Evaluation of a web enabled care planning and documentation system within aged care settings

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Abstract

A previous research project by the author demonstrated that the use of computer software known as an expert system could successfully provide decision support to nurses within aged care settings. Such software mimics the reasoning processes used by experts in a particular domain, which in this case was nursing diagnosis. Nurses in the study reported in this article also provided positive feedback stating that the software was easy to use, saved time, improved standards of documentation, and provided a vicarious educational experience. They also identified additional functionality which was needed if the program was to be more useful to them. As a result of this feedback the program was re-written to run via the Internet. This article reports the results of a survey mailed to users of this revised version of the software. The educational impact of using the program was again reported, along with perceived benefits to both residents and nurses. Issues of implementation and use were identified which should help managers rolling out computerised systems in aged care facilities. The software impacted positively upon workload and was reported as easy to use by users. Finally, and of immediate value, the views of nurses obtained in this survey will be reflected in ongoing discussions with user groups and forthcoming iterations of the software. The small sample size is acknowledged as a limitation in this study.

Keywords: Application service provider, computer systems, documentation, evaluation, expert systems

1. Introduction

This article examines survey feedback elicited from 25 Division One[1] and Division Two nurses working in three aged care facilities in Tasmania, Victoria and Queensland, Australia. This feedback describes their experiences of using an online care planning and documentation system over the past year. This computerised system had at its core an expert system developed as part of the author's doctoral thesis. Based on user feedback from this former study and further discussion with Division One nurses, the software was substantially extended in terms of functionality and also re-developed for delivery via the Internet. This also allowed the strengths of the previous iteration of the software to be built upon and online delivery to be evaluated.

The evaluation issues addressed within this study were identified through this discussion with nurses and represented their views of the important day-to-day issues by which an aged care computerised documentation system should be assessed. Ad-

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[1] *In Victoria, Australia, the titles Division One nurse and Division Two nurse equate to the more widely used titles of Registered Nurse and Enrolled Nurse respectively.*

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ditionally, the author re-evaluated several aspects of the original software to allow comparison with the revised Internet version.

2. Background

2.1 What is an expert system?

The original version of the software consisted of an expert system to provide decision support to nurses when producing care plans for residents within aged care facilities. An expert system is a computer program which models the expertise and rules used by experts and, additionally, acts as an expert interpreter of data within a narrowly focused domain [1]. In practical terms such a program allowed aged care nurses to enter resident data and then see all the nursing diagnoses which an expert nursing clinician was likely to have concluded from these data. Nurses could also consult suggested goals and interventions for the resident before using their own professional judgement regarding what appeared in the final care plan. This illusion of the software possessing expertise is created by a background knowledge base which contains a vast amount of rules on clinical decision-making derived from both nursing literature and consultation with clinical nurse specialists [2]. The software evaluated in this study meets the definition of an expert system [3] as the diagnostic conclusions suggested are determined by this knowledge base, which is a large set of IF-THEN rules, similar to the approach used in MYCIN, the early and possibly most famous example of an expert system

Further detail of the specific developmental processes involved in constructing this expert system and outcomes of this study are available [4]. This former study was undertaken in nine sites in metropolitan Melbourne and one in Vancouver Island, BC. The main outcomes of note were that nurses reported educational value in using such a system as it could explain the reasoning behind clinical decisions, which in turn extended the diagnostic conclusions they were able to derive from similar clinical data when they assessed subsequent residents. In addition, nurses felt that the system enhanced standards of documentation, saved time relative to manually undertaking the tasks and was easy to use [2]. This also demonstrated that an expert system could be successfully integrated into clinical practice if it reflected existing work flow and a user-friendly interface was provided.

Whilst they supplied positive feedback, nurses at these ten evaluation sites also outlined the additional functionality which would enhance the program and make it more useful to them. Their suggestions included inclusion of progress notes, assessment forms, access for general practitioners (GPs) and other allied health professionals, handover sheets and a variety of other reporting tools. Discussion in the results section focuses on subsequent nurse users' responses to the implementation of this extended functionality.

2.2 Web enabling the software

In 2001 it was decided to re-develop the program to include these suggestions and, at the same time, web enable the software. The term "web enabling" simply means converting the software to a version that will run on the Internet. This work was undertaken by programming staff at iCare in Melbourne (see http://www.icare.com.au).

