Clinical communication: A new informatics paradigm

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Observational studies of clinical workers in a hospital setting suggest that communication problems are a significant source of inefficiency. The need to reduce interruptions, improve contactability, and the sharing of informal information suggests that a mobile communication system capable of supporting asynchronous messaging, role-based contact, and communication policies would be beneficial. A prototype of such a system is described.

INTRODUCTION

Information and communication are deeply intertwined. This also holds true technologically, as the distinction between information and communication systems is rapidly disappearing. It is surprising then, that the way in which information and communication interact in health care has attracted little interest. Further, the health care system suffers enormous inefficiencies because of poor communication infrastructure. One estimate suggests that the US health system could save $30 billion per annum with improved telecommunications. [1]

However, there has been surprisingly little work done in examining the causes of communication inefficiency in health care, or how they might be remedied. This is despite the existence of a significant body of research into mediated communication. [2] What work has been done, mainly in Telemedicine, is driven largely by technology rather than problems. [3]

This paper reports on detailed studies of communication patterns in a clinical setting. It focuses on the relationship between communication and information access, and on the adverse consequences of some communications practices. These results will be used to suggest new ways in which clinical workers could be assisted with their communication and information needs, and to formulate the design of a clinical communication system.

METHODS

In the absence of strong hypotheses about clinical communication, a non-participatory and qualitative observational study was conducted. An ethnographic approach was adopted. [4]

The study proceeded in two stages. A set of 23 preliminary semi-structured interviews of clinical staff were undertaken at two US and two UK hospital sites, covering senior and junior medical, nursing and clerical staff. The interviews focused on individual's perceptions of communication and information access problems, and the relative importance of both.

These interviews provided a set of foci for a second, more detailed study. Observations of 12 clinical workers completing their routine duties were undertaken at a UK hospital. The study cohort comprised eight physicians of varying levels of experience from junior to senior, two nurses and two radiographers. Subjects were chosen in order to obtain a reasonable cross-section of the different roles and experience amongst hospital staff.

Subjects were each shadowed for a period of four hours by a researcher. Each subject carried a small radio-microphone that recorded their speech during the study period. Subjects had the opportunity to suspend recording if they felt patient confidentiality would be breached, or could retrospectively exclude recorded material for similar reasons. The observations were followed by interviews with subjects. These interviews were used to obtain clarification of events seen during the observational period.

The observational and interview data were then pooled and analysed to identify significant events and emerging patterns. These were then used to generate more general models that described the observed data. This process of model evolution is a permutation of a qualitative research technique known as grounded theory. [5]

At this stage the models can be considered to embody hypotheses about the observed communication patterns. There are several ways in which these models can be tested. Firstly, further observational studies can be constructed to test specific aspects of the models. Secondly, in the iterative prototyping approach adopted here, parts of the model are embodied in a communication system design. This is then tested with new users. Their reactions to the system will test the model. The results reported here include some of the initial observational studies and models generated, and the initial systems design. A formal trial of the system in a clinical setting is currently being planned.

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RESULTS

The preliminary interviews suggested that communications problems were perceived to occur more frequently than information access problems, and also to have greater impact on work. These results were explored in more detail through the second study. Here the data gathering and analysis focused on the methods and purpose of communications amongst hospital workers. It also tried to characterise the information that was passed across during communication, to understand any potential implications of communication for information system design.

There were a number of key characteristics of hospital staff that seemed to influence their communications. Firstly, in contrast to other populations such as office workers, health care workers were highly mobile during their working day. Nursing staff were least mobile, spending most of their day moving around their home ward. Medical staff and radiographers ranged widely across the hospital campus. Senior medical staff also moved off campus, but remained in contact through a wide-area paging system.

Secondly, the hospital was a highly interrupt-driven environment. All subjects received multiple interruptions, either face-to-face from colleagues, or through the paging and telephone systems. The consequence of this was that subjects had to repeatedly suspend active tasks to deal with interruptions, and then either return to the previous task, or deal with a more urgent interrupt. Further, since most workers already had multiple tasks to accomplish, they were constantly rescheduling their work plans. There thus seemed to be a significant cost in time and efficiency arising out of the interrupt-driven nature of the hospital work environment.

