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Designing digital documents to support medication management

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Abstract

The lack of electronic decision support is an emerging issue for pharmacists in Australia involved in medication reviews. A digital document approach allows a flexible means of communicating and sharing medication-related information through a simple, easy-to-use artefact. This document-centric approach is also a comfortable fit with health professionals' existing practice, and suggests practice improvements in safety, quality and efficiency of the medication management process. Our research has also identified factors which influence how decision support tools should be modelled and implemented - missing information, using conversation for information exchange, the effect of information granularity on model development, the 'perspective' of practice tools; and the level of technology use. Our research approach advocates that an essential information model provides a complement to specialist knowledge and contextual decision-making by pharmacists and doctors – providing 'systems for experts', rather than expert systems – and may offer an effective way forward using 'lightweight' technology.

Keywords: Digital documents, medication management, information models, decision support

1. Introduction

1.1. Medication safety

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 United States (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, adherence to medication regimens has surfaced as an important issue. The consequences of deficient compliance with therapy are poor health outcomes and increased healthcare costs [1, 2]. Conversely, satisfactory compliance with beneficial drug therapy is associated with a decreased risk of mortality [3]; and interventions to improve compliance may have a far greater impact on health than any improvement in specific medical treatments [1].

The disadvantage of increasing use of medication, however, is the problem of medication-related adverse events, many of which are potentially preventable [4]. The influential report, To Err Is Human: Building a Safer Health System [4] first brought to light the extent and cost of preventable injuries arising from the health system, which were estimated to affect 3%-4% of hospital patients in the US, accounting for over 7,000 deaths annually. The cost of preventable adverse drug events for hospital inpatients was estimated to be about US\$2 billion for the US as a whole.

Findings in the United Kingdom (UK) are of a similar order, suggesting inpatient medication errors cost about £500 million a year [5]. Australian figures suggest that 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 [6] A review of high-risk people within the community also found 2.8 medication-related problems per person [7].

1.2. Medication Management

Medication management offers a potential solution for the problem of adverse events [8] where medication management broadly describes a set of relationships and decisions through

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which healthcare practitioners and patients work together to produce specific drug therapy outcomes [9]. However, this is contingent on better availability of patient-specific information by those involved [10] and information exchange improved within health-care settings via electronic communication [11]. A consumer-centred medication management role is evolving 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 [12]. Pharmacists have similar requirements for information and knowledge to doctors in this role [12].

1.3. Decision Support in Healthcare

Information technology (IT) can be a valuable tool in Health to provide productivity gains, cope with demand for services, make healthcare delivery more consumer focused [13]; and address issues of quality and safety [6, 14, 15]. Clinical decision support tools are a particularly important development to assist clinicians in accessing relevant information at the point of care for improved patient safety [16], although the representation of patient-related information and ability to structure it for decision support remains problematic [17]. Further, missing information [18] and inaccurate information are common issues [19] affecting patient care [20]. There is considerable, though fragmented, activity in the area of electronic decision support systems to support medical care [21], although little such activity exists for pharmacists, beyond traditional pharmacy functions [22]. We believe this is an emerging issue for Australian pharmacists involved in medication reviews.

2. Aims

The aims of the project reported in this paper were twofold:

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

The rationale for our approach is discussed in the following sections.

3. Background and Methods

3.1. The need for an information model

Our search for a model of information components to support medication management identified no suitable existing solution. Cited models generally described processes or guidelines and were not relevant to our research. Cameron has identified two models: a 'Medication Management Model' which described a medication review process involving a home care nurse, pharmacist and doctor to manage four high risk medication problems in the at-risk elderly population [23]; and a pharmacist intervention program, PHARMAssist, involving six monthly meetings between participants and pharmacists to discuss correct and safe medication use, supported by a shareable medication record card [24]. Other medication management models in the literature used broader interpretations of the term, including: collaborative service delivery [25], disease-based pharmaceutical care such as in asthma [26], primary care pharmacy [27]; and substance use disorders in patients with severe mental illness [28]. The lack of an existing model on which to base our research - related to information components to support medication management - led us to develop a model of our own which could cater for the needs of the project.

3.2. The document approach

We chose a document-oriented user-interaction approach as providing both an intuitive way of supporting clinical documentation and an effective mechanism for information communication between healthcare professionals [29]. The documentoriented view of a data structure, supported by XML, also matches the organisation of healthcare data very effectively [17]. We implemented our digital document using 'XForms', an XML-based, next-generation markup language for defining Web-based user interfaces. XForms provides ease of authoring, reuse, device independence, accessibility [30] and structural flexibility [17].

