difficulty of requirements engineering – ensuring that a developed system will truly reflect the needs of its users – becomes still more complex when there are a variety of users, with differing needs. It was not surprising to find a considerable level of concern about the effectiveness of decision support systems in an acute care setting. Participants also noted that the availability of wider information depended on 'someone' to enter it; that reliance on such systems could present other problems; and that it was possible for information to be incorrect, e.g. a diagnosis could often be incomplete, being a 'work in progress' for the first few days of admission. There was a clear question of how decision support tools could be made be made to operate within an environment of varied and changing information.

4.7. Designing systems for experts

Much of the decision support discussion that arose in hospitals (particularly that relating to electronic prescribing) focused on expert systems; and we have reported on the problems of capturing and structuring knowledge to allow a complete representation of a patient in an information system. A further influential factor we observed was the extensive use of personal (tacit) knowledge by healthcare professionals in their clinical practice. We did not quantify such use, but statements from pharmacists indicated the extensive use of personal knowledge – this was the first strategy used in responding to a question. Within the hospital environment gaining this knowledge took many years, fed by a range of formal and informal sources. Clinical practice and personal experience were particularly significant. Over time, pharmacists' recall of previous situations became the knowledge base for approaching new problems. Pharmacists' understanding of the systems outside the hospital environment also allowed them to consider patient care more broadly than simply in terms of immediate medication use within the hospital admission. For example, one knowledge-based approach to information gathering by pharmacists was to infer which medications a patient should be taking on the basis of that patient's diagnosis – the absence of a particular medication in the patient's list could indicate a possible omission in the current medication list, or a need for the pharmacist to recommend a therapy option to the patient's doctor. The nature of pharmacists' behaviour observed was very much that of an expert, raising questions as to how a decision support system should support them.

4.8. A technology-poor practice environment

Pharmacists have used (computerised) dispensing systems for many years and many have experience of computer-based information tools and could be seen as quite experienced in the use of information technology. Yet the shortage of tools to support medication management has been demonstrated in this environment. All pharmacists were using 'simple' technology support, e.g. mainly word processing tools for HMR reporting. There was very little (if any) use of technology-based communication tools, e.g. email or Web-based tools – paper-based information sources prevailed. Nevertheless, pharmacists were not averse to trialling the digital document. In fact, they were happy to 'try something new', but were more comfortable with a process that reflected their usual routine. When they had a choice (within this project) of using a server-based service or a local tool, they invariably chose the latter. Although they were 'not ready for this yet', we gained the impression that simple, useful tools to help with HMRs would be welcomed.

4.9. The 'viewpoints' of professional practice tools

In the community, GPs expressed the view that an interface to, or interaction with, the GP desktop system was needed for the digital document. This desire was to some extent mirrored by pharmacists, who believed GPs would not use two separate systems. Pharmacists also suggested that the digital document could incorporate some features of existing prescribing and dispensing systems: primarily drop-down lists. The project, however, had no intention of duplicating features of these systems, as they serve entirely specific and different purposes. Prescribing is concerned with the intention to supply a medication to a patient; and dispensing with the actual supply of medication to a patient. However, neither can claim to represent what the patient is actually taking – although some GPs and pharmacists can believe that prescribing and dispensing systems do provide such information.

In relation to representing broader medication use, the GP prescribing system encountered in the project had some limited ability to record Complementary Medicines (CMs) and Over-the-Counter (OTC) medications taken by the patient (if this medication had been entered into the system by the GP). A CM or OTC, however, could not be recorded in a dispensing

system by the pharmacist. The only way to reveal what medication the patient is really taking is though a medication review. The digital document used in this project has the potential to record all medication used by a patient – it could become the current medication record, based on its ability be shared by the relevant healthcare professionals (and, ultimately, the patient).

There are valid reasons to recommend additional system containing medication information be added to that already used by GPs and pharmacists. Not only are the viewpoints of the digital document and the GP desktop system entirely different, the underlying data structures of the GPs' proprietary systems are unlikely to exist in a form allowing the representation of a current medication record. Our own experience suggests that the proprietary nature of many GP desktop systems makes even simple data interchange difficult.

A further influence of the GP desktop system on the referral information given to pharmacists was the 'pattern' of information determined by the report (output) used by the GP. This pattern was essentially the result of the different information headings in the reports, which dictated what possible information could be provided to the pharmacist – although there was no certainty that this information was provided. The effect of GP data entry habits was not studied during this project.

