ITS and Transportation Safety: EMS System Data Integration to Improve Traffic Crash Emergency Response and Treatment – Phase III Report

Final Report

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Executive Summary

The transportation safety and emergency medical services (EMS) literature has called for the development of better information system tools to support EMS to aid in reducing the human impact of medical emergencies. Building upon previous phases of research by these authors, this report seeks to advance a prototype of such an information system tool, known as "CrashHelp." CrashHelp is a mobile and web-based information service designed for use by various emergency medical practitioners involved in the end-to-end continuum of emergency patient care. The broad objective of the research undertaken for this report was to examine the potential to provide – through a geographic information system (GIS)-based visual and interactive platform – an easy to use analytical tool that can provide a holistic view of crash information (such as distance, age, severity of crash) that can better serve practitioners and agencies in planning for and responding to traffic crashes.

The specific research objectives for this research were to: (1) collect and examine information regarding the potential for using the CrashHelp system in the state of Idaho as a case-study; (2) identify and develop aggregate performance metrics for end-to-end EMS responses to automobile crashes for inclusion in CrashHelp; and (3) expand the CrashHelp prototype to include aggregate level clinical and operational performance metrics that would provide valuable decision-level information for planners and practitioners.

With regard to the first objective, the researchers validated the applicability of the CrashHelp system management model and workflow process in the Idaho region. Validation was received through a series of on-site and web-based presentations, round table discussions, and interviews with EMS practitioners in the region. Regarding the second objective, stakeholder interviews and feedback session from the Idaho case study and previous research by the researchers confirmed that the following may prove valuable for emergency medical decision making: patient age (over age 65, and under age 12), crash site location (distance from hospital facility and mapped location), elapsed time from incident start, estimated time of arrival to hospital (the projected and estimated time of arrival, visualized on a map). As a result, the CrashHelp prototype was significantly refined to better visualize and incorporate indicators of this information, with customization based on iterative input and feedback from Idaho stakeholders. As for the third objective, the aggregate information generated by CrashHelp is expected to improve the understanding about EMS responses for public health and EMS practitioners and thereby improve the manner in which EMS is evaluated and planned holistically, particularly with respect to linking socio-geographic data to emergency response. The benefits of this information may extend to state departments of transportation in creating a strategic highway safety plan (SHSP) that meets the data intensive requirements of the Safe Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) with the ultimate goal of reducing the number of highway fatalities and serious injuries on all public roads.

From the experience gained through this research for this report, the CrashHelp prototype has been significantly improved and is now expected to be pilot tested in Idaho across two ambulance providers and five hospitals. Based on findings to date, providing accurate and timely crash information to EMS providers and hospital practitioners through the CrashHelp model may have the potential to transform emergency medical response and provision.

Chapter 1.   Introduction and Background

This research transcends literature across several disciplines and context domains, including Emergency Medical Services (EMS), transportation, public health, and information systems. Parallel to the recognition that EMS is a key focal point in relation to patient health outcomes is the dire need for improvements in information systems integration and coordination across transportation, health, and enforcement services. In terms of transportation, EMS is referred to as one of "the four E's" of transportation safety (U.S. Department of Transportation, 2006). The transportation safety and EMS literature has called for the development of better information system tools to support EMS to aid in reducing the human impact of medical emergencies (NHTSA, 2004). In a study examining institutional, operational, technological and financial facets of transportation and emergency service agencies, participants (agency representatives) reported that increased coordination across these sectors was necessary for making overall improvements to emergency services (Shepherd, Baird, Abkowitz, & Wegmann, 2006). Information technology is viewed as a key "enabler" of this coordination.

Chapter 2.   Improving Patient Outcomes

It was recently reported that patients who suffer traumatic injuries have a 25% better chance of survival if taken to the appropriate trauma center according to the severity of their injuries (Landro, 2007). Information technology has also been viewed as an "enabler" in this regard. That is, technology can enable faster and better decisions about when and where to transfer an EMS patient. Two-way radios had a significant impact when introduced in the late 1960's and early 1970's. The internet has also allowed improvements in the decision making process more recently. Building upon these concepts, this phase of research represents, in many ways, the culmination of several years of research by Horan and Schooley: translating the findings about the importance of end-to-end systems, the value of IT in enhancing the timeliness and quality of EMS information, and the need for data mining and analytical capabilities to improve the response process (Horan and Schooley, 2007; Schooley and Horan, 2007; Schooley et al. 2007a,b; Schooley et al., 2009). The approach uses interactive, geographic information systems (GIS) capabilities, much in the way that www.SafeRoadMaps.org has brought interactivity to the fatal accident reporting system data (Hilton et al., 2008; Hilton et al., 2009).

In prior work, the research team has been able to systematically understand the information flows of emergency response systems (Horan and Schooley, 2007). Their model was used to guide a case study analysis of a Minnesota county-wide EMS system. This provided a foundation for understanding the potential role of information technologies in speeding the type of data used in EMS as well as speeding the flow of that information (Schooley et al., 2008). The research also revealed that there were considerable variations in services depending on the geographical location of the emergency, which has given rise to the need to conduct spatial (GIS) analysis of safety and health information (Schooley et al., 2009). This work has led to the development of the CrashHelp system prototype as well as http://saferoadmaps.org, which is an innovative application of fatal traffic crash data into a visual information system platform (Hilton et al., 2009).

The need for designing such a prototype was also one of several outcomes from a national symposium conducted on the topic by the proposers. This symposium gathered researchers and practitioners from around the country to review the time-critical information systems model, case study applications and research and practice needs. Several experts commented on the lack of tools that could assist EMS providers with analytical and decision-aid tools. They also noted that ideally such a tool would provide a holistic version of crash information that could aid responders in planning for and responding to traffic crashes.

In this manner, the goal of this project is to advance an initial "CrashHelp" prototype to include methods and tools for displaying intelligence about crashes, EMS responses to those crashes, and resulting health outcome data. The prototype will be utilized to examine the potential to provide—through a GIS visual platform—an easy to use analytical tool that can provide a holistic view of crash information—such as distance, age, severity of crash—that can better serve practitioners and agencies in planning for and responding to traffic crashes.

Chapter 3.   Research Objectives, Approach and Methodology

Objectives

The research objectives for this project include:

- Examine comparative case study data for use in CrashHelp system in another state (i.e., Idaho), focusing on use of socio-demographic variables in system use.

- Identify and develop aggregate performance metrics for end-to-end EMS responses to automobile crashes for inclusion in a GIS based CrashHelp tool.

- Expand the CrashHelp prototype to include aggregate level clinical and operational performance metrics that would provide valuable decision-level information for planners and practitioners.

Approach and Methodology

For this phase of research, several methods have been employed across four research tasks. Task 1 included a comparative case study analysis between Minnesota and Idaho to extend knowledge and validate findings from work conducted in Minnesota. Idaho was purposively selected as a comparative case study due to the state's innovative approach to integrating EMS and trauma information, its recent implementation of statewide trauma and EMS data systems, and its progressive legislative policies that allow for sharing EMS and trauma data for research purposes. Clinical and operational performance metrics were then implemented into the CrashHelp prototype using a Design Science approach. This approach includes a set of rigorous and iterative activities such as: collecting end-user requirements, developing an information technology artifact according to user requirements, demonstrating and gaining feedback from users on the value of the artifact, and testing and evaluating the utility of the artifact. The CrashHelp prototype system was expanded upon using the Design Science approach to include metrics found to be important by Minnesota and Idaho participants (An academic article on this approach can be found in Appendix A). EMS and health information system data (including geographical and age related data) from the comparative case were used to develop and populate the performance management model aimed at enhanced safety decision support. Feedback analysis from policy-makers, planners, public health, EMS, safety engineers, emergency planners and citizens were used to inform the usability, success factors, value proposition and National level applicability and generalizability of the system. Policy and planning recommendations and next step guidance were then constructed.