In recent years web enabling strategies such as the Application Service Provider (ASP) technology used in this project have extended the IT implementation models available to aged care facilities [5]. Using the ASP model, the software runs on a server outside of the aged care facility, as opposed to running on a server within the organisation. The facility does not own the application but typically "rents" the system, typically on a per-user or per-bed basis. The ASP model provides software as a service. This can significantly reduce the total cost of ownership for an organisation and enables rapid deployment of an innovation, whilst also reducing the need for on-site IT support or a sophisticated on-site IT infrastructure [6]. An individual aged care facility only needs PCs with Internet access and, while broadband connections speed up data transfer, adequate performance has been reported by nurses using dial-up lines.

This also brought potential economic benefits to organisations by the reduction of hardware and data storage costs, whilst also adding increased system reliability and flexible user access [6]. The ASP model offers the further advantage that updates are handled in more seamless fashion. Previously software vendors have commonly needed to send out updates to customers on a CD and this may also have required the client to contact the vendor to find out how to apply the update. The ASP model eliminates these issues because the vendor provides the update directly to the application through the Internet without impacting on the aged care facility.

This new version built on the identified existing program strengths, and allowed the program to be used from any Internet-connected PC, to users with appropriate access rights. There are many inherent strengths in this approach as data may be shared by many users, passed between and used by different applications, and accessed from multiple locations [7-8]. This should in turn result in a more cost-effective and streamlined method of data management. The underlying structural relationship of the online software modules is shown in Figure 1.

The new version also allowed data to be entered via a hand-held device such as a personal digital assistant (PDA), either via wireless connection or by cradling the device to update data and, more recently, users may also interact with the system via touch screen. This has allowed greater flexibility of user interaction choices to suit an individual facility's requirements. It is acknowledged that whilst the use of PDAs has become a focus of software development and research in its own right, PDAs have demonstrated their usefulness in clinical audits [9] and a positive impact on physicians' clinical
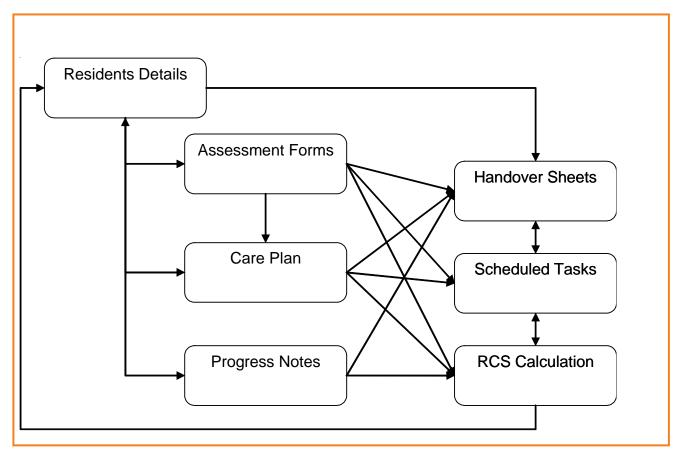
Figure 1: Organisational structure of the web enabled system

decision-making [10]. Despite these successes, many of the earlier users of the web enabled software in this study have however expressed a preference for either PC or touch screens. This appeared to be based on the limited size of a PDA for data entry, plus perceptions that they could easily lose or damage the device in the course of a shift.

2.3 Challenges for nurse managers

The variety of computer software "solutions" to documentation and care planning available to nurses within aged care is rapidly increasing, as evidenced by the number of vendors and products within the market place. This is also evidenced by a web search for *aged care software providers* conducted in late December 2006 using http://www.google.com.au which yielded 20 Australian vendors in the first page of results. Whilst this growing range of product offerings does serve to increase the choices available to nurses, it also raises some important issues, namely

the need for judicious selection of such software, and consideration of how the software might be best implemented within the clinical area. Software vendors should therefore be asked to provide substantive evaluation data to support the plethora of claims which are made within promotional and sales materials.

Anecdotal evidence from the Australian aged care sector would also suggest that nurse managers are increasingly seeking and implementing IT solutions to replace time-consuming manual practices. Concurrent to this scenario is the reality that older people will be the largest demographic group in Australia, the United States and most of Europe [11]. This will impose additional pressure on organisations to seek technological solutions to assist in documentation, care monitoring and planning.

2.4 The lack of evaluation

Nurse managers involved in the decision making processes regarding

which system might best suit their individual facility are also confronted by a paucity of available evaluation studies to assist them in this task. This problem has been evident for a considerable period of time.

