Understanding Trauma Resuscitation:
Experiences From the Field and Lessons Learned

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Abstract
This paper describes the experiences and lessons learned from fieldwork in the trauma resuscitation domain conducted over the past seven years at several Level 1 trauma centers.

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Healthcare; Trauma resuscitation; Study design; Fieldwork; Video recording; Research ethics.

ACM Classification Keywords
H.5.3 [Group and Organization Interfaces]: Evaluation / Methodology; J.3 [Life and Medical Sciences]: Health

Introduction
Over the past seven years, our multidisciplinary research group has studied the work of medical teams during trauma resuscitation—a high-risk, fast-paced, and information-laden process of treating severely injured patients in a dedicated facility in the emergency department (trauma bay, Figure 1). The resuscitation process is one of the most demanding in healthcare, requiring the team of 7-15 medical professionals to focus on patient care for a short time period, while adapting to complex and changing circumstances driven by patient status [1].
Our long-term research goal has been the design and development of a context-aware system that monitors the work of trauma teams and alerts them to errors and process deviations associated with adverse outcomes. Conceptualizing such a system required a careful study of the work processes, including team communication, team interactions, decision making, leadership, and errors using several approaches, including fieldwork. To date, we have conducted studies at and collaborated with three urban, highest-level US trauma centers, two of which are pediatric: Children’s National Medical Center (CNMC), Washington, DC; The Children’s Hospital of Philadelphia (CHOP), Philadelphia, PA; and Robert Wood Johnson University Hospital (RWJ), New Brunswick, NJ. The studies involved fieldwork (i.e., participant observation, interviews, shadowing); video review of real and simulated resuscitation events; and design, development and evaluation of technology prototypes using participatory design. Although our studies are not completed, we have accrued knowledge and experiences, and learned many lessons that we believe can be helpful to others who are either planning or conducting field studies in safety-critical settings such as trauma resuscitation. As a member of our research group who has been responsible for designing and running field studies, I will use this space to discuss several themes and challenges that we encountered in our work, including access to research sites, project management, study design and ethics, fieldwork experiences and collaboration with healthcare professionals.

Site Access & Project Management

Access to research sites and project management are closely related because they both depend on the working relationship with medical collaborators. Finding a medical collaborator who will dedicate a substantial amount of his or her time to managing research at the site, helping with grant applications, co-authoring papers, and generally be involved in the research, is difficult. Trauma resuscitation as a discipline lies within the realms of emergency medicine and general surgery. Because the trauma patient represents an extraordinary drain of resources, some trauma centers have designated trauma teams whose sole responsibility is taking care of trauma patients. Yet many hospitals do not have such resources and members of the trauma team have other duties throughout the day (e.g., surgeries, emergency care, critical care, etc.), which makes their involvement in research less likely.

Although our research sites are not dedicated trauma centers, they are located in urban, teaching hospitals with established research infrastructures and mechanisms that allow medical personnel to conduct research. We were fortunate to find dedicated collaborators at most of our sites. Two factors contributed to this success. First, we conceptualized our research to have an impact not only within the human-centered computing and engineering fields, but also on improving patient care, allowing our medical collaborators to become important stakeholders. They saw an opportunity to develop their own research agendas within the projects’ scopes; they were able to extend their roles from collaborators to project co-investigators and even principal investigators, leading aspects of the research that were patient-centered rather than just technology- or design-centered. This arrangement allowed our medical collaborators to be independent yet accountable, and to have budgets for managing research at the sites (e.g., paying research

Figure 1: Example trauma bays at our research sites (a, c), and at the Shock Trauma Center, Baltimore, MD (b).
coordinators to assist with participant recruiting and ethical approvals, buying equipment, covering participants’ expenses, etc.). Second, most of our collaborators are physician-researchers or division chiefs with a significant percentage of their time research protected (e.g., 75% research protection and 25% clinical time). Depending on the hospital, protected research time may also mean physicians’ responsibility for securing additional funding. This factor has played a crucial role in our research because it further motivated medical experts to work with us.

Having established such working relationships with our collaborators made it relatively easy to obtain unrestricted access to research sites, medical personnel, and events of interest. For each site, I received a hospital badge and a pager (Figure 2). The pager was especially useful during observations because it is used to notify trauma teams of an incoming patient; if in close proximity, I was able to arrive to the trauma bay in time to observe real events. Most helpful, however, was the arrangement with one of the hospitals where I spent six months working as a volunteer. I had a dedicated desk in the office adjacent to the emergency department, shared with personnel involved in research and administrative aspects of trauma resuscitation. I often refer to this arrangement as my research residency since it allowed me to (a) spend as much time as I needed in the hospital; (b) understand not only the domain of interest but also the hospital life in general; (c) meet with medical experts and personnel from different departments and disciplines; and (d) collect rich data. I next discuss the design of several studies and the approaches we used to obtain ethical approvals.

**Figure 2**: Tools of the trade: Notebook, audio recorder, hospital badges, pager, and digital camera (used to capture this photograph).