Chapter 4.   Task 1 – Comparative Case Study of EMS Performance Data

A case study approach was utilized to compare and contrast Minnesota safety and emergency systems with the state of Idaho, which represents another state with innovative safety/EMS data system efforts. For this portion of the study, the research team gathered existing information about the EMS infrastructure in Idaho and conducted a field visit to gather additional operational information through interviews and focus group discussions with the state EMS Bureau, the two ambulance agencies in the Boise region, and the state 911-dispatch center. The CrashHelp prototype was then presented to several stakeholders including: the state EMS Bureau Chief, Department of Transportation (DOT) – Office of Highway Safety (3 participants), the EMS Pre-Hospital Advisory Committee (25 participants), and the EMS Pre-Hospital Medical Advisory Committee (15 participants). Per Freeman's definition of stakeholders, "A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives," we view stakeholders as penultimate to the success of this project (Mitchell et al., 1997). We fully expect our stakeholders to be affected by the use of the CrashHelp system. Through these meetings, the research team validated 1) the applicability of the CrashHelp system management model and workflow process to the Idaho region, and 2) the importance of several clinical performance metrics included in the CrashHelp incident visualization model. These are described further below.

Validation of the CrashHelp Model

As presented in the TechPlan Phase II final report, and shown in Figure 1 below, the CrashHelp system includes several technical and user components. First, paramedics and EMTs who respond to a vehicle crash and medical emergency collect patient information using a handheld application running on a Smart Phone device. The information collected includes basic demographic data (age, gender, name), pictures, videos, audio recordings, and global positioning system (GPS) location. This information is sent securely to a server and is then distributed to the appropriate receiving emergency department (ED) for medical practitioners to consume.
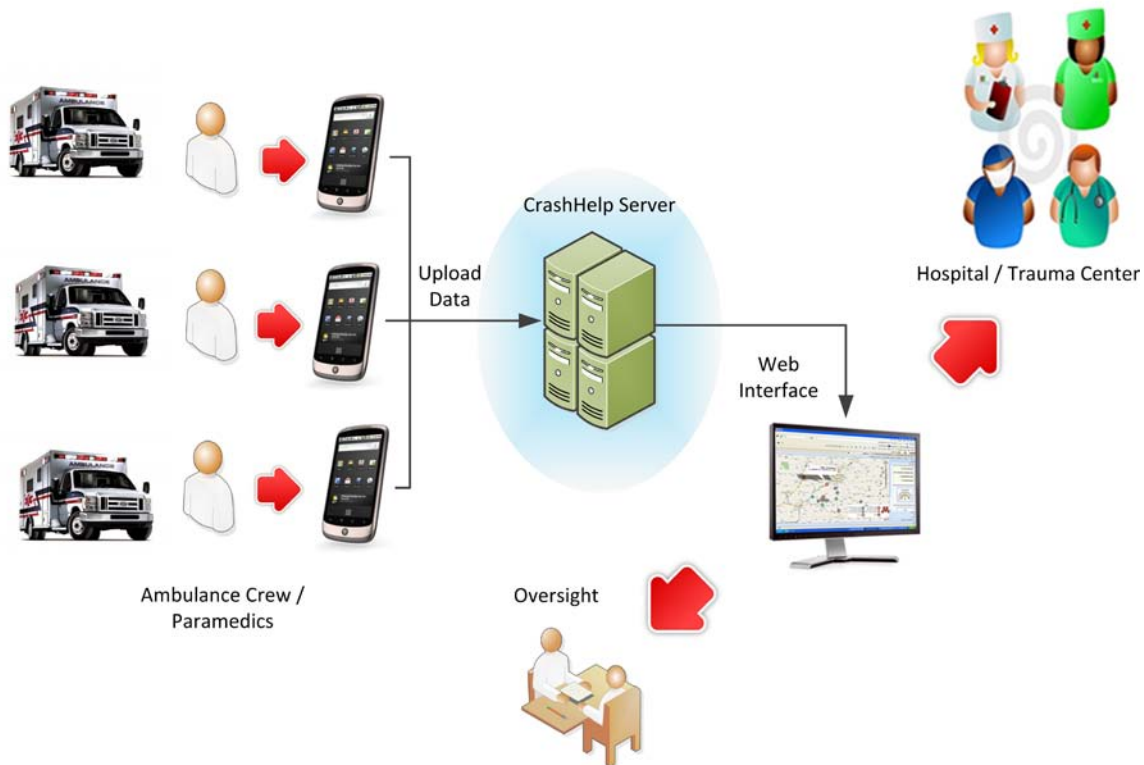
Figure 1. CrashHelp System Architecture

This model, along with the specific process model for capturing, sending, and visualizing data, was validated by Idaho participants. The Trauma Director of one of the Boise area hospitals stated, for example:

> "I'm 100% behind this system. I would like to see this in our hospital."

The EMS medical director for the state acknowledged:

> "This product has great potential. I look forward to seeing it being used and to test its real impacts."

Overall participants agreed that the CrashHelp processes, policies, and activities functioned in a manner that could be integrated with Idaho emergency medical practices.

Validation of CrashHelp Clinical and Performance Metrics

Findings from prior research in Minnesota determined that for EMS, time, distance, and age factors are important for clinical decision making. For example, increased utilization of EMS and increased vehicle-related mortality has been found among the elderly (Svenson, 2000) and in lower population density regions (Clark, 2001). Nationally, over 60% of vehicle related fatalities occur in rural areas, making up to 80% of all fatalities in some rural states (NHTSA, 2008a). Widespread attention has been given to public health issues associated with adolescent injuries and fatalities due to automobile crashes; the number one cause of death among persons 15- to 20-

8

years of age in the U.S. Per vehicle miles traveled, teenagers are involved in three times as many fatal crashes as all other drivers (NHTSA, 2008b).

Analysis also reveals that elderly drivers are more likely to be injured and die as a result of a motor vehicle crash (Clark, 2001, Evans, 2004, Yee et al., 2006). Some studies indicate that drivers 75 years of age and older have higher fatal crash rates per mile than other accident-prone groups (Jun et al., 2000). Most accident prone drivers are teenagers and the elderly population. In addition, a higher proportion of accidents take place in rural areas (Zhang et al., 1998). Case study findings from Idaho also validated these issues. Participants confirmed that the following indicators may prove valuable for emergency medical decision making:

- Patient age (over age 65, and under age 12)

- Crash site location (distance from hospital facility, and mapped location)

- Elapsed time from incident start

- Estimated time of arrival (ETA) to hospital (the projected and estimated time of arrival, visualized on a map)

As such, the project team significantly refined the CrashHelp prototype to better visualize these indicators. Appendix B contains screen shots of the refined CrashHelp, as customized based on input and feedback for Idaho stakeholders; these refinements are further discussed in the next section of this report.

