Review Article

Leveraging on Information Technology to Enhance Patient Care: A Doctor's Perspective of Implementation in a Singapore Academic Hospital

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Abstract

Information technology (IT) can improve the safety of patient care by minimising prescribing errors and organising patient-specific information from diverse databases. Apart from legibility, prescribing safety is enhanced as online access to databases carrying patient drug history, scientific drug information and guideline reference, and patient-specific information is available to the physician. Such specific information includes discharge summaries, surgical procedure summaries, laboratory data and investigation reports. In addition, decision support and prompts can be built in to catch errant orders. For such system implementations to work, the IT backbone must be fast, reliable and simple to use. End-user involvement and ownership of all aspects of development are key to a usable system. However, the hospital leadership must also have the will to mandate and support these development efforts. With such support, the design and implementation team can then map out a strategy where the greatest impact is achieved in both safety and enhanced information flow. The system should not be considered a finished work, but a continual work in progress. The National University Hospital's continuously updated Computerised Patient Support System (CPSS) is an example of an IT system designed to manage information and facilitate prescribing. It is a client-server based, one-point ordering and information access portal for doctors that has widespread adoption for drug prescription at outpatient and discharge medication usage areas. This system has built in safety prompts and rudimentary decision support. It has also become the choice means of accessing patient-related databases that impact on diagnoses and management.

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Introduction

Information technology (IT) has become truly pervasive in everyday life; however, in the field of medicine, we have yet to fully harness its full potential in the care of our patients. Most restructured hospitals in Singapore have been wired up with fast local area networks (LAN) and desktop personal computers are evident in inpatient wards, offices and clinics. Many of these systems were originally designed to serve administrative functions like billing, registration and inventory.

Thankfully, this very backbone sets the stage for delivering information to multiple sites at all times, and allows patient-specific data to be merged from diverse locations. Many hospitals are beginning to attempt to better organise such data as well as the ordering process to enhance clinical practice, albeit with varying success. The speed of wired connections and switches have also finally reached a point where rapid sharing of large volumes of medical data and real-time online ordering can realistically be carried out.

This paper attempts to outline the necessity for all Singapore hospitals to utilise IT much more, and attempts to define what issues need to be considered in the implementation of IT solutions for hospital practice. I will be using the experience of the National University Hospital (NUH) as a specific example.

Defining Needs and Determining Objectives

There is always the temptation to utilise computers in the patient care setting, but it would be a mistake to move into what will be quite a substantial investment without being cognisant of the actual need for IT and the overall objectives of such a move.

Objectives

From the doctors' perspective, the principal objectives of utilising IT should be to reduce error and increase convenience of medical practice. Medication errors are one key area which should galvanise administrators and leaders to mandate implementation of automated system interventions, given the prevalence.[1] The American Hospital Association lists the following as some common types of medication errors:[2]

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- Incomplete patient information (allergies, concurrent medications, previous diagnoses, and lab results);
- Unavailable drug information (no up-to-date warnings);
- Miscommunication of drug orders (poor handwriting, drug names confusion, misuse of zeroes and decimal points, confusion of metric and other dosing units, and inappropriate abbreviations);
- Lack of appropriate labelling as a drug is prepared and repackaged into smaller units;
- Environmental factors, such as lighting, heat, noise, and interruptions, that can distract health professionals from their medical tasks.

In the area of medication errors, studies have shown that computerisation can reduce errors by more than 55%.[3,4] In the prevalent manner of determining drug allergies, for example, most practitioners and dispensing pharmacists rely on 3 sources of information.[5] The patient (or relative) is asked for such a history, existing records are perused for any notation or documentation of such an allergy, and the separate pharmacy record (mostly electronic but not necessarily linked institutionally let alone nationally) is consulted. It is evident that all are individually unreliable and the fact that many agents are involved simply magnifies the likelihood of error. IT can bring in even more levels of safety apart from merely checking from a central database for allergies. It can check for drug-drug interactions, prompt when wrong doses are entered and prompt when a prescribed agent is possibly harmful because of existing illnesses that impact on prescribing.

The convenience factor is another attraction of computerisation. Prescription orders can be almost instantaneously transmitted to the dispensing pharmacy and transcribed to the pharmacy's labelling system facilitating pre-packaging of medications. This would shorten wait times for patients, apart from saving unnecessary work for pharmacists. Databases for laboratory results, X-ray reports and past procedures are stored at different sites. Collation requires human intervention, and by various individuals, into the hardcopy medical file. As with the issue with recording an allergy, IT can automatically collate information from diverse linked sites and organise such information in the background into a presentable form. The added benefit of having this store of information at hand at all times and from anywhere within the hospital augments safety as well as accuracy in diagnoses.

