Enhancing Patient Safety through Clinical Communication Knowledge Representation

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Abstract— **Clinical communication is considered the leading cause to medical errors [1]. In order to improve communication, a comprehensive understanding of the overall communication process in health care is required. In an attempt to further understand clinical communication, we conducted a thorough methodology literature review to identify strengths and limitations of previously utilized approaches. This research work proposes a new data collection plan that will study the clinical communication activities among the ICU clinical team. Along with refining the clinical communication model we previously proposed [2], this is a step towards building an exhaustive representation of the clinical communication framework to be implemented in medical error reporting systems through an ontological approach. The aim behind further understanding clinical communication is to develop an educational tool that can educate clinicians about communication habits, trends, and risks. The ultimate goal of our research is to improve clinical communication knowledge, reduce medical errors and hence, enhance patient safety.**

Index Terms— **Clinical, Communication, Knowledge, Representation.**

I. INTRODUCTION

WITHOUT a doubt the concern over patient safety has been the utmost focus of many clinicians and researchers. The level of safety patients receive is directly related to the frequency of the occurrence of medical errors. Research states that inefficient communication is a significant factor in the occurrence of medical errors [3-5]. By induction, the quality of clinical communication is essential to improve patient safety. This paper aims to introduce a novel approach to further analyzing clinical communication by identifying the key players in the communication process, and the most influential communication factors.

In this research we define communication as the exchange of ideas, messages or knowledge between two or more entities through verbal, non-verbal, written, and visual forms where entities can be individuals or technological components. Since health care includes communication through clinicians and computers and in an attempt to encompass human-computer and human-human interactions, our definition uses the term "entities" to refer to communication among both humans and technology aided-devices. Clinical communication can be categorized into the four categories mentioned in or definition.

A. The effect of communication on patient safety

In 2008, the health care industry provided 14 million job opportunities and potentially 3.2 million new jobs by 2018, which makes the health care sector be the largest and most diversified industries [6]. The degree of diversity in health care introduces numerous influential variables to the work places such as training, culture, and education. These varying degrees of personalities introduce different, sometimes uncommon, communication skills which can result in incoherent communication and also, misunderstandings. For these reasons, there is an emphasis on ensuring high quality of communication.

Clinical communication is reported as the main cause for 75% of medical errors and 65% of sentinel events [7-8]. With medical errors being the 8th leading cause of death among Americans [3], exceeding motor vehicle deaths, there is obvious necessity to improve the quality of care by focusing on the causes of medical errors, namely clinical communication. In 2006, the IOM stated that at least 1.5 million preventable adverse drug events occur annually in the United States as a result of medication errors [9]. With communication being reported as the main cause behind these errors, there is a strong correlation that shows that high levels of communication cause lower medical errors resulting in improved patient safety outcomes.

According to the National Healthcare Quality Report (NHQR) that tracked 40 core measure of quality, the current health status is far from the 50% reduction in medical errors that the IOM aimed at previously [10]. This shows that more efforts are required to enhance communication in health care in order to elevate the patient safety bar as well as patient satisfaction.

B. Communication in the Intensive Care Unit (ICU)

The ICU receives critically ill patients who suffer life threatening conditions, and medical interventions are carried out by the clinical team in minimal time intervals. This multidisciplinary and complex nature promotes the frequent occurrence of medical errors. During working hours, the ICU team communicates through obtain tests, perform tasks, diagnose, treat, and prevent pain [11]. The strong emphasis and reliance on communication to perform core tasks at the

ICU encourage more efforts to explore and identify limiting factors within the communication process. While research considers communication failures a common underlying factor in ICU adverse events [12], there is urgent need to improve patient safety through better understanding of communication behaviors within the ICU [13]. Thus, we believe that the nature of the ICU will generate rare instances to be captured and will include the majority of communication events that occur within other clinical departments.

C. Communicating via technology

Clinical communication includes various channels such as verbal, written, and technology-aided communication. The adoption of Clinical Decision Support Systems (CDSS) and Electronic Medical Records (EMR), have facilitated evidence-based care and patient care by reducing serious education errors [14] and enhancing the delivery of preventive care services[15-16]. However, the utilization of these systems has introduced new medical errors to practice.

In a study examining human-computer interactions, two types of errors were identified: (1) errors submitting and retrieving information to and from a computer information system (CIS), (2) errors in the communication and coordination processes that (CIS) is supposed to support [17]. Therefore, in order to introduce overall improvements to clinical communication, human-computer interaction has to be considered as a major component of the communication process.