Chapter 5.   Task 2 – Prototype Enhancement with Socio-Geographic Performance Metrics

The CrashHelp prototype as seen by hospital practitioners was enhanced based on findings from case study work. Interview and focus group discussions performed in Minnesota and Idaho were used to develop GIS based clinical and operational performance metrics. These metrics are described further below, along with an illustration on how these metrics were implemented in the prototype.

Figure 2 below shows the CrashHelp homepage. Here ambulance and hospital ED personnel can select their company or hospital to login and view the submitted information. Figure 3 shows the CrashHelp secure login page that personnel will view and enter their login credentials once they have selected their ambulance company, hospital, or agency that they work at.

Figure 2. CrashHelp Homepage

Figure 3. CrashHelp Login Page

Figure 4 below shows the CrashHelp "List View" as seen by hospital ED personnel. It shows a list of all incoming patients provided by ambulance agencies using the Smart Phone CrashHelp application. It allows for the user to click on the viewable patient records to access additional details as captured by ambulance personnel.

- Each record will display patient demographic information, the incident date and time, and pictures, videos, and audio recordings taken by ambulance personnel. Additionally, several indicators are displayed including:

- Age: When a patient is reported to be over the age of 60, or under the age of 12, a flashing red indicator is presented and remains. This calculation is made based on the data input by the ambulance paramedic.

- Elapsed response time: When an emergency response has lasted 30 minutes or longer, a flashing red indicator is presented and remains. This calculation is made based on the data input by the ambulance paramedic.

- Estimated time of arrival (ETA): The ETA continuously runs on the left bottom corner of the patient record to indicate to practitioners when to expect patient arrival. The calculation is based on the current location of the patient and the road route the ambulance is driving. The handheld CrashHelp device provides this data.

- Estimated distance from patient to hospital: Related to the ETA, the distance between the patient and the hospital continuously runs on the left bottom corner of the patient record

to indicate to practitioners when to expect patient arrival. The calculation is based on the current location of the patient and the road route the ambulance is driving. The handheld CrashHelp device provides this data.

The ETA and estimated distance from patient to hospital indicators are conceptualized features of CrashHelp, but have not been constructed in the prototype at this time. The time and resources to build this feature are beyond the scope of project funding. It is expected that this will be developed in a future phase of funding.
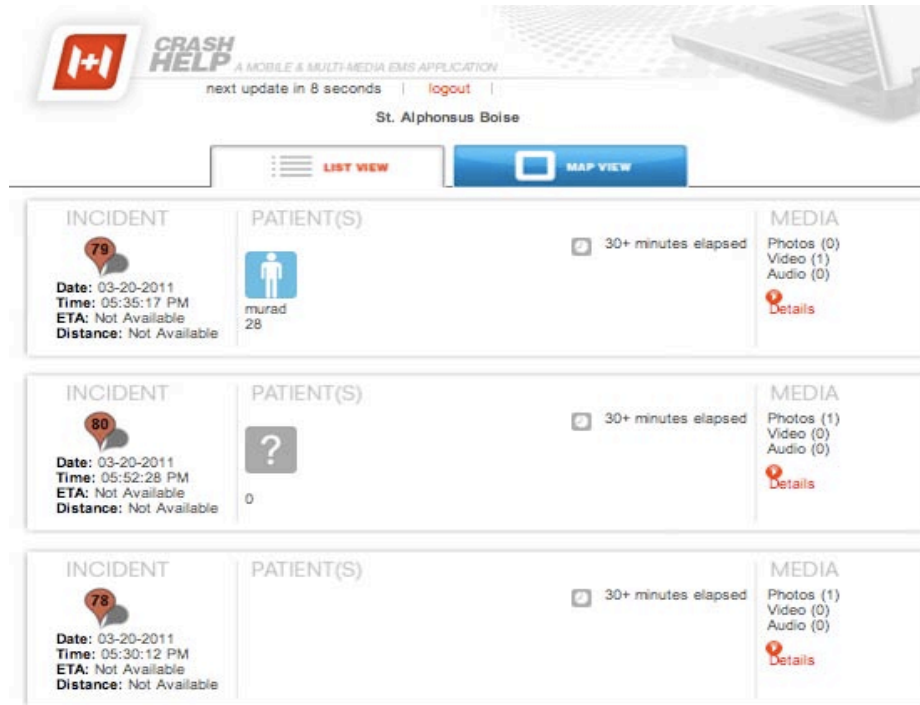

Figure 4. System Indicators for Hospital Emergency Department Personnel

In the "Map View" in Figure 5 below, also available to hospital ED personnel, the location of incidents are displayed on a map, with a list of current incidents shown on the left side of the screen. The map provides a "distance" and "time" indicator for emergency practitioners.
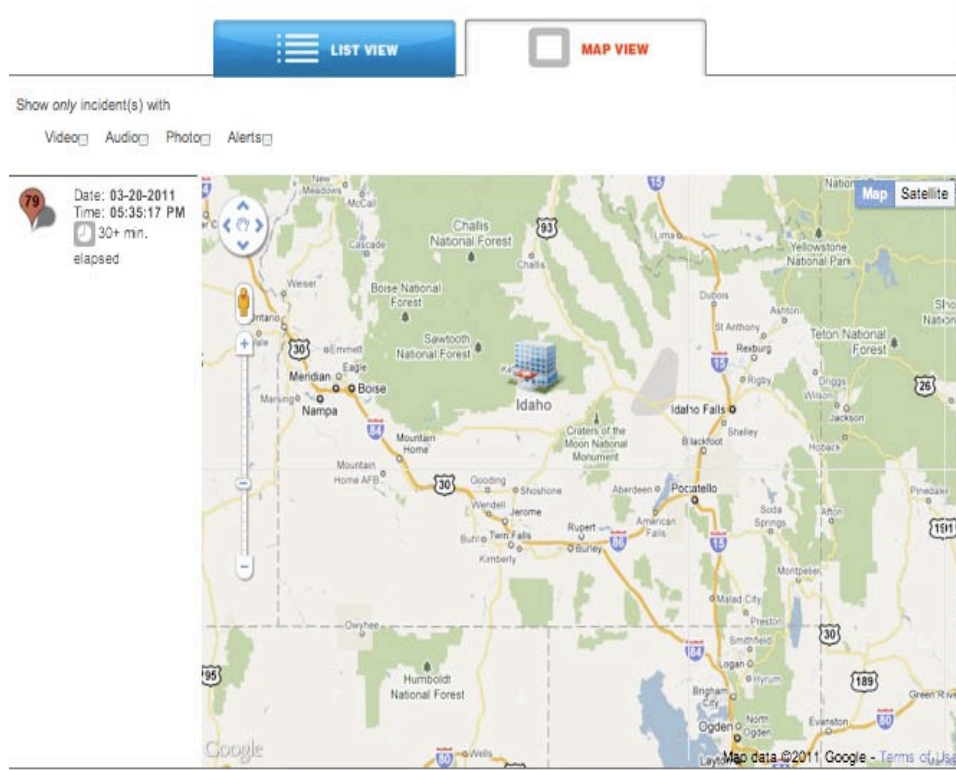
Figure 5. Location Indicators

