"What's the Story?" Information Needs of Trauma Teams

Aleksandra Sarcevic, MLIS[1], Randall S. Burd, MD, PhD[2]
[1]SCILS, Rutgers University, New Brunswick, NJ
[2]UMDNJ–Robert Wood Johnson University Hospital, New Brunswick, NJ

Abstract

This paper reports on information needs of trauma teams based on an ethnographic study in an urban teaching hospital. We focus on questions posed by trauma team members during ten trauma events. We identify major categories of questions, as well as information seekers and providers. In addition to categories known from other critical care settings, we found categories unique to trauma settings. Based on these findings, we discuss implications for information technology support for trauma teams.

Introduction

Trauma remains the leading cause of death and disability in children and young adults[1]. During the initial management of a critically injured patient (trauma resuscitation), the trauma team must stabilize the patient, determine the extent of the injury, and develop an initial treatment plan for hospitalization. Trauma resuscitation is prone to errors because care providers often manage patients with unstable medical status and make time-critical decisions without the benefit of detailed medical history[2].

Efforts to develop information systems for supporting trauma teams have had limited success[3]. Challenges to the application of information technologies in this domain include communicating in a stressful and noisy environment, acquiring information from diverse sources, interacting with computers while having hands and eyes busy with the patient care, supporting collaborative activities, initial resistance towards new technology, and the stringent requirement of a fail-safe system. Developing information tools to support teamwork in trauma resuscitation requires a better understanding of how trauma teams work, their information needs and information seeking behavior.

In this study, we examined the information needs of members of multidisciplinary teams in a trauma center based in an urban, teaching hospital. Information needs were assessed by analyzing the inquiries posed by team members during ten trauma events. This study provides additional insight into the collaboration dynamics of complex teamwork and extends the knowledge of clinical information needs.

Trauma Teams Overview

Trauma teams typically include an attending surgeon, surgical residents, an anesthesiologist, an orthopedic surgeon, nurses, a respiratory therapist, a pharmacist, and an x-ray technician. Each team member has a role with precisely defined responsibilities. For example, a team leader (usually a 3rd year resident) supervises patient care, makes major decisions and delegates work to other team members. A junior resident performs hands-on evaluation and treatment, while a primary nurse provides needed bedside care. Another nurse (recorder) is primarily responsible for documenting the event.

Upon learning about a pending patient arrival, trauma team members assemble in the shock trauma bay—a designated trauma room in the emergency department (ED). Most trauma resuscitations require a core team of a minimum of seven team members, but the number of team members may be as large as 15 depending on type of the injury and staffing.

Trauma teams follow a well-defined protocol, Advanced Trauma Life Support (ATLS)[4], which provides a framework for conducting trauma resuscitations around the world. The first phase is a rapid evaluation of major physiological systems focusing on establishing and maintaining airway patency (*Airway*), adequate ventilation (*Breathing*), and perfusion (*Circulation*), and assessing neurological status (*Disability*). This initial evaluation is followed by a more detailed assessment to identify other injuries.

Information acquisition, exchange and archiving are currently only minimally supported by information technology. During resuscitation, team members perform their prescribed tasks and report relevant patient findings to other team members. Information exchange is between pairs of team members, small groups of team members, or the entire team. Communication is mostly verbal with only critical patient data and events recorded by hand using a standard form.

Related Work

While the medical and information science literature includes studies that evaluate information needs and information seeking behavior of healthcare providers, these aspects of trauma resuscitation have been relatively understudied. Previous studies have examined information needs of physicians and nurses in diverse settings including primary care clinics[5,6], general medicine training programs[7], academic institutions and small clinics[8], and emergency departments[9]. This body of work has primarily focused on individual care providers, rather than on collocated and interdisciplinary teams. Findings from these studies suggest that physicians heavily rely on patients' medical records and sources within the hospital, such as information retrieval systems and libraries. These information sources are often not available in the time-critical setting of trauma resuscitation, potentially limiting extension of these findings to trauma resuscitation.

The complexity of information needs of medical teams has been initially studied in several types of clinical settings, including intensive care units (ICU)[10,11] and emergency departments (ED)[12]. These studies have shown a high prevalence of organizational questions in both the ICUs and EDs, highlighting the importance of understanding the relationship between clinical and organizational aspects of work in these units.