3.3. Determining an Information Systems (IS) approach to research in the healthcare environment

Healthcare professionals work in an increasingly complex field, as a result of: medical advances, increasing specialisation, rising patient expectations; and the sheer size and diversity of healthcare service provision [31]. The interaction environment within which clinicians carry out their work is similarly complex, as individuals communicate across rich social networks [32]. Information Systems (both generally and in the healthcare sector specifically) are socio-technical solutions [33, 34] in applied areas [31], relying on multi-disciplinary fields and reference disciplines [35]. In particular, they face many organisational issues when attempting to integrate people and technology to improve outcomes and performance and have quite high rates of failure, or failure to adopt [35]. The healthcare environment is particularly: information intense, organisationally comturbulent; subjective plex, and emotionally charged compared with IS in the broader business environment [35]. The many parallels between Healthcare research and Information Systems research in terms of organisational and information issues suggests that similar research methods are appropriate for building theory and improving practice in both domains.

As this research project sought to develop an appropriate set of decision-making tools for pharmacists involved in medication management, one research method which suggested itself was Design Research: an approach which aims to gather a body of knowledge about artificial objects and phenomena designed to meet certain desired goals [36]. Since this research project used a qualitative, interventionist approach, other frameworks also suggested themselves, including: Action Research, Ethnography, Grounded Theory and Case Study. Our goal of improving practice suggested that the most suitable candidates would be Action Research and Design Research and, given that the intervention was centred on a technological artefact. Design Research seemed to be a natural fit. The prototyping loop suggested by Design Research also suited our need to determine essential requirements from a pool of complex candidate elements and interactions. Prototyping was another possible alternative, but Design Research's ability to lend itself to generation of knowledge about user-artefact interactions proved the deciding factor in selecting the most appropriate framework for this project.

From an IS perspective, Design Research addresses business or problem-solving needs by constructing and applying innovative IT artefacts understand the problem(s) to addressed by the artefact [37]. As IS (and thus Healthcare) are socio-technical systems [33, 38], their essence lies in the 'contextualisation of the machine in the social system' -Design Research resonates well with this audience as it is sensitive to social context [38]. In particular, Design Research addresses 'wicked problems' [37] characteristic of Healthcare such as:

- unstable requirements and constraints based upon ill-defined environmental contexts
- complex interactions among subcomponents of the problem and its solution
- inherent flexibility to change design processes, as well as design artefacts

- a critical dependence upon human cognitive abilities such as creativity to produce effective solutions
- a critical dependence upon human social abilities such as teamwork to produce effective solutions

Thus, through the artefacts produced by the project – the information model and digital document – the qualitative, exploratory, cyclic process of Design Research allowed us to intervene in our world (of medication management) in order to improve it [39].

In fact, the investigation of existing problems and the contribution of interesting new knowledge to the community assures relevance [36]. while rigor in Design Research is achieved by appropriately applying existing methodologies, using either computational and mathematical methods or empirical techniques, depending on the problem addressed [37]. Our Design Research method used a qualitative approach iterating through three scenarios: hospital; bench top testing; and field studies. This cycle allowed us to



Figure1: The design research loop

change our perspective of the design of the information model and consequent digital document as we moved through the phases - each being a constructive intervention allowing a 'reality' to become the basis for new theorising and a new intervention [36]. Within the three scenarios, there were iterative, incremental changes to both the information model and digital document based on the input from the various data sources used in the project (described in the next section). This refinement led to the major changes made to the artefact to prepare it for use in the next scenario. Performance measures within the prototype bench testing and field study scenarios were designed to evaluate users' perceptions of how the digital document might improve the medication process. This evaluation thus sought to ascertain the usefulness of the artefact to the users' processes, in contrast to the iterations within the scenarios themselves, which sought to adapt the artefact to the users' processes. Our design research loop is shown in Figure 1.

3.4. Data sources

The data sources were broad to allow data triangulation and consisted of interviews, questionnaires, focus groups, document analysis and digital document prototype testing through the different scenarios (these tools are too numerous to describe in this paper, but are described elsewhere [40]). Questions contained in the questionnaires and interviews were held consistent across the scenarios to allow an evolving view of the issues as they unfolded across the scenarios, which are summarised in the next sections.