Figure 6 below presents an additional map view that will pop up when you view details on a specific patient. The patient information will appear at the top of the page and the map view will show below. Figure 6 provides a visual description of the probable and actual route of the ambulance en route to the designated medical facility.
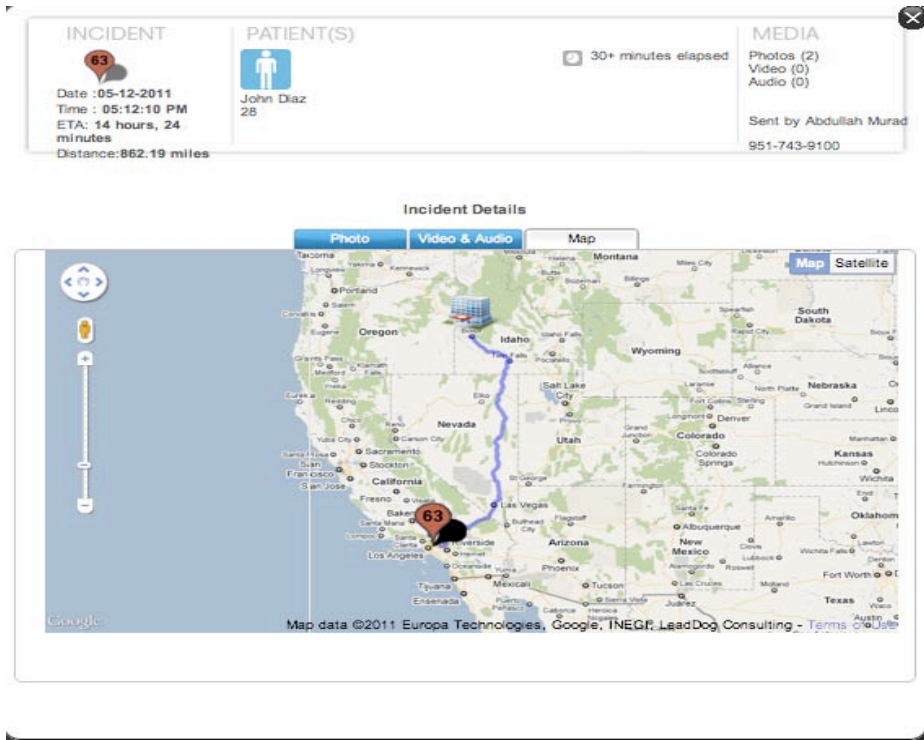
Figure 6. Additional Map View

In Figure 7 below, managers and administrators from the hospital ED ambulance agencies, and government oversight agencies are able to access visual details about all emergency incidents over time. The data can be viewed and queried to better understand longitudinal socio-geographic patterns in regional emergency responses.
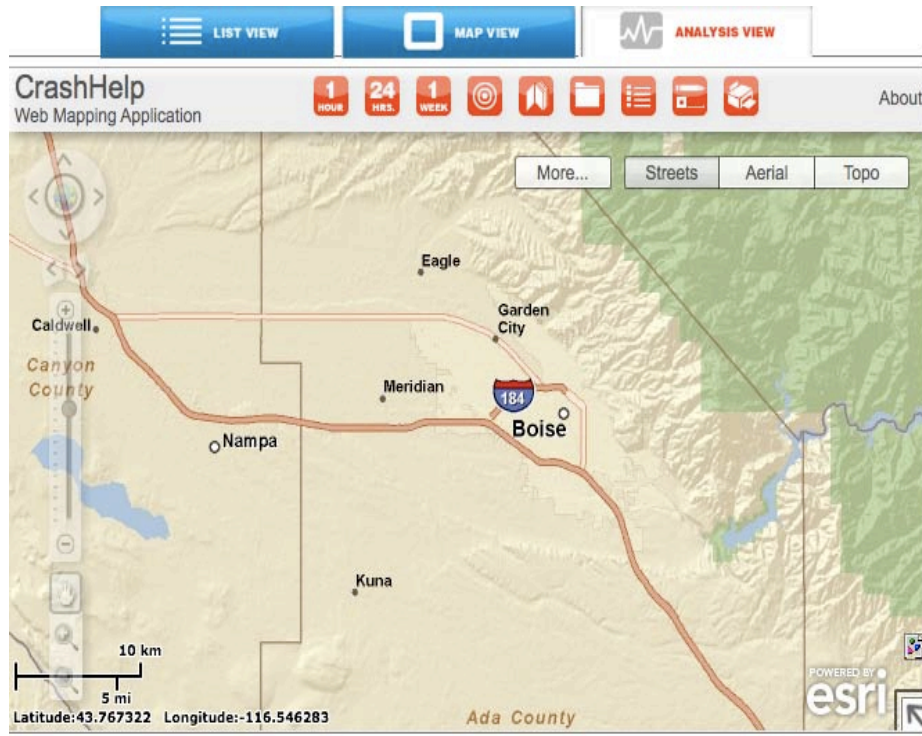
Figure 7. Analysis View

Figure 8 shows the technical assistance page. Users of the CrashHelp phone application and website may click this link from the home page. The technical assistance page includes links for users to report a bug, report a broken, lost, or stolen phone, request a password change, suggest improvements, view the user manual for the website, and view the user manual for Android users. It also shows the voicemail number that users may call and leave a message for the CrashHelp team. Most of these links include forms that can be filled out by users for assistance from the CrashHelp team. One of the user manuals is provided in Appendix D.
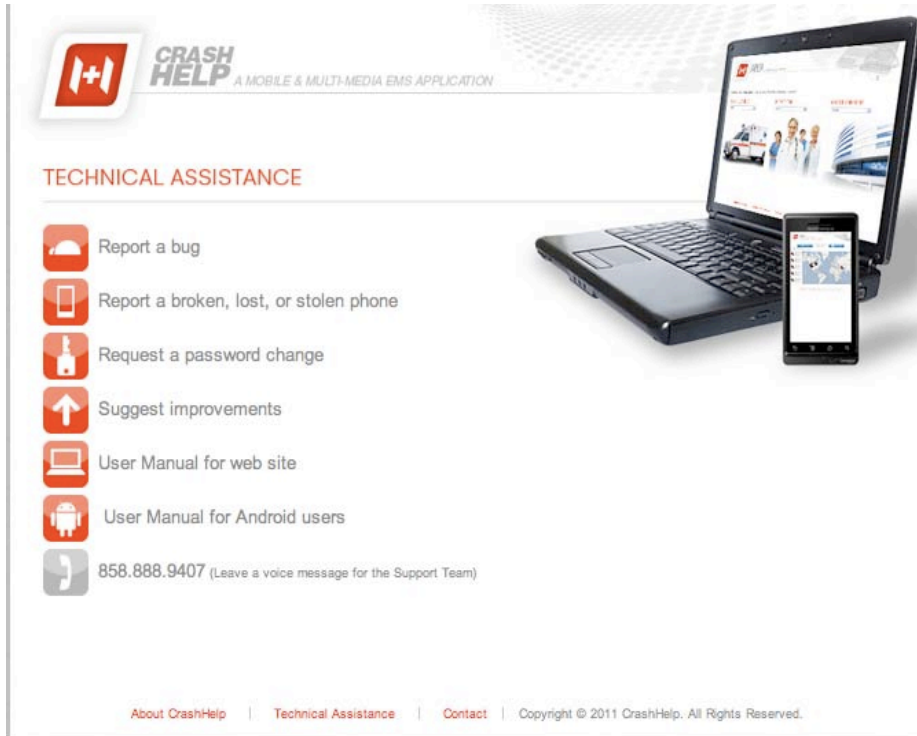
Figure 8. Technical Assistance Page