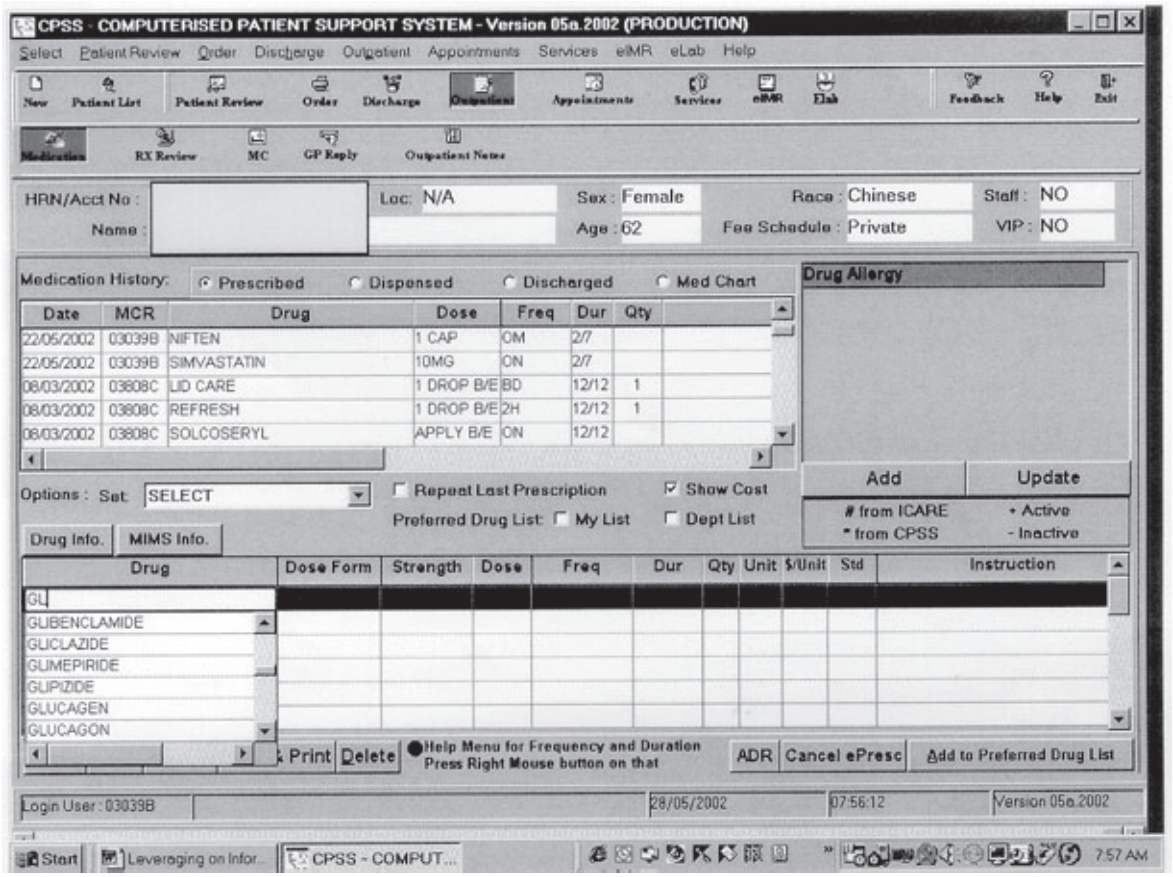

Fig. 1. Prescribing using the Computerised Patient Support System. Screen capture showing prescription order view. Note the drop down list called up automatically by inputting just the initial letters of the medication name. The repeat prescription and two preferred drug list options simplify prescribing. Known drug allergies are prominently displayed and can be updated on this same screen.

Building in convenience by having information available at multiple access points 24 hours a day is a very necessary inducement for adoption of computerisation if we are to ultimately move to an almost paperless system and a patient-centred record. This stems from the fact that apart from speed, the paper record remains flexible in that it allows not only text but drawings and photographs to be appended to it. Hence, building an "available everywhere" information portal would be another key IT initiative.

Quite apart from the costs saved from reduced adverse drug incidences, IT can also deliver 'best practise' to the user in the form of information and guidance so that physicians comply to pathways and guidelines. This has been shown to reduce hospital length of stay and unnecessary repeated tests, and result in more cost-effective antibiotic choices.[6,7]

Users Needs

The users are the key here, and it is these users that will determine if the initiative ultimately succeeds. In hospital environments, the key users of such systems would be doctors, nurses and paramedical support staff. Each individual group's requirements will differ. In addition, inpatient wards are distinct from outpatient areas, surgical theatres or diagnostic laboratories. I will largely present this process from the doctors' perspective, but many of these principles also apply to areas like laboratories and pharmacies.