Finally, all subjects were members of teams. For example, medical teams were lead by a senior doctor and shared responsibility for a group of patients under their care. Nursing teams and radiographer teams had slightly different structures based upon their differing responsibilities. In each case however, the team-based nature of work demanded that subjects communicated frequently with their team-members throughout the working day.

Synchronous Bias: The team-based nature of work and worker mobility both contributed to the need for communication with, and hence interruption, of colleagues. This however seemed insufficient to explain the level of interruption observed in the study. In particular, it seemed that several other factors predisposed workers to rely on synchronous, rather than asynchronous, communications. Why was it that subjects did not use non-interruptive asynchronous channels of communication whenever possible? Several explanations seem likely:

- The study hospital, like many at present, did not offer asynchronous channels like voicemail or email. Some asynchronous mechanisms were available, but their use seemed minimal. For example, it was possible to leave written messages in patients' notes. Messages could be left with the secretaries of senior medical staff. Some nursing staff wrote down tasks for doctors on sheets of paper at the ward desk, in preference to paging them.

- There seemed to be pressure in such an event-driven environment to deal with events when they arose. In order to feel that a task involving communication could be 'ticked off the list', subjects needed an acknowledgment of receipt of message from the other party. Acknowledgment was possible with synchronous channels but not with the available asynchronous channels.

- Subjects were often opportunistically interrupted for face-to-face discussion, usually relating to complex matters of patient care. Such discussion was perceived to be of high value by those interrupting because of the richness of interaction afforded. Since such discussions were difficult to schedule, any opportunity was avidly seized.

- Finally, most subjects did not reason about the consequences of their communication actions. In particular they often did not consider the effect of a phone call or page on the other party. Their actions could thus be characterised as locally selfish. This effect could be attributed to a lack of guidance or understanding of the wider implications of interrupting colleagues, and the cycle of escalating interruptions caused by everyone acting 'selfishly'. Some more experienced staff were the exception here.

Informal information: Clinical decision-making is information dependent. Information in the study was seen to be obtained from two different sources - formal or permanent sources like patient notes or laboratory results, and informal sources. Informal information is often obtained verbally from colleagues, sometimes annotated in personal notebooks or on loose paper, and often is not transferred to the permanent record in great detail, if at all. One important observation arising from the study is that much of the information that was used in day to day decision making was informal. This ranged from requests for specific patient details, to questions of diagnosis and therapy.

Roles: Organisations evolve structures to facilitate communication, and one of the most basic of these is the creation of pre-defined roles, which have associated

responsibilities. [6] In hospitals, staff often have multiple roles. For example, a doctor could be a member of the cardiac arrest team, as well as a member of a physician team. Some role assignments, like on-call duties, changed daily. Others, like membership of physician teams, may last several months. Permanent staff roles may extend over many years.

Role-based contact was possible through three mechanisms - the use of special pagers assigned to critical roles like the cardiac arrest team, through an inquiry to the switchboard that had a copy of most role assignments, and from hospital phone books that recorded more permanent roles.

Four distinct stages were identified for communications involving roles:

1. Task dentification, when a task is identified and associated with a role.

2. Connection, when an attempt is made to contact someone in a role.

3. Communication, when task specific information is exchanged between the parties.

4. Disconnection, when the task reaches some stage of completion.

Two classes of error were associated with this sequence. *Communication errors* arose from the way in which the communication system functioned, or was used. For example, staff may forget to carry their role pagers. More frequently, a worker in a role is simply not contactable, usually because they are busy and not responding to a page. Other reasons for a role not being contactable included a worker failing to hand-over their role to a co-worker before leaving the site. The second class of errors were *information errors*. Associated with each stage in the role contact sequence, there was a potential requirement for information (Figure 1).