3.4.1. Developing the information model in the hospital scenario

The hospital scenario was used as the basis for formulating the information model of medication management components. We chose to begin with this scenario as the role of clinical pharmacists in this context is similar to the emerging medication review role of community pharmacists, while the hospital environment is more 'information rich' than the community setting, allowing us to develop a more complete information model. Data collection involved: questionnaire administration to and interviews with eleven clinical pharmacists and nine doctors; work practice observations of pharmacists during medication reviews; and analysis of medication-related documents used by pharmacists. The model formulated at the end of this phase became the basis of the digital document prototype implemented using XForms.

3.4.2. Testing the model and digital document for the community context

Once the digital document prototype was developed, it was 'benchtop tested' by six pharmacists accredited to conduct home medication reviews (HMRs) in Australia. Testing involved the pharmacists using the digital document with five patients who had undergone HMRs, allowing us to evaluate the digital document's functionality and extend the information model for community use.

The first consequence of testing was the addition of information elements required for the community context, e.g. the reasons for HMR referral (not necessary within the hospital environment) and some physical information about the patient (e.g. problems with eyesight, communication, etc.). Some of these elements would be 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); and the addition of body mass index (BMI) and creatinine clearance (CCl) information - important calculated values in consideration of obesity and kidney function, respectively.

3.4.3. Field studies

This final scenario tested and evaluated the digital document prototype, using six community pharmacists, five doctors and 47 patient cases. 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. Issues such as patient confidentiality were discussed with each participant and taken into account. Study patients were usually enrolled by doctors, but sometimes included by pharmacists (with the approval of the patient's doctor).

4. Results

The results of the project are summarised in four sections: the information model, the digital document, evaluation of the intervention; and issues which emerged from the research.

4.1. The information model

The use of different data collection tools (questionnaires, interviews and work practice observations) allowed us to ascertain what information participants: said they used; what they would like to see used; and what was actually used. This final category was a subset of the other two. Concentrating on what medication-related information was actually used resulted in a model of 'essential information' required for medication reviews. This essential information was only supplemented by other information components that were not frequently encountered in practice, but important to the patient e.g. an adverse drug reaction. As the model

was intended to support medication management in general, it was important to add the community context achieved by the benchtop testing. Again, information elements were added based on a need identified by actual patient cases, rather than 'wish lists' of pharmacists. The information components which were added were those not immediately available to the community pharmacist - mainly patient-related information such as immunisation status, or physical information such as knowledge of previous falls, blood pressure or information related to compliance available to their hospital colleagues from other information sources such as patient case notes or through conversation with other healthcare professionals. Similarly, some community pharmacists expressed a need for calculators (e.g. to measure BMI and creatinine clearance) which are often available to their colleagues in the hospital scenario.

The information model was extended from one supporting a hospital context, to one which could also support a community-based medication review. Field studies added only a single additional information component to the model – the 'commentary' element within the referral information branch. The amended model enabled a referral reason (from the doctor) to be addressed by a recommendation (by the pharmacist) and, in turn, a subsequent action (by the doctor). With the intention of minimising the amount of information the doctor had to deal with, however, many pharmacists wrote a concise summary report which could easily be processed by the doctor - accommodated by the new 'commentary' element. The changes to the information model are summarised in Table 1; and the final information model is shown in Figure 2, where elements which were added or underwent major changes are boxed with a double line.

Information group	Information element	Change from hospital to community context
Referral information	All elements	This information was not required in the hospital
Patient information	Calculators for body mass index and creatine clearance	These would be available by in other ways in the hospital setting
	Recent BP (blood pressure)	Available in other sources for hospital pharmacists
	Serum creatinine	Required by the calculator
	Other contacts	For family members, other healthcare professionals in the community
	Physical information group	Factors that can affect adherence to medication for patients in the community (or can be affected by medication e.g. falls)
Medication information	Immunisations group	An important consideration for the elderly in the community.
	Generic and brand names	This existed as a single element in the hospital Mode, where the generic name is preferred
	Regular and when required medications.	This existed as a single group within the hospital model
	Alert for presence of warfarin	Added to test usefulness of alerts in the community setting
Investigations group	Alerts for presence of INR (and along with warfarin)	Added to test usefulness of alerts in the community setting

4.2. The Digital Document

Each of the five major information sections in the information model corresponds to a tabbed 'page' of information in the digital document e.g. the referral information branch of the information model corresponds to a referral 'page' in the digital document. The changes made to the digital document reflected the changes in the information model, because the document represented the enactment of the information model. It is not possible within this paper to show the full set of pages making up the digital document, but Figure 3 provides an example of a medication information page displayed in the Visual Basic® viewer.