Chapter 6.   Task 3 – Clinician Stakeholder Feedback and National Applicability

As mentioned previously, stakeholder interview and feedback sessions were conducted to refine the CrashHelp prototype in terms of usability, utility, value, and success factors. Stakeholders for this project are viewed as having two of the three stakeholder attributes Mitchell views as important in understanding stakeholder claims – power and legitimacy. These stakeholders are the ultimate users of the CrashHelp system and because they are viewed as experts, the CrashHelp team views their opinions and suggestions as legitimate and valuable to the overall success of the project (Mitchell et al., 1997). The basis for legitimacy of the relationship between CrashHelp and our stakeholders is contractual in that they are the users of the CrashHelp system and are able to provide feedback on the system. Stakeholders from Minnesota, Idaho, and from National EMS and highway safety organizations provided expert feedback on the extent to which CrashHelp could provide value to safety planners and decision makers. We have also drawn from the knowledge and expertise of the Intelligent Transportation Systems (ITS) community throughout the design and development process of CrashHelp, including from industry (e.g., presentations at ITS Minnesota), academia (e.g., presentations and papers at Transportation Research Board (TRB) and the annual University of Minnesota ITS Institute meetings), and through interviews with experts on ITS architecture (see Schooley et al., 2007a). Practitioner experts included academics from the Public Health Informatics program at the University of Utah; EMS practitioners and researchers from the Federally sponsored Inter-Mountain Injury Prevention and Control research center; practitioners and policy makers from two State level EMS Agencies (Minnesota and Idaho); practitioners from an EMS professional organization (EMS Safety Foundation), and practitioners from the Idaho case study location including representatives from two ambulance providers and three hospital systems. Feedback was collected in a group interview format that included the following stakeholder types: ED physicians (15), ED managers (3), trauma physicians (4), hospital administrators (7), EMTs and paramedics (8), EMS Administrators (3), EMS Operations Managers (3), Public Health Administrators (3), medical informatics researchers (3), injury prevention researchers (3), and EMS IT Managers (3).

Participants were presented the CrashHelp model and then asked open-ended questions about the validity of the system problem and need, the perceived value of CrashHelp, the desired improvements for the system to provide value to each type of practitioner, and how the system could be modified to improve patient care. Table 1 below summarizes CrashHelp design goals and the degree of validation received from EMS stakeholders.

Table 1. Testable Design Product Propositions

	Degree of Validation
System will be perceived by consumers as helpful to patient health care	+
Consumers will want to use system	+++
System will be perceived as beneficial to EMS health care delivery processes	+
System will be perceived as helpful for health care decision making	++
Consumers will desire to communicate EMS information to peers through using the system	++
Consumers will desire to use mobile and interactive features	+++
System can collect multi-media patient information in a simple manner	+++
System can present patient data and key clinical indicators in a consumer-oriented display	+++
System can provide EMS incident and patient profiles	+++
System can provide real-time incident and patient status	+++
System can allow for customization of information services	+++

Chapter 7.   Incorporating ITS and Health/EMS Data into Safety Planning Efforts

The primary beneficiaries of CrashHelp will be those individuals in the traveling public that have had the unfortunate circumstance of being involved in an automobile crash. The CrashHelp system would extend current EMS systems to include a greater range of information, including difficult to obtain information that is needed by public health and transportation safety decision makers. Today, ED practitioners often do not receive information, or receive fragmented or incomplete information about an incoming patient from EMS providers. The ability to receive basic patient information, patient indicators, pictures, and an audio recording of the EMT report is aimed at addressing this critical information gap and enable better patient care decisions.

This information is expected to improve the understanding about EMS responses for public health and EMS practitioners and thereby improve the manner in which EMS is evaluated and planned holistically. For example, a key area of focus is linking socio-geographic data to emergency response. Our Phase II research has highlighted how this may be particularly important in improving the response to rural elderly citizens who are involved in a serious crash. This phase of work systematically incorporated such data into the CrashHelp analytical framework. The CrashHelp users are expected to have a decision tool for real-time visualization of crashes that will thereby aid them in preparing for and responding to victims of crashes. The research team continues to work directly with trauma and EMS practitioners in the design and development of the CrashHelp prototype so as to increase its usability and utility.

The benefits of this research may also extend to state departments of transportation in creating a strategic highway safety plan (SHSP) that meets the data intensive requirements of Safe Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) with the ultimate goal of reducing the number of highway fatalities and serious injuries on all public roads.

The main ITS related application is the use of mobile technology to communicate about the nature and severity of crashes. The above summarized the development and use of mobile technology in assessing and communicating crash data.

Chapter 8.   Conclusion and Next Phase of Work

The research objectives for this research were to: (1) collect and examine information regarding the potential for using the CrashHelp system in the state of Idaho as a case-study; (2) identify and develop aggregate performance metrics for end-to-end EMS responses to automobile crashes for inclusion in CrashHelp; and (3) expand the CrashHelp prototype to include aggregate level clinical and operational performance metrics that would provide valuable decision-level information for planners and practitioners.

With regard to the first objective, this research validated the applicability of the CrashHelp system management model and workflow process in the Idaho region.   Regarding the second objective, stakeholder interviews and feedback sessions from the Idaho case study, and previous research by the researchers, confirmed that certain types of information may prove valuable for emergency medical decision making, including: patient age (over age 65, and under age 12) crash site location (distance from hospital facility and mapped location), elapsed time from incident start, estimated time of arrival to hospital (the projected and estimated time of arrival, visualized on a map).   As a result of this finding, the CrashHelp prototype was significantly refined to better visualize and incorporate indicators that conveyed this type of information. As for the third objective, the aggregate information generated by CrashHelp is expected to improve the understanding about EMS responses for public health and EMS practitioners, and thereby improve the manner in which EMS is evaluated and planned holistically, particularly with respect to linking socio-geographic data to emergency response.

Based on the experience gained through this research, we conclude that providing accurate and timely crash information to EMS providers and hospital practitioners through the CrashHelp model may have the potential to transform emergency medical response and provision.   The next step in moving the CrashHelp model forward is to field test it.   Accordingly, the CrashHelp prototype pilot test was recently launched and is currently being pilot tested in Idaho across two ambulance providers and six hospitals. The pilot launched in July 2011. Upon completion of the pilot program in Boise, Idaho, we expect to use findings to make recommendations about the applicability of the CrashHelp system in other states across the country. Appendix C contains the nature and objectives of this demonstration, which represents and important field-test of this application.

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Appendix A: HICSS Paper

Process Improvement and Consumer-Oriented Design of an Inter-organizational Information System for Emergency Medical Response

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Abstract

This research employs Information Systems Design Theory (ISDT) to design, develop, and assess an inter-organizational information system for Emergency Medical Services (EMS). This research takes both a goal-oriented process improvement and consumer-oriented approach to systems design. While IS development has a rich history of focusing on improving organizational processes, the consumer-oriented approach aims to incorporate socio-psychological considerations of users. System goals include 1) improve patient information exchange from emergency responders to emergency department practitioners, and 2) develop the system in a manner that users believe to be ethical and otherwise intrinsically motivating to use. Data collection, system requirements, and system design and kernel theories are presented, design propositions are evaluated, and implications discussed on the role of consumer-oriented approaches in the development of multi-organizational, multi-consumer information systems.

