Understanding the Physician to System Interface – Designing Better Systems for Physicians

Chow Yuen Ho

Department of Medical Informatics, Singapore General Hospital, Singapore

Abstract

Technological capabilities have matured to a stage where positive contributions to the practice of medicine have become a reality. The disparity between technological capability and successful implementation is multi-factorial. As the physician is often the coordinating party at the beginning and end of the technology utilization cycle, the interface between the system and physician is critical to successful implementations. This paper reviews the specific intricacies of the physician to system interface from a local perspective, to provide an in-depth understanding of the unique demands of the clinical information system interface. It also seeks to explore new possibilities where this interface can be enhanced with currently available matured technologies.

Keywords: *Medical Informatics, Health Informatics, Physician System Interface,*

Introduction

There have been many reasonable arguments supporting the use of EMR systems in clinical practice[1]. Benefits from the use of doctors systematically entering data into automation systems are legion. These include reduced medical errors and consequent better patient safety[2,3], faster search and retrieval of records, basis for natural language processing and clinical decision support[4], legible recording, ubiquitous access of information across multiple platforms and locations and faster processing of clinical orders.

This same argument can be loosely applied to other similar clinical and para-clinical systems doctors interface with everyday. There are benefits of Information Technology (IT) in making accurate and up-to-date information more readily available to the clinicians involved in the care of patients.

Yet despite many attempts to implement systems to these effects, there have been many failed systems. For example, Cedars-Sinai Medical Center put on hold their Computerized Physician Order Entry (CPOE) system in January 2003 because it was perceived to be unduly time-consuming.[5]

The causes of these failures are multi-factorial, and while it is beyond the scope of this paper to discuss the various reasons why such systems fail, a large portion of responsibility can be attributed to the failure of the physician to system interface. In many computerization approaches, the physician is central to the technology utilization cycle because he coordinates clinical care for the patient. The objective of this paper is to review the specific intricacies of the physician to system interface to provide an understanding of the unique demands of the clinical information system interface, from our local experience. It also seeks to explore new possibilities where this interface can be enhanced with currently available matured technologies. It is hoped that armed with a better understanding of the specific requirements of such an interface, better integration of the physician into the digital hospital of tomorrow can become a reality.

These considerations can be divided into three broad categories: Physician factors, systems factors and location factors.

Practical Limitations Faced by Doctors

In understanding the specific limitations faced our doctors in their daily processes, specific system design can be employed to circumvent these shortcomings.

Time

A physician's time is a very valuable commodity. The number of tasks required of a doctor in each day directly determines the number and quality of the physician to patient interaction, and his clinical decision making process[6]. Emphasis needs to be placed on the physicians' clinical time, with minimal distractions by administrative tasks.

Visual Acuity

The age range of doctors in Singapore is between 26 (at graduation) and 65 (at retirement), with exceptions. Presbyopia tends to occur from around the age of 40. Taking this into consideration, a fair number of doctors will be unable to read quickly off smaller computer screen formats, especially those of miniature portable or handheld computers.

User Interface Training and Acceptance

Studies have shown no demographic differences in the profile of physicians using electronic medical records systems with respondents scoring high in computer literacy[7]. In our local experience, we found that doctors have limited time available to attend user training, making

intuitive user interfaces which require little or no training a boon.

Practical Limitations of the Computer Systems

While various putative technologies may be employed in improving interfaces, it is prudent to be aware of the potential limitations of use of information technology in different medical arenas. Key factors include:

Radiofrequency (RF) Interference

In the quest for ubiquitous wireless networks, RF interference with other medical devices may limit their deployment. Standards of wireless interference with medical equipment need to be adopted. For example, the United Kingdoms Division of Health Medical Devices Agency issues alerts on electromagnetic compatibility of medical devices with mobile communications.

Image Quality Versus Medicolegal Considerations

When deploying image systems in various platforms and devices, image quality needs to be compared to existing accepted practice norms to satisfy the test of ethics and medico-legality. In medical imaging, it is important that there be a visual consistency in how a given digital image appears, whether viewed, for example, on the display monitor of a workstation or as a film on a light-box. In the absence of any standard which regulates how these images are to be visually presented on any device, a digital image which has good diagnostic value when viewed on one device could look very different and have greatly reduced diagnostic value when viewed on another device[8]. Generally, the Digital Imaging and Communications in Medicine (DICOM) standard is well recognized as a standard for diagnostic medical imaging.

