

Requirements for Communication and Exchange of Health Information: A Socio-Technical Approach to Understanding Healthcare Information Exchange

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Abstract- The communication and exchange of information in healthcare is complex and requires the coordination of a wide range of diverse information generated by individual health professionals and healthcare teams. Complex structures have evolved for facilitating the interchange of health information (i.e. team, organizational and technological). These complex communication networks and architectures need to be more fully understood in order to allow for effective design and selection of healthcare information technologies, making deployment of advanced computer technology in healthcare settings (i.e. hospitals) extremely challenging. In this paper we describe the communication and exchange of health information in such environments and describe a number of possible communication architectures. In addition, we describe our work in applying socio-technical approaches and clinical simulations to assess the requirements for developing and deploying information technologies to support communication and exchange of health information.

Keywords- communication, information management, teams, health professionals, requirements engineering, communication architectures, socio-technical, information

exchange, clinical simulation, procurement, software engineering

1. INTRODUCTION

The ability to access, obtain, communicate and exchange health information is an important aspect of health professional work. This is especially the case when managing critically patients where there is urgency associated with making a decision or feelings of uncertainty may be present as not all patient information is available at the time a decision has to be made. Understanding how healthcare teams work is critical to developing information and communication architectures that support hospital work. These information and communication architectures must be understood in order for hospital chief information officers to select and customize technologies (i.e. software and hardware) that adequately support health professional information exchange and communication with greater speed and with fewer interruptions so that health professionals can make decisions early in a patient's illness process [1]. Healthcare systems in differing countries utilize differing types of health professionals to deliver healthcare. Along these lines, healthcare systems use differing constellations and groupings of health professionals to deliver healthcare to patients [2].

In this paper we will use our experiences with the Canadian healthcare system. We will describe the communication architectures that are currently used by health professionals and require technological support. More specifically, we will examine how healthcare is currently delivered by Canadian health professionals and how communication networks or architectures need to be developed to support health professional management of patient healthcare and provide a basis for designing technological support. We will also discuss our research in developing clinical simulations to better understand health professional communication and information exchange needs in hospital settings [3].

2. BACKGROUND

2.1 Health Professionals in Canada

In Canada there are differing types of health professionals that are involved in a patient's care in hospitals. Physicians and nurses are the primary coordinators of patient care and thereby have a central role in communicating and exchanging information between themselves and other types of health professionals. This work often involves seeking information from others about a patient's health, giving information about a patient's health, and exchanging information among health professionals about a patient's health condition. In addition to physicians and nurses, in a hospital setting it is typical to have other types of health professionals involved in a patient's healthcare as coordinated by the physician and nurses that are primarily accountable for the patient. For example, the physician that is primarily responsible for a patient's care (e.g. the attending physician) may involve differing types of physicians with varying speciality backgrounds in the management of a patient. The patient's physician may coordinate communication among these physician specialists and then use this information in the management of the patient's health. These physicians may include specialists in areas such as respiratory medicine, internal medicine or cancer care.

Along these lines, there may be multiple differing types of nurses who may be involved in a patient's care such as clinical nurse specialists or nurse practitioners who may be managing a patient's

wounds, their cognitive status or experience or their experience of pain. These nurses may provide suggestions to the physician responsible for the patient or the nurse who is responsible for the patient. In addition to these "specialists" in medicine and nursing, other health professionals may be involved in a patient's care depending on the healthcare needs of the patient such as the respiratory therapist who may provide treatments, and education aimed at improving the patients lung health, a pharmacist who is involved in helping physicians identify and prescribe the medications that are best able to support the patient's healthcare needs. Other health professionals such as occupational therapists and physiotherapists may also be involved with the patient depending on the patient's healthcare needs. Physio and occupational therapists help patients regain their physical health as well as help patients manage their physical limitations or disabilities so they can live independently at home. Dieticians may also be involved in a patients care. Dieticians help patients to address their nutritional needs so that their bodies nutritional needs support the restoration of health. Lastly, speech language pathologists and social workers may be involved in caring for patients. Speech language pathologists may help patients recover after a stroke – helping patients to regain their speech, ability to swallow and/or ability to eat and drink independently. Social workers have a critical role too. Social workers can help patients who are experiencing difficulties with their families, home or financial issues. Social workers help promote psychological and social health and help individuals live at home. Lastly, on a day-to-day level, nurses are responsible for a patient's care over a 24 hour period and across a seven day work week. The patient's nurses must be able to obtain and exchange information with other nurses who may be responsible for the patient at another time of day (e.g. during a day, evening or night shift) and among days of the week (e.g. weekdays versus weekends).

