Cognition Factors and Decision Making in Critical Care Environments

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Abstract

This panel focuses on cognitive factors in decision making in the critical care environment. Critical care environments such as the ER and ICU are distributed systems that are composed of human and artificial agents distributed across internal and external representations, across team members, and across time and space. Critical care clinicians perform life-critical tasks that require acquisition, processing, transmission, distribution, integration, search, and archiving of significant amount of data in such a distributed environment in a timely manner. Understanding the cognitive factors in decision making in this type of environment is important for the improvement of healthcare quality and patient safety. Zhang will first introduce the theoretical framework of distributed cognition. Patel will then present cognitive studies of medical errors in the critical care environment. From the clinical perspective, Shabot will present studies of information management in the ICU. Rucker will respond to the three presentations. Finally, Shortliffe will summarize the presentations by the four speakers and coordinate the dialog with the audience.

1. Introduction

Critical care clinicians perform life-critical tasks that require acquisition, processing, transmission, distribution, integration, search, and archiving of significant amounts of data in a distributed team environment and in a timely manner. They monitor their constantly changing information environment, respond to unpredictably occurring issues, collaborate and communicate with other people in the system as issues arise, and prioritize and solve multiple issues as they occur. Rather than focusing on a single task at a time, critical care clinicians are forced to switch between multiple tasks and usually multiple patients. They are constantly affected by information overload, multitasking, time pressure, and interruptions. Understanding how critical care clinicians perform their tasks, make decisions, and manage activities in this environment is important for improving healthcare quality and patient safety.

This panel focuses on the cognitive factors in decision making in the critical care environment. Zhang, a cognitive scientist with extensive publications at the intersection with biomedical informatics, will introduce distributed cognition as the theoretical foundation. Patel, an eminent researcher in cognitive aspects of biomedical informatics, will focus on the ER from a cognitive perspective. Shabot, a surgeon with expertise in critical care and patient monitoring, will address issues in ICU from a clinical perspective. Rucker, a critical-care and ER physician who directs clinical systems for Siemens, will respond to all three presentations. Shortliffe, a physician and clinical informatician with a broad view of research and practice in our field, will summarize the presentations and moderate the discussions with the audience.

2. Theoretical Foundation (Jiajie Zhang)

Distributed cognition (DC) provides a unique framework to describe the dynamics, interactions, processes, and knowledge structures critical to decision making in the critical care environment. DC allows researchers to focus on complex informational, social, organizational, and cognitive issues involved in team interactions with information technologies within a distributed, collaborative environment. DC looks for cognitive processes, wherever they may occur, on the basis of the functional relationship of elements that participate in this process [1]. The core unit of analysis is the functional system that is composed of human and artificial agents and their relations that are distributed across time and space dimensions [2-6]). DC suggests that the critical issue in a distributed system is how information is distributed and propagated across members of a group, across internal and external representations, and across space and time. DC can lead to discoveries concerning how interactions between agents are coordinated and how artifacts and tools are really used. DC helps determine which features of the activities or artifacts are relevant for the efficiency of task performance and which are necessary for the activity to continue to perform well. It can identify complex interdependencies between human and artificial agents that occur in collaborative work environments and thus give the researchers a better understanding of why simple breakdowns in communications and interactions between them can have such serious and significant consequences.

3. Cognition and Information Management in Critical Care (Vimla L. Patel)

In critical care, medical errors occur with high frequency and often have severe consequences. There are several reasons for this: many decisions have to be made with a very limited amount of information; the processes of decision making and problem solving are usually complex; there is often time pressure, stress, and fatigue; a single caregiver may be involved in multiple tasks at the same time; the social dynamics of teams increase the complexity of tasks; and multiple and complex medical devices may be difficult to use and prone to inducing errors [7]. A series of studies were conducted in the adult medical and psychiatric emergency departments (ER), and in the cardio-thoracic intensive care unit at a major urban medical center [8-10]. Data were systematically collected at all three sites using ethnography, observations, shadowing, and interview techniques. Several latent conditions that could potentially lead to error were identified, including information transfer over time and across teams (particularly handoffs) and difficulty in coordinating complex plans involving multiple teams and health care resources. ER personnel have to deal with many patients at the same time, constantly prioritizing and dividing their attention between patients, increasing their cognitive load. In this presentation, Patel will discuss this latent flaw in the medical and psychiatric ERs and the mapping of these potential flaws into a cognitive model. In our view, human errors in a dynamic environment such as critical care are products of cognitive activities in people's adaptation to their complex physical, social, and cultural environments. The clinicians' actions reflect the level of expertise and the demands of tasks in making clinical decisions. The empirical results from this study, unlike the popular goal of achieving flawless performance (through development of error-free systems), can be used to enhance and modify the current, more static, error taxonomy. They can guide development of adaptive systems that anticipate errors, respond to them, or substitute less serious errors that allow subsequent intervention before the errors result in an adverse event.