1. Introduction

Consumer-oriented approaches to IS development are on the rise in the healthcare domain [2, 3, 4].

Motivated by the need to increase patient safety and quality of care, health information systems have largely been developed to improve the efficiency and effectiveness of health care processes and support decision making for practitioners [28, 29]. While process efficiency has long been an important motivator for IS development, IS professionals must increasingly take into account a wide range of other end-user socio-psychological motivations, such as relational, ethical, and enjoyment factors. Characterized by a close association between users and system developers as co-creators, consumer-oriented approaches focus on innovating, designing and developing information services that users *want* to use. Consumer-oriented approaches lend themselves to a customizable and service oriented design, as opposed to stand alone software products, that can address a potentially wide range of needs across many user types [26, 27].

We posit that a consumer-oriented approach may be useful in combination with goal-oriented process improvement objectives. As such, we have taken both approaches in the development of an IT artifact for multi-organizational Emergency Medical Services (EMS). We aimed to develop a system to 1) meet the business process goals of organizational leaders, and 2) to meet the consumer needs of the people on the "front lines", motivated by socio-psychological factors. We have taken a design science [1] approach to develop CrashHelp, a mobile and web-

based information service for use by various emergency medical practitioners involved in the end-to-end continuum of emergency patient care.

While information systems design theory (ISDT) has been used extensively as a research framework, gaps remain in terms of how to employ it within the consumer-oriented development approach, and when eliciting requirements from distinct and different user types across different yet cooperating settings. Our driving research question is: *How can a consumer-oriented information system be developed to achieve both a set of desired business process goals and a set of consumer goals?*

2. Background: EMS Information Systems

Information technology is generally viewed as a key "enabler" of coordination and decision making. Health Information Technology (HIT) has been found to help improve the quality of patient hand-offs, lead to decreased errors of omission, and reduce risk of patient injury during the transition of care [13] [14]. Past research identifies the potential role of HIT in significantly reducing emergency medical response times [7, 8] and improving the care provided to the injured at varying points across the inter-organizational continuum of emergency care [9, 10] [6, 11, 12, 15, 16]. However, emergency department (ED), trauma center, and other health practitioners typically receive little contextual information about a patient and his/her related emergency incident information from pre-hospital emergency responders at or before a patient enters the hospital. This is largely due to the dynamic, fast-paced, and stressful emergency environment that does not allow for timely data capture [6, 30, 33]. There are currently no examples of IS artifacts that address this gap. Thus, researchers have applied design theory in this project to address the needs of EMS practitioners in this regard.

This research focuses on developing a set of tools aimed at addressing the needs of different types of consumers across the emergency medical service chain. The first application is a mobile wireless application that enables emergency responders to collect incident and patient information. The second is an application that displays information collected by emergency responders in a visually oriented interface for emergency department (ED) and hospital physicians and nurses. The goal of the cross-organizational (pre-hospital + hospital) system is to enable better emergency medical response decisions. To accomplish this goal, researchers must understand the operational and socio-psychological needs of the information consumers.

3. Consumers of EMS IS

What, or who, is a consumer of EMS information systems? The definition of a consumer has been construed broadly [27]. In this research, we identify a consumer as someone who provides, interacts, manipulates, and uses EMS information. We view these users as "consumers" for several reasons. First, the system under development is positioned to be an innovative and web-based service [26]. Second, while users represent certain specific job functions, many are only loosely associated with a specific organization. Third, the users of the system play a paramount role in determining whether or not the system will be used. These types of users are highly resistant to change and must participate in system design if the system is to be used. Finally, we view these consumers as being critical to the creation of content (producers) that will be valuable to their peers (consumers).

Consumers of EMS information systems include any individual involved in an emergency event from beginning (patient medical onset) through response, medical treatment, and patient outcome – as presented in the Time-Critical Information Services (TCIS) framework (see Figure 1). These roles may include 911 operators, paramedics, fire fighters, emergency medical technicians (EMTs), law enforcement officers, nurses, physicians, surgeons, patients, bystanders, and others. While we envision many opportunities for various consumer types to use EMS information, to date the development of CrashHelp has focused on a select few user types for purposes of scope and practicality. The information consumers in this study include paramedics, EMTs, and emergency department nurses, physicians, and surgeons. It is important to note that these users span two traditionally disparate, yet cooperating institutions – pre-hospital emergency response and hospital emergency medicine (emergency department, trauma, etc.).
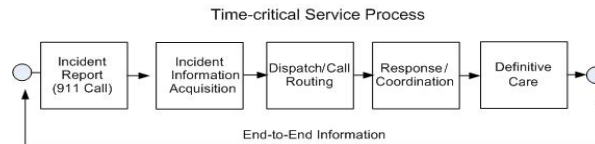
Figure 1. Time-critical service process

3.1 Consumer Driven Theory for EMS: Ethics in Healthcare Organization

Health care providers deliver health services based on several varying motivations including economic, legal, political, organizational, and managerial goals. Ethics in Healthcare Organization maintains that the top priority in all health care organizations should be first and foremost a focus and concern for the patient [20]. In short, health care professionals should be driven by a desire to help, to do the "right thing" for a patient. This core socio-psychological priority became apparent in prior work by the research team [7, 9, 10] and is the foundational consumer oriented goal for CrashHelp. That is, CrashHelp must be designed to address an intrinsic need, or motivation, to care for people, combined with personal satisfaction from using the system, including a belief that using the system will indeed help a patient. As such, consumer requirements must be well understood in order to design and deliver a service that will be embraced. Here, consumer emotional responses to an information service play a significant role [34].

3.2 Socio-Psychological Motivations to Use IS

Socio-psychological theory has focused a great deal of attention on *intrinsic motivation,* or the motivation to engage in an activity primarily for its own sake, because the activity itself is interesting, engaging, or in some way satisfying. Theorists have proposed that intrinsic motivation is made up of several interrelated active components including interest, excitement, elation, happiness, surprise, and fun [35, 36, 37]. To what degree do these components also carry over to the use of IS by EMS professionals?

Prior research indicates that many emergency medical professionals are highly motivated intrinsically. For both pre-hospital (EMTs) and hospital (physicians, nurses) personnel, this intrinsic motivation is characterized by a desire to help people. Physicians have long been known to be motivated by the need to help others [31][25]. Intrinsic motivation is perhaps most apparent with EMTs, whom are highly satisfied with their jobs [23], rate their peers high in terms of professional integrity, empathy, and patient advocacy [23], yet earn annual salaries that are far lower than most other health care professionals [6]. They also experience a high degree of health and safety hazards, experiencing a fatality rate that is more than twice the National average for all job positions and is comparable with Fire and Law Enforcement jobs [6]. Furthermore, approximately 36% of EMTs nationwide are volunteer workers. This number is as high as 50% - 70% in some states. Indeed, a National longitudinal study showed that most EMTs entered their profession for the purpose of helping others by providing medical care [24].