Figure 2: The information model



Figure 3: Medication page in the digital document

4.3. Evaluation of the intervention

The research goals for our intervention were to measure the effect on quality, safety and efficiency of the medication review process in the community setting. To evaluate the intervention we used a modified version of the Human-Organisation-Technology (HOT) Fit model originally described by Yusof *et al* [41]. This model contained dimensions of specific interest to this research (both human and technology dimensions) and, at various levels, described the goals for the field research. The HOT fit framework was developed on the basis of a critical appraisal of existing healthcare IS findings, building on previous models of IS evaluation. The authors then applied this model in a primary care setting in the UK, which made it a particularly appropriate choice for our own analysis of medication management in the Australian primary care environment. We omitted those elements in the original model which were not relevant to our project, such as access to technical support (under System Quality) and data entry methods (under Information Quality). We also added a 'quality' parameter to the 'Net Benefits' group, as the general concept of quality was often central to pharmacists' discussions of the medication review process. Our modified HOT Fit Model is shown in Figure 4.



Figure 4: The modified HOT Fit model

This model also provided a mechanism for the evaluation of both the information model and digital document artefact.

We summarise the results of our intervention under the 'Net Benefit' parameters of the HOT Fit model in Table 2, for both information model and digital document, since both are independently artefacts of interest. The results (assessments and benefits) claimed within the HOT Fit model are those perceived by users in the field trial studies. Some indicative user perceptions follow:

- GP Information (in relation to the information model) was: 'not too much, not too little'
- GP The digital document had: 'great potential'
- Pharmacist 'there are advantages with what you are trying to do here, and is really important to some practical problems that are being encountered while we are all using hard copy'
- Pharmacist (in supporting digital document approach) 'there is a

need to change the workflow. This will be major issue to address to get tangible gains'

Although we acknowledge that it is difficult to make generalisations from a qualitative intervention, we believe that user perceptions provide an indicative assessment of the effectiveness of the proposed intervention. As we discuss later, we believe that we have found a useful framework, but that there is now a need to validate our claims with further research (already underway).

HOT Fit Model element	Information model	Digital Document
Direct benefits	Provides a template of essential medication-related information that is to the point, relevant; and can be understood and shared by healthcare professionals.	Allows a flexible way of communicating and sharing medication-related information through a simple, easy-to- use artefact.
Job effects	Simplifies the need to determine what information needs to be collected. This can standardise expectations of what information is transferred between healthcare professionals.	Provides opportunities for audit and peer review (although this is done by the HMR process anyway).Could be a source of information for ADRAC (through pharmacist alerting)
Efficiency	Streamlines the medication management process since the information structure is known.	Through timeliness (of the information) and availability of the document.
Effectiveness	Aids completeness of information collection.	As an effective and flexible way to represent and communicate information.
Error reduction	Prompts for collection of relevant information, increasing the chances of errors being detected and rectified.	Accuracy of information improves as the document is shared and updated by a number of healthcare professionals. Encouraging the move from hand-written documents.
Communication	Provides an expected set of information that will be communicated (although not necessarily a complete set).	Provide 'seamless' communication between pharmacist, and doctor. Flexibility in use (patient files can be used on server or notebook, or downloaded / uploaded from laptop computers).
Clinical outcomes	Is the basis for greater clarity of information presentation possibly increasing the uptake of recommendations by doctors	Information can be communicated more quickly; recommendations may be effected more quickly leading to better patient outcomes.
Cost	No cost benefits were attributed to the information model.	More efficient process and better outcomes could lead to cost benefits over time.
Quality	Standard elements guide the depth and quality of information for reporting; and this assists Quality Assurance.	Overall, seen as a step to generally improving the quality of reporting; and as a move from hand-written documents.

Table 2: Net benefits of the intervention

The main benefits of the information model were that, through a template of essential information elements, it allowed the sharing of relevant information which could be understood by a wide range of healthcare professionals. This further allowed simplification of what information needed to be collected and standardised the expectations of what information was transferred between healthcare professionals. The ability to share this information template also meant that (over time) information collection would be more complete – in part alleviating the problem of missing information experienced by healthcare professionals. Prompting for relevant information was also seen by project participants as a means of increasing the chances of error detection and correction. Overall, greater consistency and clarity of the information was considered likely to improve the quality and uptake of medication review reports.