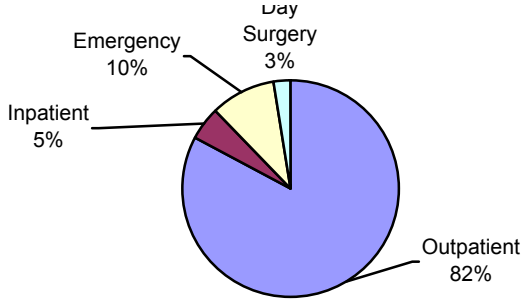
System Response Time

Many factors come into play when system response time becomes a consideration. These include issues like computer speed limitations, network bandwidth limitations, software architecture etc. These become an important consideration when processing large amounts of data (e.g. high resolution radiology images) or complex calculations (e.g. rule-based clinical decision support).

Understanding the Arenas

Healthcare provision takes place over several arenas. The prototypical hospital consists of, but is not limited to the following areas. In a multi-centre healthcare provider in Singapore, the patient visit statistics is divided approximately in the proportion shown in Figure 1.[1]

Figure 1. Patient Visit Breakdown for a Multi-Center Healthcare Provider in Singapore



Consideration of the intricacies of each environment means that different interfaces or views of an application need to be developed for each point of access. Also, understanding of the logical process flows allow high level planning of systems that span departments in order to integrate well into the entire hospital system. For example in tracking a patient hospitalized for surgery, the typical process flow spans three different clinical systems as shown in Figure 2.

A system designed for such a flow would include integration of the hospital EMR system, the OT monitoring system and the ICU monitoring system, with overlaps.

Outpatient and Polyclinics

The outpatient clinic is one of the most utilized areas of the hospital.

The consultation room may be limited to having a single computer for EMR access and results reporting, and certain specialty specific equipment like video scopes etc. It should be stressed that this is one of the key areas where medical decisions are made, (e.g. decisions for elective surgery, drug therapy decisions etc.) and minor procedures are done. Conversely, it is also one of the areas where IT process automation is usually most lacking.

Inpatient Wards

The wards are perhaps the biggest challenge for physician to system interfacing. Like a travelling salesman, physicians need to locate patients under their care, make their way to the correct bedside and see the correct patient. Often, many unexpected complications arise, for example patients not at their bedside (having gone to the toilet, for investigations or been transferred to another bed), case

[1] Patient visits is used as a surrogate indicator for actual patient encounters. Patient encounter figures are likely to be higher for Inpatients as there are multiple encounters per visit.

sheets and x-ray films gone missing or doctors joining or leaving the ward round team unexpectedly.

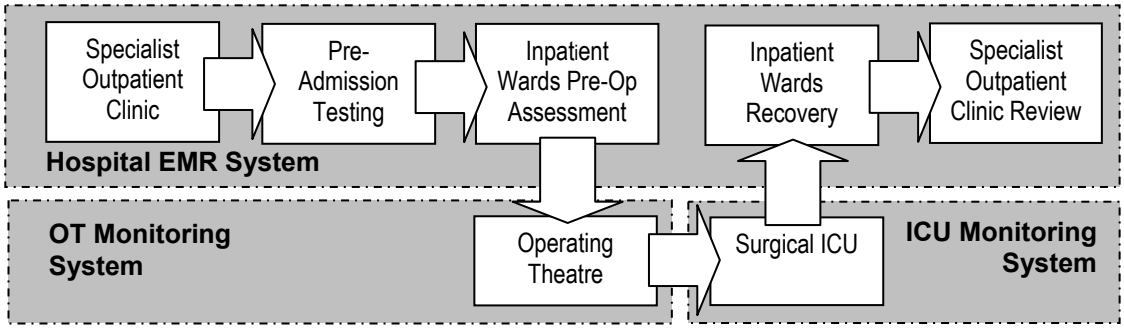


Figure 3: Sample Process Flow for a Surgical Patient Across Three Different Clinical Systems

The mobile nature of the consultation makes it very suitable for mobile devices. However, this very mobile nature of the doctors makes larger devices impractical. Yet another challenging consideration is that the ward is almost a public place, where patients and visitors come and go freely, making security of devices and wireless networks a priority, lest theft or network intrusion compromise security.