The major classes of information error observed were:

- Task -> Role - Workers were often unsure about who could assist them with a task, especially for infrequent tasks - "who do I call to arrange a venogram?". Some tasks had no specific role associated with them.

- Role -> Person - The information that mapped individuals onto specific roles was on occasion not up-to-date, or more often simply difficult to locate.

- Task Execution - Information needs to be ready during a conversation. For example, patient details may need to be at hand before an investigation is ordered. Failure to have information ready for a discussion may mean that the task cannot be immediately completed.

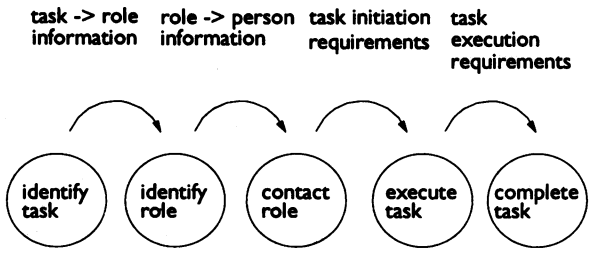


Figure 1 - A model of role-contact tasks, and their associated information requirements.

The cost of both communication and information errors is that workers need to make multiple attempts at contacting co-workers, expending unnecessary effort themselves, and often generating unnecessary and avoidable interruptions.

Policies: Subjects often had clear tactics to manage their communication. These policies were used, for example, to decide whether a page would be answered. Subjects tried to assess urgency by the number of times they received a page from the same number, the location from where the page originated (e.g. emergency room), the likely person in that location making the page, and the likely task that person had in mind. For example, some doctors receiving pages from their home ward suggested that they would infer that the nursing staff were calling them with minor tasks, unless they paged them twice in succession. Consequently they often would not reply to a single page. On the sender side, failure to reply to a page within a short period was taken to mean that no answer was coming, and the caller might move to another ward. When the page was eventually answered, the call would be wasted.

A few senior medical subjects had secretaries, and were able to articulate the policies they conveyed to their secretaries for message taking, forwarding calls to others covering them in a role, and when they should be interrupted. There was a clear contrast in the reliability of the policies carried out by secretaries and those without secretarial support. The latter were forced to make assessments based on incomplete information and as a result were more likely to manage calls inappropriately.

DISCUSSION

The study results should be understood within the limitations of the methodology adopted. Firstly the study was observational, so the resulting qualitative descriptions do not have statistical significance. Further, only a small cross-section of hospital workers was studied, and it is likely that slightly different results

might have come from a different sub-population. Nonetheless, the study captured some 50 hours of observational and interview data from the 12 subjects, which represents a substantial corpus for examination. Finally, the study focused on hospital workers, and not for example, primary care (although interactions of staff with people outside the hospital were observed). Consequently, the implications for system design may be more appropriate to a hospital setting than elsewhere, although the early indications are that they do have wider application.

SYSTEM DESIGN

The study results suggest the need for a communication system with the following features:

- support for mobility.
- asynchronous messaging (e.g. voice and email) along with acknowledgment of receipt capability.
- role-based dialing and call-forwarding.
- personal and organisational policy support.
- informal data capture and sharing.

The hypothesis is that these features will lead to improvements in staff efficiency and task outcome through reductions in errors and inefficiencies associated with communication. For example, providing appropriately designed asynchronous messaging facilities such as voice and email should decrease the reliance on synchronous channels, increase the use of asynchronous channels and, as a consequence, decrease the number of inappropriate interruptions.

The system architecture chosen to deliver these features consists of: [7]

- A mobile client combining a GSM digital cellular phone[8] and a pen-based palmtop computer, providing voice, data and short message channels.