Although it is difficult to separate some of the benefits attributed to the digital document from the underlying information model, the digital document was seen as a flexible way of communicating and sharing medication-related information through a simple, easy-to-use interface. The document-oriented interface was also a comfortable fit with the current work processes of the healthcare professional participants - typified by the use of paper documents against a background of low technology use. Surprisingly, there were still instances of hand-written medication reviews reports - simply using the digital document in lieu of these hand-written reports was seen as a positive step towards improved legibility.

In summary, although the intervention was not of sufficient depth to measure improvements in quality, safety and efficiency in quantitative terms – either for the medication review process or patient outcomes – all participants expressed significant satisfaction with the document prototype and indicated that these goals would be achievable over time in actual use.

4.4. Important issues suggested by the research

Qualitative analysis of data from: interviews, questionnaires, focus groups and other interactions with project participants revealed a number of issues (initially identified in the hospital scenario) we consider directly or indirectly important in considering technology approaches in the medication management setting. Some of these issues were common to the community scenario, although additional issues emerged because of contextual differences. These issues suggest particular difficulties in the design and uptake of decision support tools for medication management and the healthcare sector more generally. These include 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'. These issues will be the subject of a future publication but are summarised for this paper in Table 3.

Issue	Comment
Missing information	Occurred frequently. This problem was used as a surrogate for information value (information was valuable if it was pursued by a healthcare professional) – this consequent/y led to the inclusion of the information component into our information model.
Information granularity	The granularity of the information item in the model was determined by the need of the healthcare professional e.g. a laboratory (atomic) value required to guide a single decision about therapy or medical notes (aggregated values) when less was known about the patient
Conversation	Conversation was used to obtain information from other healthcare professionals when patient-related information required for decision-making was missing. Conversation was also an efficient way for pharmacists to obtain contextual information about the patient even when other sources were available – this behaviour is likely to exist alongside any information systems.
Time	Time impacted on where information was sought by healthcare professionals (hence the significance of conversation) – they would chose the avenue that was the fastest. Time also impacted on what technology approach would be successful e.g. using information summaries would be more time efficient, but the ability to 'drill down' for more detailed information was desired.

Table 3: Information and	l technology	related issues
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The influence of professional practice tools	The information 'templates' contained within GP Desktop systems influenced what information could be supplied to pharmacists undertaking home medication reviews – if an information element was not listed in the template (e.g. diagnoses), then the pharmacist would not receive this information. Consequently, incomplete information would be
	available to the pharmacist prior to medication reviews.
Decision support tools	The level of exposure of pharmacists (and doctors) to decision support systems varied but generally was limited to simple information retrieval systems. This influenced what support they believed decision support systems could provide - if they were only exposed to simple systems (e.g. drug information), they could only suggest desired decision support in that context.
The technology-poor medication review community	The vast majority of pharmacists used simple tools (e.g. word processors) to support their medication review processes in the community. There was very little (if any) use of other technology-based communication tools, such as email or web- based tools, and paper-based information sources prevailed. This suggests that the implementation of technology-based tools will require a paradigm shift (away from paper) – using an approach which can be implemented incrementally; is flexible in use; and complements the work flow of individuals.

Table 3: Information and technology related issues

5. Discussion

The traditional approach to the design of decision support systems has tended to concentrate on: the identification and development of taxonomies or guidelines, knowledge translation into active rules; and development of software which appropriately combines the knowledge and rules (and local data) to provide appropriate decision support functionality on a user's desktop. This research project, by contrast, focused on identifying the issues which underpin the development of the information model. Our methodological approach, using the Design Research method, appeared suitable in allowing both the identification of user requirements and knowledge of what factors may affect a successful technology intervention in the healthcare domain. We believe that a particularly important finding is that decision-making can be effectively supported by a collection of essential information elements as a complement to human knowledge, rather than attempting to represent all information and knowledge within a model. This stance acknowledges the difficulty of categorising complex, healthcare-related information, the need for humans to apply information in a wide variety of differing and variable contexts; and the manner in which healthcare professionals use and communicate language which is meaningful for their purposes. Our experience suggests that collecting and communicating a simplified set of relevant medication-related information between healthcare professionals may mean that, over time, information collection would be more complete - and would provide a way of increasing the consistency and clarity of information exchanged, increasing the chances of detecting medication-related errors.