5. Discussion

During our research we observed a number of issues that we believe have implications signalling particular difficulties in the design and uptake of decision support tools for medication management and the healthcare sector more generally including: missing information, information granularity, the importance of information transferred by conversation, the impact of time constraints on information gathering and use, the influence of professional practice software, the nature of technology use; and the notion of what systems should support 'experts'. We acknowledge that many of these factors have been discussed more generally in the literature, but offer specific observations in the area of medication management which affect pharmacy practice in the discussion which follows (we use the terms 'information technology' and 'technology' interchangeably during this discussion).

The greatest significance of missing information is its profound effect on the effectiveness of decision support systems, which cannot function in the absence of relevant information, e.g. the inability to calculate a dose in the absence of a patient weight value or the inability to prescribe in the absence of a coded patient diagnosis. Until these problems can be resolved, one way forward may be to allow a decision support system to operate with missing information, but to signal caution or limit recommendations – and, especially, to highlight the need for clinical judgement. This approach would also have less impact on the work processes of healthcare professionals. From the point of view of this project, missing information became important as a basis for formulating the initial information model. Whether hospital pharmacists pursued missing information for their decision-making was dependent on the importance of that information to their decision. We concluded that a decision to actively pursue an information element could in itself be seen as a surrogate for the value of that information element to the decision-making process – and, consequently, its inclusion into the information model. Further, because the digital document (the implementation of the model) is communicated and shared among healthcare professionals, the decision to identify sought information elements provides an opportunity to collect these missing elements over time and thus provides a more complete, possibly current, record of medication use.

We suggest that the information granularity has two implications for clinical systems in representation and communication.

Representation: there is enormous difficulty in providing all patient data at an atomic level suitable for patient-centric decision support (attested by the vast efforts in producing typologies and terminologies on which to build decision support systems). By contrast, the clinical narratives, including acronyms and 'shorthand', used and valued by pharmacists and GPs do not readily underpin decision support. This represents a tension for the design of healthcare information systems – the need for atomic data to develop shared terminologies and ontologies on which to build decision support systems and allow epidemiological research vs. the need to share contextual information for patient care. The reporting of information needs at different levels of granularity suggested that the information model and, consequently, our decision support tool, should also reflect this granularity. Passages of text present particular problems. How can structured lists be used to compose meaningful (and readable) clinical narrative? The information exchanged between these healthcare professionals requires additional knowledge – the patient context – to make it meaningful. Meaning occurs now because healthcare professionals make use of their shared and understood 'language'. It might be expected that any structure imposed by decision support tools on these 'conversations' will be met with resistance from healthcare professionals.

Communication: the information communicated between healthcare care professionals should occur in a way that complements their work processes. This project identified simplicity and flexibility as important aspects of information communication between pharmacists and doctors. The issue is, once again, how aggregated information can be communicated between systems to allow humans to retain and share the rich narrative that is meaningful to them – while simultaneously supporting the categorisation of the information

needed for seamless inter-connectivity between information systems.

The use of conversation as a significant means of communicating information has several implications for decision support tools. Firstly, it is unlikely that all the information required for decision-making will be captured for any decision support system, since much communicated information is the tacit knowledge of other healthcare professionals. Secondly, information about a patient will be summarised and can be highly contextual to the decision-making process: this is a very efficient way of transferring information and is the reason why pharmacists often use conversation as their first information-gathering option. Thirdly, conversation plays other social roles, or roles which cannot be directly supported by decision support tools. It is clear that decision support tools can only partially support the information needs of healthcare professionals and that these tools must also support conversations and other means of communication between healthcare professionals.

The impact of time on healthcare professionals has already been well reported, but we suggest that one impact which has not been widely reported is on shaping the information required or produced by these professionals. This information shape always took the form of high-level information summaries that could be considered quickly. In the community setting, in particular, unless there is a significant change to the time available to GPs, or the nature of the HMR process, GPs' enthusiasm for HMRs is likely to remain low. And in this setting, even with the possibility of providing information in the correct form, any technology must realise a balance between the information quality required for safe patient care and the expediency required for business efficiency.

Alerts and reminders are generally held to be practical and useful components of decision support tools – and, with the ever-increasing amount of information available, the inclusion of alerts and reminders to assist healthcare professionals in recalling crucial issues is intuitively desirable. However, tailoring alerts for each drug, disease and patient possibility is difficult and we believe that such features pose a quandary for decision support tools. For alerts and reminders to be truly useful in day-to-day practice, as well as being well designed, they must also capture and structure information so that it is relevant to decision-making in both hospitals and the community. In addition, the utility of such features will also depend on health professionals' work management practices.