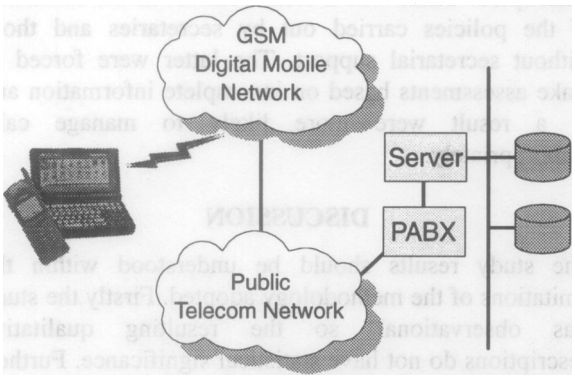


Figure 2 - Major components of the prototype communication system.

- A communications application server.
- A server connection to a PABX (switchboard).

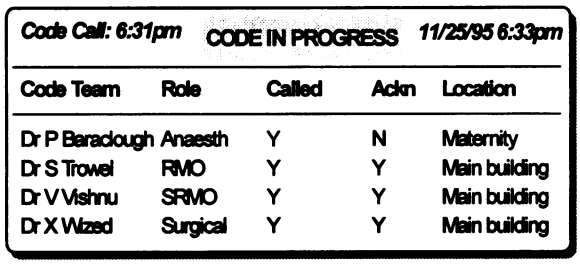
Key features of this architecture are that mobile clients can access data on the LAN, and that access to the system is possible using existing telephones via the PABX (Figure 2).

The communication application features include:

- A single personal mail box for voice and email.
- A role-based yellow pages directory, allowing calls to be made to a role, via a database associating roles with people. Calls are made by selecting a role, without needing to know who is in the role or what their contact number is. If a person in a role is not contactable, the system will attempt to contact the next person in the list of names associated with a role, and in accordance with any specified policies. Where useful, information about task requirements before contacting roles could be attached to items in the directory.
- Information display on call receipt (e.g. who is calling, is it urgent, in what role am I being called?)
- Policy specification mechanisms for the organisation (e.g. who can occupy a role) and for individuals (e.g. divert all calls to my mailbox, divert calls to a colleague, only accept urgent calls). To begin with, organisational policies will over-ride personal ones to prevent unwanted interactions between the two.
- Informal information can be captured by voice or pen and saved for personal use, or shared via the communication applications.

These basic services can be combined to produce more complex applications. For example, emergency team coordination could use information about roles and location of individuals (obtainable from the cellular system). When a 'code' is called, members of a medical team in named roles are paged. They are sent location and event information which may be a voice recording or text. Failure to acknowledge by a team member, or inability to attend, results in the system attempting to call others able to fulfill the same role. A coordinator is able to monitor progress, and communicate to team members if necessary (Figure 3).

Clinical guidelines for managing the event can be made available by accessing databases on the LAN, and a record of the event can be captured formally or informally, and stored there.



Code Call: 6:31pm CODE IN PROGRESS 11/25/95 6:33pm

Code Team	Role	Called	Ackn	Location
Dr P Baraclough	Anaesth	Y	N	Maternity
Dr S Trowel	RMO	Y	Y	Main building
Dr V Vishnu	SRMO	Y	Y	Main building
Dr X Wized	Surgical	Y	Y	Main building

Figure 3 - Example screen from palmtop communicator, showing status of team members during a 'code call'.

CONCLUSION

There are several implications arising out of this work that extend beyond the specific system described here. Firstly, the results reinforce the value of mobile communications and asynchronous messaging in a clinical environment. [9] [10] The implementation of these well understood and relatively inexpensive existing technologies should bring immediate benefit.

Secondly, the traditional view of informatics emphasises the importance of formal information systems. This current work suggests that much is to be gained by supporting informal information capture, storage and exchange, which forms the bulk of the information used by clinical workers in a hospital setting. The implications of this change in emphasis for the form and role of the electronic medical record are significant. Equally, the role of communications systems should be reassessed. The phone is an information system, albeit an informal one.

Finally, the richness of the findings to date suggests that further work may result in significant improvements in our understanding of the role of communication, its interaction with information needs, and how that affects the technologies and processes brought in to support it.

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