2.2 Individual Health Professionals

At the individual level of a health professional, each of these healthcare professions seek, generate,

give and communicate information to other health professionals in order to develop a comprehensive mental model of the patient and reduce the level of uncertainty associated with knowing about and understanding the patient's health status so that patient specific and appropriate healthcare management decisions can be made. Such knowledge ensures health professionals can make informed decisions about the patient's care and can help the patient return to health as quickly as possible given their current state of disease.

2.3 Health Professional Teams

Over the past 50 years there have been significant advancements in the medical and health sciences. These advancements have prolonged life but they have also changed the nature of illness. Patients who are entering hospital are more critically ill and their medical conditions are more complex. As the complexity of a patient's disease has increased, so has the complexity of the healthcare that is being delivered (i.e. patient's are more seriously ill and they have multiple, differing types of healthcare problems). These changes have altered the nature of healthcare. There is now a need to obtain expertise from health professionals who have knowledge in differing areas of patient health and wellness.

Along with this, health professional shortages in areas such as medicine and nursing and the rise of new, emergent health professions over the last 20-30 years has led to knowledge being spread out among differing individuals. There is a need to draw on this knowledge as well as disseminate knowledge quickly and effectively so that a patient's healthcare needs are addressed rapidly. Therefore, there is a need to identify ways that these individuals can seek, give, communicate and exchange information among them to manage a patient's care. In response the healthcare system, from an organizational perspective has seen the emergence of new organizational units, groups or teams that are now used to support health professional management of patients (i.e. the use of healthcare teams). Organizations have supported the development and use of healthcare teams for a number of reasons; the most important being the ability of teams to improve patient outcomes,

reduce length of stay and reduce healthcare costs while at the same time improving the effectiveness and efficiency of providing healthcare to patients.

2.4 Differing Types of Health Professional Team Structures

Over the past several years, healthcare organizations have seen the emergence of differing types of healthcare teams to address the needs of patients. These teams can be classified as being unidisciplinary and multi-disciplinary. Unidisciplinary teams consist of health professionals who belong to the same profession but may differ in terms of their expertise in a given area (i.e. they may be specialists in a particular health discipline such as physicians) or differ in terms of when and where they work together (i.e. they are bounded by time or location as in the case of nurses who may work together as a team as they work on the same shift, during the same days of the week and on the same hospital unit). Multi-disciplinary teams are groups of individuals who work together towards a common goal (such as improving the health of a patient in a given area) but their membership consists of individuals from differing health professions (e.g. as in a physician/nurse team or a team that consists of a physician, nurse, physiotherapist and occupational therapist). In these teams health professionals become part of the team or leave the team depending on whether the patient has a healthcare need. These teams may range in size from two individuals such as a physician and nurse and up to ten or more individuals each with a differing health professional disciplinary background. Over the course of a typical patients' hospitalization a patient's health may be managed by many unidisciplinary and multidisciplinary teams. For example, a patient may be managed by a several unidisciplinary teams and a multidisciplinary team over a seven day hospital stay: a team of physician specialists coordinated by a physician that is responsible for the patient in the hospital (see Figure 1: Unidisciplinary Team Communication Example) and 6 teams of nurses (a differing team for each day, evening and night shift for the first part of the work week and another set of teams for the second part of the week for each day, evening

and night shift). Lastly, a multidisciplinary team of differing health professionals may also be involved.