Our study complements and extends this previous work to a different clinical setting. Although there are some similarities between trauma and other critical care units, there are also important differences that may limit extension of previous findings to trauma resuscitation. First, the core members of the trauma team (attending surgeon, resident physicians, anesthesiologist, and orthopedic surgeons) are not dedicated only to trauma care and are called from their regular duties when trauma occurs. Second, trauma resuscitation is a stressful, noisy and highly dynamic environment in which information that guides decision making becomes available during a very short time period and in a continuous data flow from sources inside and outside the hospital. Finally, trauma resuscitation requires managing patients based on emerging rather than existing information. In contrast to other settings, such as the ICU that have the availability of sometimes detailed historic patient data, trauma resuscitation requires that care providers identify and treat potentially life-threatening injuries using information obtained during a much shorter period (about 30 min).

Study Methodology

We conducted an ethnographic study in a US level 1 (highest designation) regional trauma center, over a period of 18 months.

Approach: We observed and videotaped ten trauma resuscitations using two ceiling-mounted cameras and microphones. Institutional Review Board (IRB) approval was obtained for this study. Because of medicolegal concerns about maintaining archived videotapes, we obliged to erase video recordings within 96 hours. This requirement led us to an approach for generating transcriptions that captured information from these events for later analysis. Transcripts were detailed and included every observable task and utterance during each event. The transcripts were generated by a specialist in ethnographic analysis and verified by a trauma surgeon or nurse for accuracy. In each transcript, we included the time (*when* things happened), the actors (*who* in a team did or said something based on their role), the subjects (*to whom* the utterances were directed), and the information sources and instruments used. We coded each transcript assigning one or more semantic codes to each discrete task or utterance using schemes that we developed for this domain. These interdependent schemes included: (1) *medical task codes*, which represent the medical goals of the action and specific steps from the ATLS protocol; and, (2) *control task codes*, which represent the behavioral aspect of the action, such as "inquiry," "observation," "assessment," or "intervention." The two coding schemes contain about 30 codes each and account for most types of tasks and utterances observed in a typical trauma event.

To determine the information needs of trauma teams, we isolated all utterances that were coded as "inquiries" and "responses," and applied the grounded theory approach[13] to identify categories of questions from the data. We also evaluated who in the team asked and answered questions to identify the most common information seekers and providers.

Participants: The membership of the trauma team changes with different work shifts and with individuals joining or leaving the institution. While we do not track specific individuals, we estimate that findings described in this study involved between 70 and 150 provides, drawn from a pool of over 200 who have given consent to be videotaped.

Research setting: Our trauma center admits about 600 patients a year who are evaluated by a full trauma team mobilization. These patients have been injured by different mechanisms including automobile accidents, falls, and gunshot wounds. In

addition to the *patient*, current information sources include:

- *Trauma pagers*, for summoning the trauma team;
- *Trauma flow sheet*, a paper-based form for documenting patient data and treatments;
- *Vital signs monitor*, for displaying the patient's continuously measured vital signs;
- *Digital x-ray workstation*, for x-ray images access;
- *Diagnostic tools*, for tests such as HemoCue for analyzing hemoglobin and glucose levels in blood;
- *Wall charts*, for information on treatment parameters by patient age/weight;
- *Whiteboard outside the trauma bay*, for providing summary of pre-arrival patient information; and,
- *Healthcare providers*, including members of the trauma team, ED staff, and other specialists.

Results

We identified 581 questions in 10 trauma events (58.1 ± 25.8 questions [mean ± SD]). We observed no correlation between the number of questions and duration of an event (Table 1). Our preliminary analysis of what affects the number of questions pointed to several factors, such as type of the injury or number of team members present in the room. This is part of our ongoing work.

Categories of questions: We identified 16 major categories of questions (Table 2). Most questions related to *patient evaluation* and were aligned with the steps of the ATLS protocol. This finding is consistent with the principal task of trauma resuscitation—continuous reevaluation of patient status and monitoring for any changes in patient status. On-going monitoring of events represents the second largest general grouping of questions and includes questions about *vital signs*, *medications* and *fluids given*. Two categories of questions unique to trauma resuscitation related to the *mechanism of injury* and *pre-hospital treatments*. These aspects of trauma care are important for preparing the team before patient arrival and planning anticipated care.