What is less clear is the role that technology can play in enacting these intrinsic motivations. For example, we found that the EMS culture is highly resistant to technology change, generally, and that any action or process that is perceived to be a distraction from patient care is unacceptable and vigorously resisted [7][10]. However, we also found enthusiastic support to perform IS related tasks that are believed to help patients. Turning to artifact design, we have sought to apply these intrinsic motivation concepts to the analysis and design of the CrashHelp prototype.

4. Research Approach and Methodology

This study employed a multi-method research approach. First, transcripts and findings from prior phases of research were data-mined and analyzed including interviews and observations with EMS practitioners across two case studies [7, 10], quantitative performance data analysis and group interviews on EMS performance information [21], and EMS IS architecture analysis [32].

Second, a subsequent phase of interviews were held with pre-hospital and hospital EMS practitioners from one of the case study locations previously studied to validate and inquire more specifically about the desired features of a cross-organizational EMS information system. Interview transcripts from all phases were assimilated, analyzed, and categorized into a set of information challenges and needs across each of the dimensions of the TCIS framework.

An information system design theory (ISDT) approach was then employed, based on the findings, to infer how an artifact might function and to identify the underlying theoretical drivers for developing a prototype system [1, 38]. Table 1 shows the ISDT framework used to formulate findings into design elements for the prototype. As shown, this analysis was used to establish the meta-requirements, meta-design, kernel theories, and testable design product propositions. The meta-requirements in Table 1 illustrate the class of goals to which the theory applies. The meta-design describes the class of artifacts to meet the meta-requirements.

We applied several kernel theories for governing design requirements including: Continuity of patient care (i.e., patient centered process improvement), Ethics in Healthcare Organization (and intrinsic motivations) [20], Wide Audience Requirements Engineering (WARE) method [5], consumer-oriented information system design, and agile development methods [19]. Testable design product propositions are illustrated to test whether the meta-design satisfies the meta-requirements. Findings from qualitative evaluation are presented in the evaluation section below.

The ISDT presented herein is dedicated to the development of knowledge useful to both research and practice [17]. The goal of the research is to afford EMS practitioner decision makers information not previously accessible, in a manner not previously delivered, while producing a technological artifact aimed to extend scientific knowledge about how consumers across multi-organizational systems use such information [18]. In this manner, the research team was able to design, analyze, and improve the system in a structured way that satisfied both design outcomes and the prescriptions and disciplines of this theory-based framework.

4.1. Data Collection, Analysis and ISDT Development

As noted above, researchers analyzed and applied findings from multiple research phases to formulate an ISDT. A wide range of requirements elicitation methods were used across research phases including observations and context focused interviews in real work settings, group discussions and elicitation, cognitive techniques such as scenario development, and prototyping, scenario-building / storyboarding, and drew from WARE methods to address needs of a wide audience of users [5, 41]. Feedback was obtained from a wide range of potential consumer types, stakeholders, and researchers to inform the usability, success factors, and value proposition of the CrashHelp model. These were held in a group interview format that included the following stakeholder types: ED physicians (4), trauma physician (1), EMTs and paramedics (6), EMS Administrators (4), EMS Operations Managers (2), Public Health Administrators (3), medical informatics researchers (3), injury prevention researchers (3), and EMS IT Managers (3).

Participants were presented the CrashHelp model and then asked open ended questions about the validity of the system problem and need, the perceived value of CrashHelp, the desired improvements for the system to provide value to each type of practitioner, and how the system could be modified to improve patient care.

Findings from across research phases helped elicit the meanings, needs, issues, and benefits of an open, standardized, integrated, secure, and private information sharing environment. These findings were utilized in the design of the CrashHelp prototype design described in the following section.

Table 1. ISDT Design Elements

Design element	Description

Meta-requirements	- Support end-to-end EMS operational processes - Support practitioner socio-psychological needs to provide good patient care - Reduce the negative health impacts of motor vehicle crashes - Humanize the EMS response - Support patient decision making for EMS practitioners
Meta-design	- Capture patient information relative to an emergency incident - Visualize information, as desired by users, to make patient health care decisions - Provide means for communicating with EMS personnel about a patient and incident - Provide means for communicating priority health indicators - Provide ways to assist non-technical users to visualize patient outcomes - Provide means to customize information views for users - Provide flexibility in use of hardware devices
Kernel theories	- Process Improvement, Continuity of Care - Ethics in Healthcare Organization - Wide Audience Requirements Engineering (WARE) method - Consumer-oriented information systems - Agile development method
Testable design product propositions	- CrashHelp will be perceived by EMS practitioners as helpful to patients. - CrashHelp will improve EMS health care delivery processes - CrashHelp will improve EMS patient health outcomes -It is possible to display spatial data and key clinical indicators in a consumer-oriented display -It is possible to provide EMS incident and patient profiles -It is possible to provide real-time incident and patient status

6. CrashHelp Prototype Design

Past research findings indicated that a system to facilitate information exchange between pre-hospital and hospital environments in a way that accompanies a patient at the ED does not exist. Therefore, the design science approach was deemed suitable to this project and an IT prototype system was developed (dubbed CrashHelp).

The prototype was designed to integrate information regarding EMS responses and hospital treatment of motor vehicle crash (MVC) patients within the Mayo Clinic trauma jurisdiction.

From the outset, the goal of CrashHelp was to design a system that consumers would want to use. The operational goal was to enhance decision making, help reduce emergency response times, and improve the quality of healthcare. Within this set of goals, the design considered how such a system could embrace or at least leverage the intrinsic interests of consumers in the system.

6.1 Requirements for CrashHelp Prototype

We envision CrashHelp to eventually include an array of rich, interactive, visual and multi-media information such as maps, two-way video streaming, interaction between actors in real time, and potentially a social networking context. To date, we have developed only those features and services that we have elicited from consumers.

Findings were synthesized and generalized into guiding principles, based on specified kernel theories, to meet process improvement goals and consumer socio-psychological goals as follows:

Process Goals:

- ***The system must facilitate information hand-off*** *at* or *before* the patient hand-off to the ED. Responses included: "We have to find a way to get it [information] to the ED on time. There has to be some way to resolve this." (ED Physician)

Consumer-oriented Goals:

- ***The system must have a visual display*** and user friendly look and feel similar to what can be experienced on the latest hand held device apps, multi-media, social networking, and location based apps. It must not take long to enter information. Responses included: "I'll take a picture of an accident with my own personal cell phone and show it when I get there [to the ED]." (Paramedic)

"I want to have some way to see a picture and then, you know, let the medics in the field know what I think. Like, move in closer [with the camera] or ask a question [to a patient]." (Trauma Surgeon)

- ***The system must provide value added context*** to decision makers at the ED/Trauma Center in a way that can be visualized and consumed quickly and easily. Responses included: "I think the basic information, the context of what happened on scene helps out the most. We need that." (Director, Trauma)

"…picture says a thousand words…it could help us know if we should assemble our [trauma] team or not."

- ***The system must allow customizable information services*** for a variety of EMS information consumers. Responses included: "I want to see what I want to see. I think most clinicians are that way." (ED Physician)

- ***The system must humanize the EMS response.*** In direct reference to the intrinsic interests of consumers of the system, our research has indicated that EMS personnel want to know what happened to the patients they treated – not necessarily because of organizational accountability, but because they "care". Responses included: "If I want to go back and see what happened [to a patient I cared for] I pretty much have to call someone [at the hospital] who's really not supposed to tell me but you know, I know them and they tell me. Did she live? Did she go home?" (EMT).