The role of documents to represent and communicate information, in either paper or electronic form, is well understood. The role of paperbased documents in healthcare is also well known. This project has confirmed the fit of a digital document for the process of the medication management for doctors and pharmacists; and has confirmed that the digital document can serve as a suitable boundary object between these practice groups in healthcare. An important finding was that the application of dynamic properties of digital documents may be limited, as they exist in an environment of information uncertainty. These results suggest both that there is great promise for the use of digital documents in Healthcare and that the complexity of the healthcare care environment demands particular attention. Our experience suggests that improvements in the quality, safety and efficiency of the medication review process and patient outcomes are achievable over time through such an approach.

The issues which emerged from this research have significant implications for technology approaches in the area of medication management and, we believe, in Healthcare more generally. The implications of these are briefly discussed here. Although, not solving the problem of missing information *per se*, an approach based upon sharing a digital document which clearly suggests essential information ele-

ments - but which does not force healthcare professionals to use these documents - may, over time, enable the collection of a complete set of information which would allow better decision-making about the patient. The contextual granularity of the information used by healthcare professionals and their language also represents tensions for the design of healthcare information systems and has implications for the representation of information in clinical systems. Further, the shared and understood 'language' of healthcare professionals used to communicate patient-related information is meaningful because healthcare professionals can interpret this information within the patient context. Modelling the enormous range of patient contexts is not within the reach of current decision support systems and the less formal approach suggested by our digital document may allow some progress. In any case, any structure imposed by decision support tools on these 'conversations' will probably be resisted by clinicians. We believe the role of conversation in information exchange, even alongside communication technologies, is understated; and that a satisfactory decision support solution must support (or at least not hinder) this desire. The ubiquitous problem of insufficient time in the healthcare environment suggests that a partial solution to this problem may be an artefact possessing summarised, relevant, patient-related information although a satisfactory trade-off between displaying essential and all information would be hard to achieve.

Existing prescribing systems do not permit information sharing, nor do they truly represent a current medication record; and although the digital document is an additional element to the GP's desktop system, this independent existence may be necessary to realise the goal of a shareable, communicable and, ultimately, up-todate medication record. Finally, we believe there are two main implications of the technology-poor practice paradigm that we experienced in the community. Firstly, the need to better support information communication requires a paradigm shift from a paper-based to a technology-based worldview; and secondly, the ability to make this change will probably require an approach which can be implemented incrementally, is flexible in use and complements existing workflows.

The high levels of missing information and significant need for pharmacists to use their own tacit knowledge confirms that medication management is not an area for novices. Consequently, there is probably no need to structure information for use over a wide range of abilities and knowledge. Across the continuum of medication management, dealing with specialists suggests a particular approach to the design of decision support tools. The enormous difficulty of capturing knowledge for a decision support system and the need to use personal knowledge suggests that providing 'essential' information and relying on a complement of human knowledge may be a practical technology compromise for medication management. Thus, for medication management, both in the hospital and in the community, we believe we should be designing systems for experts, rather than expert systems.

6. Conclusion

Despite the difficulty of designing and implementing decision support tools in healthcare, we believe we have identified a framework which can be used to improve medication management: specifically, the conduct of medication reviews. A digital document approach may provide a framework which can be used to improve the sharing and communication of relevant medication-related information between doctors and pharmacists - with opportunities for increased safety, quality and efficiency of the medication management process and, ultimately, improvements in patient outcomes. Certainly, it is impossible to be sure that any quantitative framework is the 'most' appropriate solution - we relied on the response of users to indicate how

successful approach was in providing an effective solution to their problems.

Our experience suggests that sophisticated technology is not required to implement changes in the medication management environment. An approach of providing the 'right' technology to accommodate the work processes of individuals is sufficient for supporting a paradigm change in the community. Further, the project has identified issues which may affect the approach to, and consequent uptake of, technology in the area of medication management and Healthcare in general.

7. Further research

There are number of ways of building on the research described in this paper. Extensive field studies would be highly appropriate, although the flexibility of the digital document approach also suggests a 'working document' trial within a hospital environment, as a transition between the hospital and community scenarios – both as a PDA-enabled record and as a portable personal medication record for consumers. Such a project has already commenced in Adelaide and we hope to report on this over the next few years.

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