What, then, are the needs of doctors and their patients? Broadly speaking, this can be divided into the 2 areas of orders and information.

Key Orders

In practice, all doctors make basically 2 types of orders; medication (including drugs, intravenous fluids) and investigations. We chose to tackle medication orders as the highest priority given its potential impact on safety.

Handwritten prescription orders are the historical means by which doctors have communicated medication needs. The sheer volume of such orders per physician per annum is staggering; easily in excess of 2000 individual prescription scripts on the average. Written quickly, largely from memory and with abbreviated dosing intervals and prescription durations, these scripts are then initialled in a manner that is almost indecipherable.

Despite the dangers of illegible handwriting and no means for verifying that a safe order was made without ploughing through a case record which may not be on hand, the principal advantage of this handwritten order is speed. For computerised ordering to work, it became apparent that built in safety checks were not enough of an inducement to encourage adoption.

While designing the software user interface, we also decided to build on the existing easily customisable Informix system dubbed the Computerised Patient Support System or CPSS for short. The then available interface was not easy to use, but it had some features on which we could build and, more importantly, the IT team had experience programming it and working with the Microsoft SQL databases on which the platform would run.

Strategy for Implementation of Electronic Prescription

Support and the Design Teams

For successful introduction and adoption, there are multiple levels of support required.[6] For the National University Hospital, support was garnered at these levels:

- Medical Board – to mandate the usage of electronic prescription in a staged manner;
- Users to help design the interface they would use;
- Pharmacists to assist in laboriously designing the decision support features;
- IT specialist team with commitment and willingness to adapt systems to users.

Obtaining hospital support was crucial as this allowed a mandate to switch over to the IT-based system once this was ready. It then became the responsibility of the multi-disciplinary Medical Information Technology Committee to determine when the system was truly ready to be used in place of paper.

Keeping it Simple

Many such systems also fail because the users (doctors and pharmacists) are not intimately involved in the interface design. This is particularly likely when the IT professionals design it independently.[6] For widespread acceptance, the interface had to be fast, intuitive and reliable. The design should be as close to the paper prescription order form as possible. Minimal inputs with automatic drop-down pick lists were designed and the physician could choose to use the mouse or simply hit the "tab" key to move between fields (Fig. 1). Finally, the system was designed such that a repeat of a previous prescription only required one mouse click to perform. Customised order menus for specific specialties and physicians were also catered for.

Picking the Initial Prescribing Scenarios

This was a pivotal decision. The best settings were where the physician was at a static station as this allowed us to start the implementation with desktop personal computers. It was logical, thus, to target implementation for the outpatient clinic visit, the ward nursing stations and the residents' rooms. Once end-user training was completed, CPSS e-prescribing was mandated for all outpatient prescriptions and hospital discharge medications.

Safety Features and Decision Support

The following safety features and decision support were designed and implemented in phases:

- Drug allergy display
- Drug allergy prompt
- Drug-drug interaction prompt
- G6PD advisory prompt
- Special drug specific prompts (to check blood counts, for example)
- Standard unit dose suggestion
- Drug cost information
- Standard drug advisory prompt

More are being implemented in the near future for specific medical conditions that impact on prescribing.

Other Electronic Orders

Riding on the same strategy as for outpatient prescriptions, the team went on to identify other areas where computerisation would be accepted and adopted with ease, provided convenience was designed in.

Medical certificate generation was a built in application which succeeded almost without effort. This saw widespread adoption almost from development because it automated the input of patient particulars as well as start and end dates. The doctor only had to input the duration required. It was then a very simple matter to print out a hardcopy to sign. The added benefit of an audit trail that is centralised and online makes this a better system than the old one which consists of multiple booklets which are hard to account for.

Histopathology and cytology ordering plus reporting was incorporated largely due to the efforts of the Department of Pathology. This department mandated online orders and delivered on producing online results. While end-user (physician) input was not much solicited in interface design, the fact that the overall design made accountability unambiguous was a strong benefit of this set-up.

Information Retrieval

As mentioned earlier, paper records are limited in many ways, chief of which is availability. These records are also stored at multiple sites and collation requires many human intervention steps. Yet, it is precisely the need for timely information 24 hours a day that makes the use of IT so necessary for healthcare.