**Study Designs & Ethical Approvals**

Study designs differed depending on the focus of a study, which ranged from understanding teamwork, decision making, leadership, communication, and process deviations and errors. Most studies involved real-time observations of actual and simulated trauma resuscitations, interviews with trauma team members, and shadowing. Some studies also involved analysis of team interactions using video review of both simulated and actual resuscitations. Finally, we also conducted participatory design workshops to solicit expert opinion about technology designs. Rather than having one
ethical approval that would cover the entire research, we obtained an ethical approval for each study. Although this approach was time-consuming and required significant amount of work, it provided some flexibility in conducting research. For example, research protocols involving observation and interviews required a less rigorous, exempt review, which is typically done within a week or two. Protocols involving video recording of real resuscitations, on the other hand, required the most rigorous, full ethical review. By dividing research into several protocols, we were able to start with some portions of the research while still waiting for the approvals for more complex parts.

Ethical approvals were needed from both the hospital(s) and our own institutions. We first obtained approvals from the hospitals and then applied for university approvals. Most recently, however, we switched to obtaining IRB Authorization Agreements\(^1\) rather than applying for separate university approvals. These agreements allow the hospital to act as the approval of record for another institution; the agreements obviate the need for a committee review at another institution and help speed up the process.

Even so, obtaining ethical approvals at the hospitals was not simple. Depending on the study, it took between a few weeks to several months to obtain approvals. Hospital ethics committees are used to reviewing protocols involving rigorous experimental designs and clinical trials, making our exploratory and social science-based protocols quite challenging to prepare. For example, it was difficult to calculate sample size or power, or specify primary and secondary endpoints for exploratory, observational studies. Similarly, it was difficult to anticipate the number of participatory workshops and simulations needed to reach usable technology designs. Over time, however, we learned how to adapt the language of the medical ethics committee and apply it to our protocols. For example, the protocol to assess the feasibility of a technology prototype in a simulation setting included the following paragraph about sample size and power:

"This is a pilot study. We will not have enough simulation sessions to power our primary endpoint to find the difference in the percent of team situation awareness with each intervention, as well as to power our secondary endpoints to find a difference in time to critical interventions and changes in workload. We will use this data to power our next phase study, which will likely require multiple site participation. We decided to plan for six simulation scenarios for this pilot study, based on time and participants available at this single site. However, we may determine the need to run more or less simulations based on our experience with initial simulation scenarios."

The most challenging protocols we filed to date were the ones in which we requested video recording of actual resuscitations and a waiver of informed consent. One hospital approved our video recording protocol but denied the waiver of consent and required that we erase all video records within 96 hours. To conduct research at this site, we collected consent forms from over 250 medical providers that typically participate in trauma resuscitations prior to the study; video review involved detailed transcriptions to preserve as much data as possible while meeting the 96-hours limit. We had better luck at another hospital where video

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\(^1\) IRB stands for Institutional Review Board in the US, and is an equivalent to Research Ethics Committees in other countries.
2. The waiver will not adversely affect the rights and welfare of the participants.

Video recording and data transcribed from these recordings, as well as patient data, are now being collected and used for performance improvement purposes. As stated above, PHI will only be used for linking records and will be removed before analysis for research purposes.

3. The research could not practicably be carried out without the waiver.

The individuals participating in trauma resuscitation are drawn from a large pool of potential individuals. The team includes providers based both outside and inside the hospital. In addition, the composition of the pool from which team members is drawn is dynamic, with new members being added or removed based on their assigned role rather than by their name.

(continued on p. 6)
In addition to observations and interviews, I also shadowed surgical residents during morning and afternoon rounds, and attended weekly surgical and emergency medicine conferences, performance improvement sessions, and mortality and morbidity meetings. Having access to these events was essential; discussions and reports shared during these meetings helped me to not only better understand the domain, but also to meet many people involved in trauma care. Even so, getting to know every single care provider and establish rapport proved to be challenging for one simple reason: our sites are teaching hospitals with high staff turnover, especially residents. The high turnover also meant re-introducing myself each time a new group of residents or fellows arrived (every 3 to 6 months). Although our medical collaborators made every effort to introduce me to trauma team members, it was almost impossible to keep pace with the frequently changing social fabric at each site.

**Conclusion**

I will conclude with a short story and a lesson showing that regardless of the efforts we put into planning our field studies, there are always unanticipated contingencies that interfere with our plans.

At the end of my six-month residency at one of the sites, I gave a presentation at the monthly trauma meeting. I was both excited and intimidated by this opportunity because it allowed me to share the results of my work, but with an audience composed of general surgeons, emergency medicine physicians, fellows and residents; at the time, it was the most critical audience I ever presented to. I started the presentation by describing my educational and research background, the methods I had been using, and the insights I gained during fieldwork. After the presentation, one of the surgical fellows approached me and said: "I wish you gave this presentation when you came here six months ago. I would have known better who you are and why you are doing this work." This comment was an eye opener. Have I done all this work with people barely knowing why I did it? Has this impacted the results I obtained? I was introducing myself and explaining the goals of my research many times throughout the fieldwork, sometimes even to the same people. Still, I realized it would have helped doing such presentations more often, perhaps each time a new cohort of residents arrived, or once a month, or after each round of preliminary results. It is my advice then to go back to the already busy clinicians regularly, not only for expert input or feedback on the results, but also to allow them to get to know us better.

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