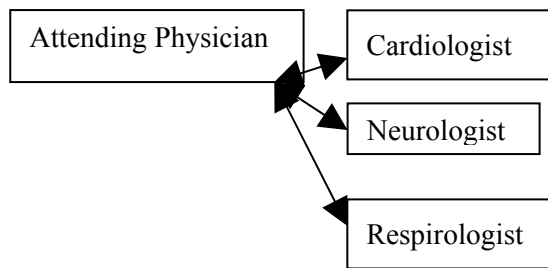


Figure 1: Unidisciplinary Team Communication Example

2.5 Coordination of Information and Communication

The communication and exchange of information among these healthcare teams can be difficult because of the number of individuals that are involved and the varied knowledge and expertise that is present among individual professionals and the multiple differing types of health professionals who are involved in patient management. Each individual is responsible for seeking information from the patient and other unidisciplinary and multidisciplinary members of the healthcare team [1]. Each individual is responsible for giving information to other members of the healthcare team to inform their decision making especially if the patient's condition is critical or their health problems are complex. Members of each of the teams must also be ready to receive information and communicate and exchange information that is critical to decision making among its members (especially in supporting physician decision making). Central to these team communication architectures are the communication between a physician and the nurse as they coordinate the involvement of differing specializations of health professionals within a discipline and between differing disciplines as needed. The physician has overall responsibility for the patient's medical care. The nurse is responsible for ensuring the patient's day to day healthcare needs are met and other health professionals that are involved in the patient's care are appropriately coordinated and

receive information relevant to their work involving the patient.

3. COMMUNICATION ARCHITECTURES

Such communication and exchange of information leads to the development of differing types of communication architectures. Communication architectures refer to the patterns of communication and exchange of information that teams may use to solve a problem or as in this case of managing a patient's care. Some types of communication architectures are inefficient and do not allow for speedy exchange of information such as communication architectures that are linear in nature and are used in bureaucratic organizations where information is passed from one individual to another flowing up or down through an organization or where one individual controls the flow of information between individuals such as the Y communication architectures (i.e. where communication paths are limited) or X communication architectures (i.e. where communication flows through central personnel) [2]. Instead communication architectures that support the quick and efficient exchange of information among members of the healthcare team are supported and encouraged (i.e. the star communication architecture that allows for quick exchange of information among members of the healthcare team) [2] (See Figure 2: Healthcare Team Example).

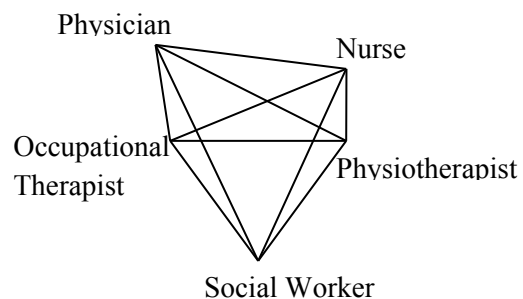


Figure 2: Healthcare Team Example

These communication architectures are developed by organizations and supported or realigned by the networking attributes of a

technology and the rules, regulations, methods and decisions made by organizations implementing a technology. For example, differing technologies have the ability to connect individuals to each other, allowing for the speedy dissemination of information among individuals who are connected to the network. Therefore, an individual who has the technology can communicate to others who are also connected to the network. Organizations influence these communication architectures.

It is interesting and worthy to note that health professionals use differing approaches to the communication and exchange of information – both manual and technologically oriented. For example, health professional teams may exchange information through manual or more traditional means such as face-to-face meetings or team discussions during a meeting or technological means such as the sending of information via pager, text messages, phone calls or electronic health record systems [1,2]. Manual means of communication architectures that are star shaped – allow for seeking and giving of information whose emphasis is on speed and efficiency. Technological means of communication allow for one-to-one direct communication between individuals – as in a nurse texting a physician to pass on relevant information or a health professional searching an electronic health record and only being able to view the information for their specific view and not the comprehensive record as contributed to by the team. The technology often becomes the mediator of information – mediating the types of information that are sought (providing team members with views specific to the discipline or speciality that is viewing the record), the types of information that are given (i.e. providing access to information and highlighting information that in routine situations is needed)[1].