While expressing opinions about the ideal decision support system, participants offered a wide range of interpretations of decision support. We believe that because participants' perceptions of the nature of a decision are generally based on their (often less than ideal) personal experiences, it is hardly surprising that clinicians, when asked what they want from a decision support system, find it difficult to express their requirements succinctly and clearly.

It seems logical that the design of decision support systems should take note of requirements from multiple user groups, e.g. pharmacists and MOs. However, there are a number of problems to be resolved:

- the conflicting requirements, not only between user groups but also within those groups
- the difficulty of incorporating all the required information to represent patient contexts
- the problem of structuring information to accommodate a variety of purposes
- the inherent conflict between providing sufficient numbers of alerts and reminders – and driving experienced users to distraction because too-frequent alerts and reminders are interfering with their actual work practices.

However, even when these problems are solved, there is still no assurance that the data held in the system will be correct. Perhaps one solution would be to maintain the status quo – allow healthcare professionals to continue to share the same information, but assist them to do so by means of technology. This not only allows simplicity of design for decision support systems, but also continues to enable the 'different eyes' of a range of healthcare professionals to contribute to patient safety. What does remain clear, however, is the opportunity (and, potentially, the need) to develop more sophisticated decision support for both pharmacists and MOs in a hospital setting.

The situation in the community was different, in that HMR pharmacists' day-to-day experience of decision support tools was considerably less than that of their hospital colleagues. This HMR group was far less sophisticated in their overall use of technology and had fewer clues available about decision support needs. The main finding within this environment was an insight about where a decision support tool might fit into the HMR process – before or after the HMR. However, the more significant effort in the community is likely to be about enabling information sharing, rather than prospective discussions about how it should be shared.

We believe that the enormous difficulty of capturing knowledge for a decision support system and the extensive use of personal knowledge across the continuum of medication management suggests a particular approach to the design of a decision support tool: the idea of designing 'systems for experts'. This approach has less to do with providing a wide range of information and attempting to adapt this information across a range of patient and user contexts, than with providing essential information to support decision-making so that a human can more appropriately understand and deal with differing contexts.

The paucity of technology use in the HMR environment throws up a paradox, because two main issues arise from this technology-poor practice environment. Firstly, there is a need for some technology to better support communication. Secondly, the ability to use any technology-

based tools will require a paradigm shift in community pharmacy practice.

From the perspective of this project, the shift required is that from communicating paper-based information to communicating digital information. A possible way forward would be to use an approach which can be implemented incrementally, is flexible in use and complements the work flow of individuals. The document-oriented approach trialled in this project offers a potential means of achieving this goal. Addressing this predicament is a matter of the right technology, not necessarily of sophisticated technology.

. Within the community, the influences of the GP desktop and GPs' information entry behaviour are significant. While the functional role of a prescribing system will never be in question the most widely-used GP desktop system does not (in its current guise) allow information sharing, nor does it represent a current medication record. Although a digital document may be seen as an additional entity, it will need to exist in its own communication space to be a shareable, communicable and, ultimately, current medication record.

Further, the variability of the information in part influenced by use of headings in fixed reports and the data entry habits of GPs into the GP desktop systems are issues that need to be addressed more generally.

6. Conclusion

Our digital document-based intervention which set out to improve the efficiency, quality and safety of medication management identified a range of socio-technical issues that we believe have implications for technology interventions in this area – and perhaps also for the health care domain more broadly.

Some of our experiences confirmed other findings in the literature, such as the prevalence of missing information and the ubiquitous problem of lack of time for healthcare professionals involved in patient care. However, we identified other issues influencing our intervention, including the need for different granular representations of information and data, issues around the contextualisation of information and the complementary need for human knowledge for optimal decision-making; and the limitations of decision support in such a complex environment. Further, in the community – the comparatively technology-poor environment within which medication reviews are undertaken – there is a need for a pragmatic approach to implementing technology to support this purpose, as well as for a strategy to overcome the influence of existing systems on the medication review processes.

We believe that our findings further support the important need for technology to support natural human processes rather than imposing an externally perceived view of what is needed. We also believe that this does not necessarily require sophisticated technology, but rather the 'right' technology. Importantly, in an area such as healthcare characterised by complex decision-making, uncertainty and highly-trained professionals, we believe that the goal of designing decision support tools should be about designing systems within the context of use by experts.

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