Intensive Care Unit (ICU)

The Intensive Care Unit is an area which is highly IT intensive. Many monitoring systems have a foothold in this environment because of the intensive monitoring nature of care which occurs. Integration of systems in this arena is a challenge, as doctors need to consolidate parameters and information from a variety of monitoring systems to a single clinical picture. Traditionally, nurses may obtain periodic readings and chart them on a single consolidated clinical chart. The challenge of this is having a variety of instruments plugging into a single system to consolidate this information. Another challenge is the large number of medical devices that need to be tested for interference with wireless network transmission protocols. Information in this environment is highly time sensitive, and accuracy is key. System uptime needs to be very consistent.

Operating theatres (OTs)

The operating theatre and anesthesia/recovery areas are like little ICUs in that they also have a wide array of monitoring, visual and control systems. However the variety of systems is less, in view of the degree of integration in intelligent OT systems offered by OT automation suppliers. There are few vendors offering complete solutions that match all requirements within an OT. Hence, hospitals tend to adopt a piecemeal approach to acquiring systems. Integration of these systems into a common reporting system is often desired.

Emergency Department

The emergency department also adopts a variety of systems in the treatment of patients. The typical emergency department in Singapore contains both an outpatient system and a trauma/resuscitation facility. High priority cases are triaged and channeled to resuscitation areas while lower priority cases are treated like general practice/outpatient clinics. Resuscitation areas contain their fair share of diagnostic and monitoring equipment which mimic an ICU setting.

Principles of Doctor to System Interfaces

Key principles in these interfaces are listed below. These need to be considered in designing systems, although the considerations are not exhaustive.

Intuitive User Interfaces

User interfaces need to draw a balance between simplicity and functionality. Most physicians scored high on IT literacy[7]. The nature of their profession also demands that they are constantly learning, hence their potential to assimilate new systems. Design of on-screen user interfaces should be simple and intuitive on the surface, with a deeper level of complexity and shortcuts available to speed up frequently used functions. All interfaces should also be task oriented, based on doctors' daily tasks varying according to location and role. In this respect, end-user customization of the user interface is an often sought feature. In particular, systems designed for specialty domain require careful study of human factors and activity[9].

Logical Sequencing

Systems should be designed in a way that allows logical sequencing of records closely mirroring the doctors thought process such that there is a natural progression for the doctor. For example, screens should show in the correct sequence the well known SOAP (Subjective, Objective, Assessment, Plan) method of clinical notes recording. Putting these in any other order is likely to feel unnatural.

Minimal Steps And Clicks

In our experience, physicians found systems requiring multiple clicks or deep navigation cumbersome. A good practice to adopt is to design systems that make functions available in the least possible clicks/menus and shallow navigation.

Faster Than Existing Processes

A common expectation of computerization is that processes should be faster than existing manual ones. After computerization, any task which is slower than the existing paper based process would likely meet with much resistance from physicians even with justified gains.

Perceived Gains For The Physician

To secure buy-in from the physician users, it is common for them to expect perceived gains in terms of time, faster results, more accurate prescriptions, better patient care etc. When re-engineering processes to require physicians to do additional work, it is important that the returns are justified and apparent.

Choosing The Right Person For The Job

Physicians make poor data entry clerks, and therefore should not be made to do clerical work. In addition, it must also be apparent that the most appropriate person be chosen to do the appropriate task. It is unreasonable for IT system designers to expect physicians to do large amounts of data entry which would be more suitably done by a clerk; hence systems need to be designed around these process limitations.

Prioritize Degree Of Criticality Of Information

It is important to prioritize and present information to doctors based on the criticality of this data. Considerations include impact on patient treatment, timeliness, accuracy, image quality, degree of comprehensiveness and sensitivity to amendments (e.g. preliminary and final results).

Involve the Physician in Implementation

Getting the end users involved and interested in the systems implementation is instrumental to designing good interfaces. Singapore Health Services was able to roll out a common platform EMR results reporting and discharge summary system across 3 acute hospitals, 4 specialist centres and 9 polyclinics because of passionate involvement from the steering committee which involved up to 20 physician user champions meeting regularly to steer the implementation. Representation from staff with executive authority (i.e. committee included key management staff e.g. CEOs, COOs) is an added bonus.

Matured Technologies Which Impact Medical Practice

Outlined below are discussions of some of the technologies which are sufficiently mature to be implemented in a healthcare setting.