4. EFFECTIVE REQUIREMENTS ENGINEERING FOR SUPPORTING HEALTH INFORMATION EXCHANGE IN TEAMS

In order to develop effective technological support of healthcare team communication it has

been repeatedly demonstrated in the literature that design of such systems needs to take into consideration the complex interaction among the healthcare team members described above. However, application of adequate methods for the gathering of team requirements has been rare. Kuziemsky et al. [4] describes a socio-technical approach to understanding palliative care team needs prior to system design by gathering data using observation and interviews. In this work a multi-method approach was used to analyze team composition, information needs and communication processes prior to the design of a team decision support tool. Inspired by socio-technical theory, such work attempts to assess information needs for both technology design and the design of social and organizational aspects (i.e. socio-technical design) of healthcare systems once a health information system is implemented in a real-world setting (e.g. clinic or hospital unit). Despite these advances and the increasing emphasis on both technical and social design, the use of advanced requirements gathering methods involving the application of realistic simulations involving individual healthcare activities and interactions involving multiple players (i.e. the healthcare team) has remained to be explored in healthcare.

4.1 Clinical Simulations to Assess Team Information Needs

In order to better assess the communication and information needs of healthcare teams new requirements engineering methods are needed. Over the past several years we have used simulations of clinical activities (involving human actors and real health professionals) in order to study healthcare activities and behaviours. In our early work in the development of what we have referred to as “clinical simulations” [1], we have examined the complex interaction between healthcare professionals and patients in realistic simulated environments, as well as naturalistic real-world settings. This has included evaluation of the impact of medication administration systems and electronic health record systems. Initial work along these lines indicated that adding a computer system into the complex interaction among health

professionals and patients can have important and often inadvertent impacts on clinical activities and workflow [1,5]. In this work we found qualitative and quantitative data revealed several key findings. We found that a medication administration system could affect subjects' (n=16): (a) interactions with the patient by introducing a more rigid sequential workflow, (b) would lead to bypassing of some system functions to provide urgent care, (c) would increase work load and (d) would lock out the clinician if another clinician was accessing the system at the same time [64]. In our more recent work we are extending such simulations (involving full video and audio recording of human-computer interaction, doctor-patient dialogue, and health professional communications) to the study of team communications [4,5,6].

4.2 Low-Cost Rapid Requirements Gathering Approach for Team Analysis

In our study of team decision making and communication we have evolved a number of methods that involve the video and audio recording of healthcare workers solving a set of complex tasks. For example, in one clinical setting (a hospital room) we have installed low-cost screen recording software on all relevant information systems (e.g. medication order entry applications, electronic health records) while collecting external video camera views of health professionals carrying out medication administration and related tasks [64,7]. The nature of such study can vary from observing and recording real healthcare tasks (in the actual hospital setting) to creation of selected hypothetical scenarios and tasks for the healthcare team to solve collectively. It should be noted that conducting simulations in this manner can be done in a cost-effective manner by carrying out the studies in the actual hospital environment (e.g. in a vacant hospital room after hours, or in an empty operating room), rather than recreating the situation and setting in an artificial laboratory [7].

In our work we have been able to assess when communication may be adversely affected by health information technology. For example, in one study we found that overly rigidly designed health systems may lock out users (e.g. doctors, nurses) from accessing critical patient information under

certain emergency situations. Furthermore, creation of many discrete views of patient information within an electronic record system (each view restricted to only one type of member of a healthcare team) may lead to fragmentation of information and lack of essential communication during critical patient decision making situations and events. Our work has involved applying methods of video coding and analysis to identify patterns for requests for information indicating health professional information needs. This type of information has also been used in order to refine and customize healthcare information systems and is also beginning to be applied in the comparison and selection of information systems by healthcare organizations during procurement.

In other studies we have found that application of information technology may facilitate team communication, as in the case of introduction of electronic whiteboards relaying up-to-date information from operating room to intensive care unit. We are also currently working on setting up simulated environments in a variety of clinical environments in order to compare the impact of the differing communication and team structures and architectures in responding to differing healthcare tasks of varying urgency and criticality. Our work in applying simulations has the advantage of experimental control (e.g. by creating specific types of cases and problems for a healthcare team to solve) and the ability to test out the implications of differing team designs, architectures and interfaces with information systems prior to their implementation on actual hospitals wards and units.

5. CONCLUSIONS

Team communication and information exchange in healthcare is extremely complex and involves the interaction between social/organizational structures and information technologies. In this paper we have described a number of models for design of healthcare teams and communication architectures that are predominant in Canada. In order to better understand healthcare information needs and requirements for system selection and customization we are currently working on developing simulation-based approaches to

observing and analyzing information exchange and communication in healthcare units.

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