4. Information Management in the ICU (M. Michael Shabot)

Intensive care presents unique challenges for both clinicians and clinical information systems (CIS). When an ICU is utilized appropriately, nearly all patients are critically ill up to the point of discharge. Each day thousands of data items are collected for each patient, including vital signs, physiologic assessments, intake/output measurements, ventilator settings, lab data, radiographic images and myriad other elements. Patient care decisions will reflect new emergencies, exigent events, and long term care goals for each ICU patient; these decisions are typically made for many patients who are managed simultaneously. Added to this challenge is the fact that individual physicians, nurses, pharmacists and other caregivers can not maintain an endless vigil at the bedside, so "handoffs" at multiple levels must occur on a regular and frequent basis. The issues to be solved include how large amounts of data can be handled accurately by ICU teams without errors of omission or commission and how frequent handoffs can occur with perfect patient safety.

Information-seeking behaviors of clinicians have been carefully studied in the ICU setting [11]. A key element of information-seeking in high performing environments is that it is collaborative [12]. Team members rely on one another to provide pieces of the overall situation for each patient, e.g., detailed physiologic data from a resident physician, respiratory and mental status from a nurse, and medication information from a pharmacist. The plan of care for the day is agreed upon by the interaction of team members, and usually with the explicit approval of the senior physician in attendance. The actual workflow and information flow in an ICU is complex and is not the same from patient to patient [13]. Ethnographic and sociotechnical analysis of ICU teams and CIS reveal that the organization of the system can affect the team's workflow and collaboration [14, 15]. This organization is more important than mere technical features of the system. A robust CIS will support the workflow and specialized information-seeking needs for all members of the ICU care team. Common data can be presented in multiple ways for different caregivers. For example, the same medication data can be presented as a Medication Administration Record (MAR) for pharmacist review, as a time-oriented work list for nurses to administer medications on schedule, and as a flowsheet for rapid physician review in the context of vital signs and lab data. Quality and safety are byproducts of multiple caregivers analyzing the available data in the manner most appropriate for the individual and the clinical situation. A well functioning CIS can serve as the focal point for all patient data and if properly organized will enhance teamwork and contribute measurably to improved patient care and safety.

5. Discussion and Summary (Donald Rucker and Edward Shortliffe)

The topic of this panel is highly relevant to the debate about the role of IT in reducing medical errors. A recently published article in JAMA [16] shows that some CPOE systems can induce medical errors, not reduce them. This is not surprising at all, as reflected in another such study [17] and it should not be considered as a negative factor for the national HIT project. The same thing happened in the aviation industry. In the old days most of aviation accidents were caused by pilot errors. Then automation was considered as the solution for pilot errors. Automation indeed eliminated some errors but at the same time it introduced new errors associated with the new technology (e.g., lack of situation awareness by the pilots). It was later realized that it was the interaction between people and technology that was the key for preventing errors.

In healthcare, most failures of IT projects are not due to flawed technology, but rather due to the lack of systematic considerations of human and other non-technology issues in the design and implementation processes [18, 19]. In other words, designing and implementing a health information system is not so much an IT project as a human project about human-centered computing such as cognition, usability, information needs, workflow, organizational change, medical error, and process reengineering. Another major factor to consider is the economics of decision making with IT in this context. IT has to move forward and it is the solution for many problems related to healthcare quality and patient safety. However, in order for IT to succeed, it has to be designed, implemented, and evaluated in the context of cognitive, social, cultural, organizational, and other non-technology factors [20].

6. References

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This is to confirm that all participants have agreed to participate in this panel.

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March 11, 2005