Creating a one-stop online information portal to attract physicians to use the networked computers was the best means to break initial apprehension to use IT. Laboratory data were already being generated electronically from networked analysers in the laboratory. It only required a link to the Laboratory Information Systems (LIS) to automatically pull patient-specific results to the main physician access software system.

In stages, the following patient results were made available through the CPSS portal:

- Laboratory results;
- Histopathology reports;
- Radiology reports;
- Cardiology reports;
- Emergency department notes;
- Endoscopy reports;
- Neurology investigation summaries.

The following key reports were also made available:

- The full electronic inpatient discharge summary (*vide infra*);
- Surgery reports.

In a parallel but separate initiative, radiology images were also made available online, riding on the fast wired local area network. Larger display panels were purchased for each ward area to facilitate viewing such images.

Summaries Online

This left the issue of how to enable doctor to enter patient data. Typing skills are not ubiquitous amongst doctors, and even the fastest of touch typists would have problems keeping up with the usual highly abbreviated, eponym rich as well as terse written comments. However, there were two areas where we could definitely either mandate online completion or facilitate online use. These were in the completion of the Inpatient Discharge Summary and the preparation of referral replies.

The Electronic Inpatient Discharge Summary

The Inpatient Discharge Summary was the best platform for many reasons. This is a time sensitive document and there are guidelines for when this must be completed. The completed document is utilised for coding, which impacts on how patient-admissions are reimbursed as well as on health statistics. Discharge summaries are often released to patients or their referring physicians as a record of their visit, and are supposed to be checked by a more senior doctor after completion by either the intern or resident. Finally, the National Healthcare Group requires that this form be shared between the cluster's institutions electronically.

The abovementioned requirements meant that we had to mandate online completion of these summaries. Practically, this was actually easy to design as it is form based and the required fields were already pre-determined. Finally, checking or confirming the record online was better than with a pile of the bulkier paper case records. Consultants and registrars could view the records on the server from their desktop PCs from any point within our hospital and

confirm the summaries, calling up case notes where necessary. Again, hospital mandate followed end-user training, and confirmed summaries in HTML format became viewable through CPSS.

Patient Referral Replies

Referral replies are valuable communication between primary care and specialist, or between specialists. These carry summaries of patient encounters and allow doctors at different sites to coordinate their healthcare efforts. A simple form-based reply letter was included in the CPSS system to facilitate this reply. To simplify the process, the referring doctor's name and address were merged from the registration database and included in the letter address lines. Completion of this reply only requires inputs into a few fields and a print command will then generate the letter for dispatch.

The Current Status of Patient Care Related IT Usage at the NUH

The NUH has slightly more than 500 networked desktop personal computers with access to CPSS. Every outpatient consultation room has its own personal computer and each nurses' station has at least two. Laser quality printers are available at every location for hardcopy generation which can include barcodes. There is server redundancy and a quick response hotline, apart from a very prominent feedback button within the software.

For the month of April 2002, 16,084 outpatient and 3424 discharge prescriptions were generated electronically. This constitutes 72% to 73% of the average total monthly prescriptions handled by the NUH pharmacy. In this same month, 5424 inpatient discharge summaries were completed online. For the first 5 months of this year, the system generated 34,665 medical certificates and registered almost 200,000 hits for laboratory data retrieval. The ability to retrieve data so impressed our nursing staff that they asked for their own portal to access laboratory data with read-only access at all the nursing stations.

From January to May this year, the drug allergy intervention alert was triggered 454 times and the drug-drug interaction alert 1705 times. This reflects the key role of computers in helping avert potential medication errors in busy hospitals, and also saves man-hours of manual pharmacy intervention at dispensing locations should the allergy or interaction even be picked up. We are currently continuing to build in more advanced safety checks and decision support into the prescribing module, and are working towards laboratory ordering with a direct link to billing.

We have now embarked on the next phase of computerising the inpatient medication prescription and dispensing system. A wireless local area network (WLAN) has been set up with base stations in all ward areas. Given the mobile nature of the doctor and nurse work teams, more than 200 tablet PCs have been purchased to run on this WLAN. This will allow doctors, nurses and patients to benefit from the built in safety features of the existing CPSS.

Conclusions

Computerisation is a necessary, albeit challenging, initiative that can enhance safety through improved access to patient-specific information, automated prompts and decision support. For successful implementation, multi-level support is necessary and the design ownership must rest with both users and the IT team. The system design should also adapt to the user setting as far as is possible and should be thought of as a constantly evolving one.[6]

While such systems can be adapted from commercially available ones, our team decided to build it in-house because we wanted full ownership of the process and felt that we had the expertise onsite. It is still a work in evolution, but it has significantly and positively impacted on the practice of medicine at the National University Hospital.

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