II. METHODS

Despite the significant impact of communication on the progress of health care services, only several promising attempts have been made to study and analyze underlying factors behind communication failures. Nevertheless, there are still significant efforts needed to build a comprehensive informatics protocol that can extensively understand clinical communication. In an attempt to continue from discoveries of previous researchers, we have developed our methodology based on findings from two main sources: (1) literature, (2) preliminary observations at the ICU. Our methodology combines what previous research results suggest as well as insightful input from domain experts.

A. Findings from previous communication efforts

For over a decade, researchers have been studying clinical communication in various ways, yet as discussed earlier the current communication state is far from expectations. In order to develop an efficient methodology approach, there needs to be an accurate understanding and assessment of previous work. For this purpose, we generated a pool of clinical communication literature including more than fifty research papers since 1996 and then we created a shortlist of eight papers that we believe are the most relevant and inclusive of the problem.

The inclusion criterion of papers was based off 5 major components:

- Observational study
- Interviews
- Human-Human interactions
- Human-Technology interactions
- Future work

In order to increase the yield of our study, we systematically studied the methods used in those selected researches. Most researches proposed a two-step approach; an observational study followed by semi-structured interviews. We favor this approach due to its ability to provide first hand and obtain clarifications and feedback from subjects through interviews. In order to relate our research with previous work, we drew a proximity map that displays the relevance between other researches and ours. Figure 1 show the ranking process which is based off a 5-point system. Each paper was analyzed and ranked according to the five inclusion criteria above mentioned, with 5 points being the most relevant. The relevance of each paper or category can be shown through the size of the arrows; the closer a category is to our research, the thicker the pointing arrow. Author's name and year of publication of each research paper are used to identify various researches.

Most studies focus on one aspect of communication, that is either human-human or human-computer interaction. We believe there is a necessity to study and integrate both components together especially, since many health care organizations indulge both interactions in their daily routine.
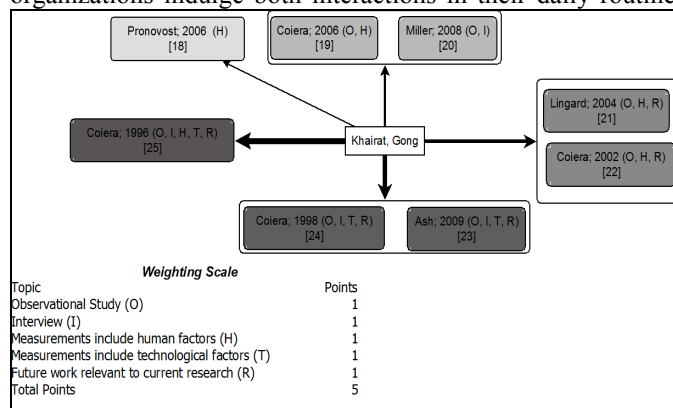

Weighting Scale

Topic	Points
Observational Study (O)	1
Interview (I)	1
Measurements include human factors (H)	1
Measurements include technological factors (T)	1
Future work relevant to current research (R)	1
Total Points	5

Fig. 1. The relevance of previous researches to current work. (Thicker arrows represent higher relevance)

B. Data collection plan

This ongoing research aims at undergoing a sequential process of transforming current data into meaningful information that can be used in education, training, and error report systems. Our data collection plan will consolidate data generated from our observational study and the survey qestions. This repository of data will be used to increase the validity of our findings through mapping similar communication cases together.

Observational study design

The chosen location for this study was selected based on certain criteria. As a nationwide in health care quality improvement and quality patient care, the University of Missouri Hospital offers primary, secondary, and tertiary health care services, and it provides formal academic teaching and constructive research services.

Eventually, this study will record and analyze clinical

communication from the perception of each team member. The PICU team includes, but not limited to, an Attending or a Lead Physician (LP), Resident, Fellow, Respiratory Therapist (RT), Registered Nurse, Physician Assistant (PA), Nurse Practitioner (NP). As a starter, the Lead Physician (LP) will be the primary focus of our research; LPs initiate and carry most communication events among the team. By shadowing the LP, we are able to capture most communication trends and patterns that occur within the team since the LP is always a significant participant in the communication.

The aim of this study is to shadow 3-5 Lead Physicians over a course of 6-10 weeks. Each LP has a two-week rotation at the ICU, and each LP will be observed 6 times on the following days: (1) first day of the first week, (2) two weekend days, (3) two week days, (4) last day of the second week.

From a clinical point of view, the first and last day of the 2-week rotations will capture the communication during chaotic first day and the more organized communication at the end of the rotation period. Also, weekends provide a different routine and pace than week days which might reveal interesting relationships.