Nearly 20 years ago it was claimed that the vast majority of all clinical software had never been evaluated within clinical environments [12]. This view was supported by other authors who also pointed out that, even though very few existing systems have undergone formal field testing, proponents continued to claim that these systems had great potential to improve health care [13-14].

Unfortunately there is little to suggest that this situation has changed. Consideration of the impact of computer technology on clinical practice to date indicates that, while many claims of a bright new [and near] future still exist, unfortunately this future never seems to arrive [15]. Additionally, assessments are often biased and undertaken by the system developers, who were merely grading themselves [15]. In order to avoid this potential pitfall

and ensure that users' views were represented, the author included assessment parameters suggested by users of the previous PC-based expert system [2].

This precursor project used a Multiattribute Utility Theory (MAUT) approach to evaluation which generated entirely quantitative data on system performance and utility to users. The emphasis in this subsequent study was however to gain insights into the revised system's strengths and weaknesses as perceived by users. This was felt to be an important strategy in order to make the emerging software user-driven and reflect the requirements of nurses in clinical practice, as opposed to being technology or developer driven.

3. Methods

Self-report questionnaires containing open-ended questions seeking user feedback on the revised software plus ordinal scales to rate system performance were mailed to nurses at a purposive sample of three aged care sites who were using the revised and web enabled software. All respondents remained anonymous. A large Australia Post Express Post return envelope was provided to each facility. Respondents simply placed their completed questionnaires in this large envelope which was then sealed and returned to the author by each facility's nurse manager at a pre-agreed date.

A total of 70 questionnaires were sent and 27 were returned. Of these 27 two had to be discarded due to errors of completion. The remaining 25 provided a final return rate of 35.7%. Despite this low return rate, some noteworthy comments were made which should prove useful to managers considering implementing a computerised approach to care planning and documentation within aged care.

4. Results

The data obtained were as follows.

4.1 Grade of Staff

13 Division One and 12 Division Two Nurses

4.2 Previous computer experience

It is increasing difficult in the early 21st century to avoid some form of interaction with computer technology, yet 40% of respondents reported that they had no previous computer experience before using the web enabled software. Those who had computer experience reported a variety of home uses such as planning personal finances via spreadsheets, Internet for both professional purposes and leisure, and several respondents identified the aged care workplace as their first exposure to computers.

The following sections examine nurses' responses to the extended functionality of the online system.

4.3 Progress notes and assessment forms

The use of documentation by exception means that nurses only record in progress notes noteworthy events or issues not already documented in care plans. Responses indicated that 72% or 18 nurses felt that the computerised system made progress notes either very easy or easy to complete. Only two nurses felt that this approach was more difficult than using the manual system.

Ease of information retrieval is an important aspect of any computerised documentation system and will impact on users' attitudes to the system [16]. Only 20% of users felt that accessing manual records was easier, with 68% indicating a positive impact on the ease of information retrieval since the computerised system was implemented. Additional benefits cited were not being frustrated by missing pages and incompleteness of records due to the use of mandatory fields which cannot be removed or missed out.

Other comments relate to the aesthetics of the documents with the *break up* or *layout* of documents with *sections clearly defined which made them easier to read*. Interestingly this layout is as determined by Australian Standard 2828-1999 for Paper-Based Health Care Records which specifies the physical aspects of health care records such as size, quality, layout, colour, and order of filing. Users should have previously encountered this layout in manual records, yet they appeared to perceive the layout as an advantage brought about by computerisation.

Documentation requirements have been commonly reported as a problematic issue by Australian nurses within aged care [16]. 64% of the nurses indicated that overall management of resident documentation was now easier using computerised data collection and documentation tools. Six users felt that it had made no impact on the ease of data collection. However, it should be noted that only 3 users (12%) indicated that it had made data collection more difficult than the previously used manual process. Many nurses reported that handwriting legibility issues which were previously problematic when using hand-written notes no longer existed.

Previous authors describe the variety of uses to which nurses have put PDAs [18]. These include logging a variety of day-to-day clinical data, managing visits to patients' homes and accessing patient data at the point of care. As previously mentioned, nurses using the early prototypes of the web enabled software expressed reservations about using PDAs. A recurrent theme in this study reported by several nurses in the three aged sites was that PDAs were problematic for a variety of reasons. They found them limiting in data which could be input due to screen size and the method of data entry via stylus, and they felt that free text input via a PC keyboard more accurately reflected resident condition due to the relative ease of input. Nurses also complained about data which had been lost on several occasions during the PDA synchronisation process.