Event #	Number of questions (*n*=581)	Approx. event length (min)
1	54	~ 22
2	47	~ 26
3	51	~ 26
4	98	~ 25
5	52	~ 21
6	40	~ 20
7	54	~ 32
8	34	~ 22
9	39	~ 19
10	112	~ 21

Table 1. Number of questions and duration for each trauma event.

Information providers and sources: Not surprisingly, patients' answers appeared to be a key information source in six out of ten events we observed (Table 3). The patients provided information about their medical history and feeling pain. For example, event 10 had the highest number of questions in the *evaluation* category (50% of the total) because of inquiries by the orthopedic surgeon performing motor and sensory exams. This type of examination requires obtaining feedback from the patient when assessing motor and sensory status. Events in which patients were not able to provide answers because of their injury also led to an increase in the number of questions within the team (e.g., events 2 and 4). In these examples, the team leader, attending physician and recorder nurse queried the paramedics and each other about patient medical history repeatedly throughout the event, increasing the overall number of questions to obtain data that otherwise might have been provided by the patient.

Information about patient evaluation, status, and treatments was provided by different members, with the team leader being the primary source, followed by the primary nurse, paramedics, and technicians (Table 3). We also observed that 12% of questions went unanswered (Table 3), indicating communication problems in this highly dynamic environment. Among the 581 questions, 130 (22%) were not directed to a specific member, but rather to the whole team, suggesting that information can be expected from several sources. Additional work will be needed to evaluate who reported what type of information. This may offer valuable insights into who are the custodians of specific information types and what kind of tools to develop for them for efficient access.

Information seekers: Our data analysis showed team leader as the most frequent information seeker, followed by the recorder, attending physician, primary nurse and orthopedic surgeon (Table 4). Because of the team leader's leadership role, questions by this individual are focused on obtaining information needed to arrive at the correct diagnoses. In contrast, the recorder nurse seeks information to document the event, while the attending physician seeks updates needed to supervise team activities.

Implications for Information Technology Design

Our preliminary observations suggest that the team leader gathers information mostly through inquiries rather than through direct observations. For example, instead of turning around to read the patient's vital signs from the monitor, the team leader asks the team about the vital signs. The reason for this behavior

Question category	Description	Questions (n = 581) 100%	Examples
Evaluation	Assessment of airway, breathing, circulation, neurological status, and other injuries; findings and status change	188 (32%)	Did you assess the airway? Do you have any pulses in the lower extremities? Do we have any spontaneous eye openings?
Patient medical history	Medications, allergies, surgeries, past illnesses, habits, hospitalization…	62 (11%)	Any known allergies? Do you take any medications?
Vital signs	Blood pressure, heart rate, oxygen saturation, temperature, respiratory rate	44 (8%)	Do you have any vitals for me? Do we have blood pressure yet? Heart rate?
Medications	Dosage, rate, type, administration, timing…	44 (8%)	How much is the Propofol running at now?
Mechanism of injury	Details about the accident	37 (6%)	What's the story? Okay, what did we get? Who know the story for this patient?
Team members / Personnel	Presence, coordination, readiness, identification…	30 (5%)	Do we have anesthesia? Ready to go? Who's going to take the ventilator?
Patient personal information	Age, gender, date of birth, profession…	27 (5%)	Do you have name on him? What kind of work you do?
Transfer	Preparing for CAT scan or operating room	27 (5%)	What room are we going for CAT scan?
Equipment	Status, handling, tracking…	23 (4%)	Anybody has blood warmer? ET tube size?
Teaching	Teaching and monitoring questions	19 (3%)	You've done ABC? What about the D part?
Pre-hospital treatments	Questions about patient status, treatments, medications, and vitals en route	17 (3%)	How was her airway in transport? What were his scene vital signs?
IV access	Specifics, location, status, number…	17 (3%)	What's the IV access? Where is the IV?
Miscellaneous	Unable to fit to any of the categories	16 (3%)	You [team member] alright? Do you have a pen?
Administrative	Order placement, paperwork, extrication time, date…	12 (2%)	Do you want me to put orders for you? Do I need to sign anywhere?
Plan of care	Treatments, interventions, and effects	11 (1%)	Are we going to intubate her?
Fluids	Type, amount, status, rate	7 (1%)	Is she getting fluid 125/hour?