The ultimate plan is to capture communication event patterns during patient rounds. Usually, bed rounds last for several hours every day. To increase the validity of this research, two non-medical researchers will simultaneously shadow the LP during bed round sessions. Based on trial ICU observations we conducted, it is evident that two observers capture more data and on occasions, one observer will record instances that the other person missed. This will increase the validity of the data being captured as well as it adds a higher degree of accuracy to the findings this research will propose.

The observational study has two components: (1) observation, (2) survey questions. During the observation session the two researchers will shadow the clinical team through bed rounds; the researchers will utilize the ICU tool to capture communication instances of the LP. During each patient visit, the researchers will be in the patient room with the clinical team; the aim of the researchers is to monitor and record communication events of interest.

After the bed rounds session, the two researchers will carry short surveys with the team members. The idea of these surveys is to know their level of satisfaction, confidence, participation in the communication process, and to serve as a baseline measurement. Ultimately, we are interested in exploring potential relationships between years of experience, training, and education and their impact on communication.

ICU Communication tool development

The development of an observational tool to be used at the ICU is not an easy task. For that reason, we incorporated the experiences from literature, domain expert experiences, and our intuition to produce a tool that does not reinvent the wheel rather, gather relevant data that can be assist the deduction of significant relationships. Literature provides many methodology approaches to study clinical communication however, no literature, to our knowledge, has proposed an

TABLE I
CLINICAL COMMUNICATION CATEGORIES

Category	Description	Measurement
Demographics	Captures information related to LP and clinical team	
Feedback LP	Identifies types of feedback	Tallies
LP Tasks	Identifies the type of tasks being assigned by LP	Tallies
Interruptions	Captures various types of interruptions	Accept / Reject
Mistakes	Discover any medical slips	Tallies

instrument that can be benefit other researchers and encourages new innovations in that field. This research aims at taking that step of providing a detailed description of our ICU tool to enrich this research with new suggestions and facilitate this research to other groups as well. However, the tool will undergo more testing and full observational study at the ICU to ensure its validity before publication.

As shown in table 1, the tool is designed to capture 5 main communication interaction categories. Each of those categories is broken down into finer levels to yield higher quality of data. The finding of our preliminary ICU study [26] suggests that interruptions, feedback have significant impacts on the communication process. In addition, we believe that it is essential to understand the main tasks of the LP as to further understand how communication assists the LP in daily work tasks.

The tool went through multiple modification iterations to improve the structure and contents of the tool. The changes made were based off a series of trial sessions conducted at the ICU. Changes included the addition of significant factors that were not in the original tool, the use of better descriptive communication terminology for certain factors, and moving around of categories based on the chronology of LP tasks.

III. RESULTS

As we continue moving forward with our research, we believe this comprehensive and innovative approach will be a significant addition to our previous work [2, 27]. Based on literature review and insightful domain expert input, we firmly believe that the proposed methodology will yield significantly important findings that will enhance clinical communication, but most importantly reduce medical errors and costs. Through analyzing the strengths and weaknesses of existing methods of clinical communication, we have proposed our innovative method for examining clinical communication with an emphasis on human-technology interaction perspective, which holds promise in revealing the complexity and interruption of many technologies used in clinical communication. By conducting the proposed plan in the next few weeks, we believe a stronger understanding of team member interactions will be acquired which will assist us to move forward with our long term plan towards building a comprehensive communication framework.

IV. Discussion and future work

The observational study is a start towards a more inclusive communication framework that can exhaustively express clinical communication. In order to further understand communication, we will continue to collect and analyze medical error cases due to communication from literature. We aim to collect more diversified cases; this will provide this research with a strong, solid knowledge base that can be used with first hand data to strengthen our findings.

Preliminary results show that more work is needed to understand the human-human and human-computer interaction in health care. There are multiple factors involved in both interactions and improving communication demands a comprehensive understanding of the effects of each factors and possible solutions to them. Therefore, in future phases of this research we aim at heavily focusing on human-computer interactions.

V. Conclusion

Research strongly suggests that in order to reach better patient safety measures, there needs to be a significant improvement in clinical communication. This paper has focused on the significance of clinical communication and its impact on medical errors. The methods section was divided into two main parts, the first being the state of previous and current research in the field. Therefore, we compared research methodologies to analyze the strengths and limitations of each paper. Secondly, we proposed our proposed methodology that will be carried out at the ICU. Based on suggestions from literature and ICU expert's vision, we proposed a new methodology approach that consists of an observational study and a post observation survey. Ultimately, we aim to use our findings from this research to validate the general clinical communication model we proposed. Also, as more data is being collected, we aim at building a web-based application that will educate clinicians about scientific suggestions on how to improve communication.

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