4.4 Accuracy of Documentation

In order to reach appropriate clinical conclusions and plan resident-specific care, nurses require the data underpinning these decisions to be accurate. However, the problem of nursing data being infrequently used to support nursing practice has been identified [19]. The use of an expert system helped overcome this problem by providing a clear explication of how resident data had been used to reach nursing diagnosis, and then generate individualised goals and interventions [2].

When asked about the impact of the computerised tools on accuracy of data, only three nurses (12%) indicated that they had doubts about the accuracy of such data. Unfortunately, no reasons were given in support of these views. This is in contrast to the 16 nurses (66%) who indicated that they had confidence in the accuracy of the computerised data or that using the program in turn gave them more confidence in their own subsequent diagnostic decisions. One nurse admitted to initially being sceptical about the software's ability to reach verifiable conclusions but was now satis-fied that it did so.

4.5 Benefit to Residents

When asked to comment on the benefit to residents, 40% (11 nurses) indicated that using the system benefited residents with only five nurses (20%) indicating that the system did not do so.

The perception of benefit to residents included the presence of more comprehensive data in progress notes and care plans which facilitated a better range of care options to be considered. In addition, nurses reported spending less time on documentation with better access to information due to web enabling. They also expressed the belief that this better access to data in turn led to better follow-up of residents' problems. This closely mirrors the previously reported responses to point-of-care computer systems [20]. Nurses in that study also indicated that they believed that the availability of more clinical information and easier access to this information led to better care delivery.

Another nurse noted that, whilst behaviours of concern such as wandering, aggression, and restlessness were included in the data set which nurses could use to describe residents, the omission of triggers to the behaviours needed to be addressed to make the care plans more accurate and give more context to the suggested goals and interventions.

4.6 Educational value

As previously indicated, the expert system also explains how each diagnosis was reached by providing the nurse with the data used in the reasoning processes to reach that particular conclusion. Many of the nurses reported educational value in using the expert system for care planning, citing the extensive range of conclusions for the data, yet they could still exercise their own professional judgement regarding whether or not these conclusions were relevant for the case being considered. The screen which manages this information is shown in Figure 2.

The provision of a range of diagnostic alternatives gave nurses *an increased awareness of individual needs* and *made it easier to be proactive*. This complements the data on the educational value of the expert system elic-
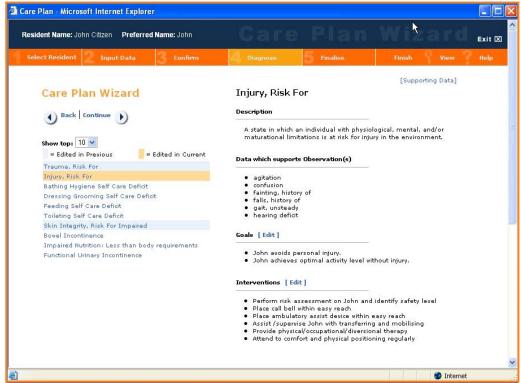

Figure 2: Expert system screen showing diagnostic conclusions reached and supporting data

ited in the previous study [2]. A further strength of the expert system was the ability of the system to pick up individual care issues that were commonly overlooked using more conventional approaches [5].

4.7 Benefits to Nurses

Nurses were very positive in their responses when asked if the system benefited them in any way. 72% (18 nurses) indicated that the computerised system benefited them in some way, with only one nurse indicating that the system was of no benefit to her. Interestingly, this particular respondent also chose the most extreme negative ordinal scale point in every instance where such a choice could be made, indicating extreme dissatisfaction with the use of computer technology for care planning and documentation.

Removing the need *to physically find manual documentation in several different locations* was reported as a positive outcome by several nurses. Again, ease of access to a variety of documentation and the ability to access this via a common point in the system was credited as contributing to this benefit. Both of these issues led to quicker information retrieval. Also the ASP model discussed earlier facilitated data entry from any available PC. Two nurses stated that, in their view, they were inclined to write more using the inbuilt word processing facilities which in turn led to a better standard of documentation.

4.8 Overall feelings towards documentation

It was not anticipated that nurses would express enthusiasm for documentation of care as it is often reported as problematic. The volume of documentation which Australian nurses working in aged care are required to complete is a common source of complaint [16]. However, only two nurses [8.4%] indicated that the system had negatively impacted on their perception of documentation and 72% of respondents stated that the system benefited them in some way.