Devices

Personal computers are a common finding at most healthcare institutions, but portable devices are gradually increasing in acceptance from notebook PCs, Tablet PCs to handheld PCs and Personal Digital Assistants (PDA). Increased complexity and sophistication of these devices allows them to develop richer functionality. However a common situation we encountered was that because of the particularly rapid advancement of this field of technology, physician's expectation of the capabilities of mobile devices tended to run ahead of actual deployed capabilities. Key considerations when choosing devices for doctors include their daily routine activities, role, age group, seniority and individual preference. As such, different doctors will require a range of different devices within the same systems implementation.

Wireless Technologies

The deployment of wireless networks (e.g. 802.11x, Bluetooth) in hospitals is quickly gaining acceptance. Coupled with mobile devices, it allows doctors to literally have access to applications anywhere there is a wireless access point.

Radio Frequency Identification (RFID)

RFID technology can be used in a variety of applications. Plausible hospital implementations include patient identification and contact tracing. For example, in the physician interface, RFID technology may be used to identify and authenticate the doctor to the patient, automatically grant access to EMR and digitally sign prescriptions and orders, thereby streamlining and securing the process of seeing a patient.

Tele-Communications

An integral part of hospital workflow rotates around the use of communications devices. Increasingly, mobile phone short messaging service (SMS) is gaining popularity although service reliability is a common issue. Alerts are an important aspect of the system to physician interface[1, 10]. Configurable alert values for blood investigations (for example high potassium levels triggering a SMS or paged alert to the managing physician) can shorten time taken to react to dangerous situations as well as reduce errors.

Novel Input Methods and Natural Language Processing

Speech recognition and handwriting recognition are some technologies which have matured over the years to have garnered real applications in some limited arenas, for example radiology and pathology departments. Natural

language processing is the next logical step and is still in its infancy, although predictions are that it will produce productivity returns in coming years.[4]

Comment

A detailed understanding of the physician to system interface is essential to successful implementation of systems where physician interaction is required. In order to design such systems, it is imperative that much thought be placed in selection of processes to be modified, tasks assigned to physicians and choice of technology and devices. Also it is important to note that because there is no one-size-fits-all solution, an implementation should consist of a variety of options to meet different perceived classes of physicians in order to succeed. Underlying this is the absolute necessity to involve doctors or trained Medical Informatics professionals with domain knowledge of the involved processes in the design of systems. Further surveys assessing the degree of importance of each interface priority may be valuable in customizing systems for each institution.

References

[1] Bates DW, Cohen M, Leape LL, et al. Reducing the Frequency of Errors in Medicine Using Information Technology. J Am Med Inform Assoc. 2001;8:299-308

[2] Kohn LT, Corrigan JM, Donaldson MS (eds). To Err Is Human: Building a Safer Health System. Washington, DC: National Academy Press, 1999.

[3] Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA 198;280(15)1611-6.

[4] Barry Hieb, M.D. NLP Basics for Healthcare: Gartner TU-17-5321, 16 Aug 2002.

[5] Fred D Baldwin, Healthcare-Informatics, McGraw Hill, May 2003.

[6] Davidoff, Frank MD. Time. Annals of Internal Medicine. 127(6):483-485, September 15, 1997

[7] Hallvard Laerum, Gunnar Ellingsen, Arild Faxvaag. Doctors' use of electronic medical records systems in hospitals: cross sectional survey. BMJ. 323(7325):1344-1348, December 8, 2001.

[8] National Electrical Manufacturers Association. Digital Imaging and Communications in Medicine (DICOM) Part 14: Grayscale Standard Display Function.

[9] Beuscart-Zephir MC, ANceaux F, Crinquette V, et al. integrating users' activity modelling in the design and assessment of hospital electronic patient records: the example of anaesthesia. Int J Med Inf 2001;64(2-3):157-71.

[10] Kuperman G, Boyle D, Jha AK, et al. how promptly are patients treated for critical laboratory results? J Am Med Inform Assoc. 1998;5:112-9

Address for Correspondence:

Dr Chow Yuen Ho, MB, BS. is the Director, Department of Medical Informatics at Singapore General Hospital and Vice President, Association of Informatics in Medicine, Singapore (AIMS). Interested readers may contact Dr Chow at Singapore General Hospital, Outram Road, Singapore 169608, Tel: +65-62367833 or via email at chow.yuen.ho@singhealth.com.sg