Table 2. Categories of questions asked by trauma team members, in a descending order by the number of questions.

could be that the dynamics of the situation require that the team leader maintain focus by minimizing physical activity and communicating verbally to obtain needed information. The recorder nurse is located on the opposite side of the room from the patient to avoid interference with those with patient contact. While this distance is not great, the noise and activity within the room make it necessary for the recorder to make frequent and repeated inquiries to obtain needed data. Not surprisingly, questions were frequent about vital signs and other patient parameters, critical for monitoring the patient. This finding is consistent with care providers' need to continuously obtain and update information about patient status, and supports the use of (large) displays that continuously present data to the entire team.

Frequent questions about medical history reflect the potential importance of this data and the need for verifying the answers because the patient may be an unreliable source of this information under the stress of traumatic injury. Questions about medical history are observed throughout the course of the evaluation, even at the end of the event. Because of the need to be engaged "hands-on" during the evaluation, physicians often miss reporting of the medical history at the beginning of the event. A technological solution for providing medical history throughout the resuscitation may reduce the need for redundant questioning about this aspect of patient care.

Inquiries about medications relate to dosage, rate, type, and timing, and are usually answered directly. Some medication related inquiries, however, require that teams members track the process of medication administration. For example, in event 3, we observed an anesthesiologist asking eight times if an anesthetic medication called etomidate was ready. There are six steps in administering etomidate: it is first ordered by the anesthesiologist, the pharmacist then prepares it, the medication is given to the nurse who checks its correctness, administers it, and acknowledges its administration. When the nurse says it has been given, that means all six steps have been accomplished. A possible explanation for this observed repetition may be that the anesthesiologist was not sure where the team was along those six steps. We believe that a technological solution for tracking multi-step procedures may help teams being more efficient with medication administration tasks.

Finally, we observed that questions directed to the patient have two purposes: information seeking as well as assessing the patient. For example, providers may ask, "*What's today's date?*", seeking to assess whether the patient's airway is patent and the patient's level of consciousness.

Information providers	Number of questions posed to each provider / source (*n*=581) (100%)
Patient	191 (32%)
Team leader	74 (13%)
UNANSWERED	67 (12%)
Primary nurse	49 (8%)
Paramedics	45 (8%)
Technician	38 (7%)
Pharmacist	25 (4%)
Recorder nurse	23 (4%)
Junior resident	22 (4%)
Other/unknown	17 (3%)
Orthopedist	12 (2%)
Chief resident	9 (1%)
Anesthesia	6 (1%)
Attending	3 (1%)

Table 3. Information providers and number of questions posed to them.

Information seekers	Number of questions they posed (*n*=581) (100%)
Team leader	158 (27%)
Recorder nurse	89 (15%)
Attending physician	84 (14%)
Primary nurse	64 (11%)
Orthopedist	61 (11%)
Junior resident	35 (6%)
Chief resident	32 (6%)
Critical care tech	23 (4%)
Other/unknown	20 (3%)
Anesthesiologist	11 (2%)
Pharmacist	4 (1%)

Table 4. Information seekers and number of questions they asked.

Limitations

In this study, we mainly focused on analyzing verbal questions and assessing the information needs of the trauma team as expressed through questions. In the future, we plan to supplement these initial findings analyzing the context in which questions are being asked within the team's tasks and activities.

Conclusions

We have examined information needs of trauma teams in a level 1 trauma center of an urban, teaching hospital by focusing on questions asked during trauma resuscitation. Through analysis of questions, we identified several main categories of questions asked by the trauma team, as well as the key information seekers and providers. Our findings revealed categories known from other critical care settings, but also some categories unique to trauma settings. We see important opportunities for using technology support to reduce the number of questions required of the team to improve overall work flow.

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