Those who expressed a positive impact indicated that they were more likely to document care as it was easier to do so using the computerised system, and mentioned yet again that this was partly attributable to ease of both access and use.

4.9 Interface standards

Whilst nurses were not asked directly to comment on interface standards, some nurses nonetheless commented on this aspect of the computerised system. These comments included statements such as the system allows ease of review of progress notes, information is easy to find, and the system is easy to use. This feedback was most heartening as every attempt had been made to maximise the transparency of the interface as recommended by design literature [16].

An amalgam of various comments on the user interface showed nurses felt that, although they were slow at first, with practice they found the system simple and quick to use. They also found the use of prompts which showed which data entry steps still lay ahead facilitated ease of data entry.

4.10 Implementation strategy

One site used a deliberately slow roll-out strategy [5]. This involved first using the more commonly used PC-based modules before introducing hand-held devices or PDAs. Staff were identified as *champions* and they provided support for other users. All nurses also had access to a self-directed computer training package for either home or on-site use. In addition, one unit within the facility was chosen as the first to use the system and, once it was implemented there, it was rolled out to other units. This emphasised an approach using small steps, ensuring staff were confident in specified aspects of system use before moving on to further training.

Modelled on this successful roll out, a very similar strategy was used at a second site. However, this appears to have frustrated some staff who wanted a faster implementation of the process and access to more of the system. Both

sites appeared similar in terms of size, staff computer experience and staff mix, yet feedback on this issue was markedly different as staff at this latter site indicated that the slow roll-out had the potential to result in the loss of initial interest and enthusiasm in the development if this was not addressed. In relation to such issues, it is important to recognise that system performance at one site is not necessarily a good predictor at another [15]. This emphasises the importance of data elicited from multiple sites, and that patterns of information technology implementation need to be tailored to individual sites. The need to involve users in order to get the social climate of change right, to avoid impeding acceptance and use, has also been identified [21].

4.11 Negative impact of computerised records

One nurse made an interesting comment "*I used to sit at tables with the resident while writing notes, now I need to stay in the office*" indicating that she perceived that the use of computerised records was reducing her ability to have close contact with residents.

The problems of erratic electrical supply coupled with hardware problems were reported by several nurses at one facility. This tended to engender a negative perception of the system, with comments such as *"when computers freeze, it is a total nuisance especially at handover time"*. Whilst these latter problems are local issues outside a software developer's control, it is nonetheless important to recognise that problems such as these appear to negatively impact on users' perceptions of the computerised system as they do not discriminate between inherent system problems and local issues.

5. Additional Evaluation

An additional and independent study carried out by the University of Melbourne also evaluated the software using only one of the three sites used

in this study. Using a survey and focus groups, they were interested in identifying the pre-implementation expectations of users [22]. These data were collected in July 2005 and the measures were repeated to identify how expectations had been met by February 2006. These researchers also note that their small sample size of n=29 restricts generalisability, yet it is important to note several striking parallel findings to this study. Nurses again reported reduced paperwork, less time spent on paperwork especially at the end of the shift, more efficient record keeping and better access to information. Nurses did also make constructive suggestions for system improvement, e.g. extending the reports produced by the software, and extending the inactive time allowed before logging out users. The nurses believed that such additions would add to the system success in the future.

In their conclusion, the University of Melbourne researchers remarked that they were struck by the implementation success, given the relative lack of familiarity of most users with computing technology prior to the implementation. They attributed this to very good planning by the management team at the facility, system training, and the high level of staff morale and commitment to the implementation.

6. Conclusions

The data elicited from nurses in this study has helped to identify areas of software design which need to be addressed in subsequent iterations. These include the need to extend the decision support provided by the program by inclusion of prompts or alerts to undertake further resident assessment when certain defining characteristics are chosen.

Issues of implementation and use were identified which should help managers rolling out computerised systems in aged care facilities. There is a need to closely monitor staff response to system roll-out and accelerate implementation if appropriate.

It was also clear that the areas of strength of the expert system identi-

fied in the author's doctoral studies remained popular in the extended and web enabled program. Nurses again indicated that being exposed to the underlying decision-making processes used by this type of software enhanced their subsequent decision-making abilities in diagnoses. This under-researched area shows promise to either extend the decision support offered by the program, or evaluate the specific impact of exposure to this feedback. Also, it is necessary to investigate other areas of nursing practice where this artificial intelligence technique may be applied.

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