Consumer-oriented and process improvements goals:

- ***The system must interfere in the least possible way with care processes*** and practices. Responses included: "I don't have time to enter all that [patient] information. If I have a choice between stopping profuse bleeding and messing around with a laptop, the choice is pretty obvious." (Paramedic)

"We already give a verbal snapshot to the doc. If I could just…record it and let him listen whenever he wanted to, then I wouldn't have to wait. I could get back out on the street faster." (EMT)

Consumer design features were identified to embed within the software application. These included:

- End-to-end patient information that can be viewed in the system from the start to finish of an EMS incident.
- A multi-organizational view of the system and use by practitioners. A common operating picture (COP) is important for many organizations and user types.
- Many consumer types including dispatch, EMS, ED, trauma, and public health oversight organizations.
- Visualization of a range of data, images, video, and audio from a range of devices (e.g., mobile phones, other EMS software), quickly consumable for a fast paced environment.

Functions were identified and analyzed in an iterative agile development manner using pre-factoring and model-driven refactoring [22]. The following are the functional requirements:

- Data Capture – utilize handheld, mobile technologies to capture digital voice, video, images, and GPS data for display and easy access in the ED.
- Incident Map – visually display spatial data about an incident for situational awareness and decision support.
- EMS Incident Profile – visually display patient information including multi-media information along with key clinical indicators (i.e., age, response time).
- EMS Incident Detail – allow drill-down on an incident to display gallery of image, video, digital voice files pertaining to a specific patient and incident.

Also the following consumer-oriented requirements were defined:

- Multimedia Content - Content can be created, used, visualized, and manipulated by consumers
- Web-based – Information can be accessed and viewed based on web-based design principles, that is, to allow for flexibility in the use of information and accessibility for a wide range of users.
- Interoperable Services – Middleware technology provides a means for integrating and routing information securely and privately between devices and interfaces. It allows for flexibility in creating a range of configurable information services, enables configurable interface visualizations, and facilitates interaction with other services and applications. The middleware allows for any compatible device to securely interoperate.
- Open Development Platforms – As much as possible, software is built using open (i.e., open source) and standardized technologies to increase accessibility of the system to the widest range of users, allowing them to choose the devices they want to use.
- Security – Identification, authorization, and authentication of users, secure data transfer, encryption and decryption are required for transmitting and saving patient data as required by HIPAA rules. A key challenge exists in balancing this requirement with the consumer need for usability.
- Data standardization - Data standardization is required for integrating data into a larger information network. The National Emergency Medical Services Information System (NEMSIS) standards as well as others (e.g., NTDS, HL7) provide frameworks for standardizing CrashHelp data.

6.2 CrashHelp Prototype Components

Drawing from the requirements above, the CrashHelp system was developed utilizing a range of current and emerging concepts and technologies including Web 2.0, geographic information system (GIS) Mashups, web services, dashboards, and multi-media mobile applications. CrashHelp has two primary interfaces utilized by end-users, 1) a hand held device for paramedics to collect information at a crash site, and 2) a web-based application to visualize integrated information at the ED. A set of server-side applications and databases are used to integrate, aggregate, and "mash-up" information for viewing in the web-based application.

The CrashHelp Prototype consists of four components: handheld application, middleware, ED Dashboard, and ED application (see Figure 2).

The handheld application for use by EMTs and paramedics was developed using the Java programming language on the Google Android operating system. The application for use in the ED for physicians, nurses, and administrators can be accessed using any device running a standard web browser. The Android application enables EMTs to collect data for a crash incident and patient, take a picture of the scene, record audio notes, and capture video for the incident. Basic patient data, GPS location and EMT contact information are also collected. These data are then sent to the CrashHelp database (See Figure 2).

The middleware plays a role for integrating between devices and interfaces. It facilitates security capability when transmitting data to and from devices and interfaces, such as the ED Dashboard. The ED Dashboard visualizes EMS data captured by EMTs and paramedics utilizing map, picture, audio, and video inputs.
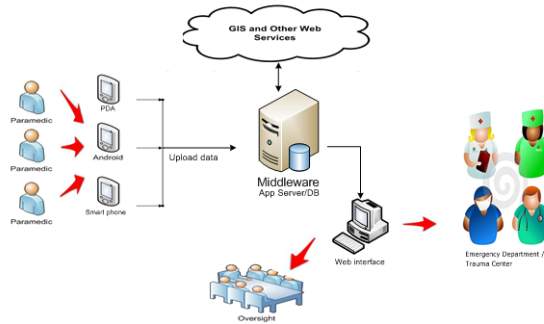

Figure 2. CrashHelp System Architecture

The ED Application displays incident and patient information collected from the Android application, as well as from other potential data sources such as computer-aided dispatch, trauma registry, and patient care record systems. CrashHelp displays the patient and incident information on a map. Detailed incident information can be displayed from the initial screen. Location information is also aggregated from Google and Microsoft web services to provide mapping, street level, and "bird's eye views" of an incident location. The CrashHelp system architecture is illustrated in Figure 2 above.

7.3 The Mobile, Handheld Application

The handheld mobile application was developed for paramedics and EMTs to use at a crash site. The first user screen allows creation of a new incident (Figure 3 below). Simple navigation then allows the user to take pictures, video, or digital audio, record basic patient information (i.e., name, age, gender), and send the data along with GPS coordinates, name of the medical attendant, and phone number of the device to the system server.

6.4 ED Dashboard

Once incident information has been sent to the CrashHelp server, it can be accessed in the emergency department via a standard web browser. Web services can be created at the Java Glassfish middleware for consumption based on what the user wants to see. The prototype (Figures 4-5) displays an example simplified list of incidents within a web browser. Incident status, map view and location of incident, estimated time of arrival and distance to arrival, patient demographics, and priority indicators are shown. From this dashboard list view, a detailed view can be drilled down on.

Figure 3. Mobile Application Screen Shots

The web application provides users (doctors and nurses) an interface to the system with the following information :

- **Incident Information:** Time/date of incident, Estimated distance and time of arrival and Incident number (from dispatch)
- **Patient Information :** Age, name , gender for all patients
- **Media Display** : images, audio and video that were taken at the incident scene by paramedics.
- **Map View :** Locations of incidents and ambulances on the map in near-real time.
- **Priority Indicators:** information such as patients' age, number of patients in an incident, and arrival time are used to calculate severity level scores for prioritizing how and where an incident is displayed in the interface.

Figure 4. ED Dashboard with Map
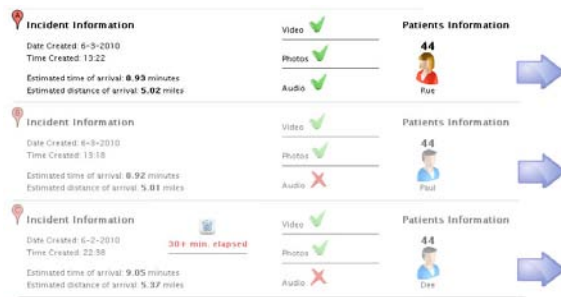
Figure 5. Close-up of ED Dashboard View

A-9

The detailed ED dashboard view displays a picture gallery, video and audio gallery, and detailed map view with estimated ambulance routing information of each incident as collected by EMTs. It also displays a Microsoft Virtual Earth map, and a Google Street View map (see Figure 6).
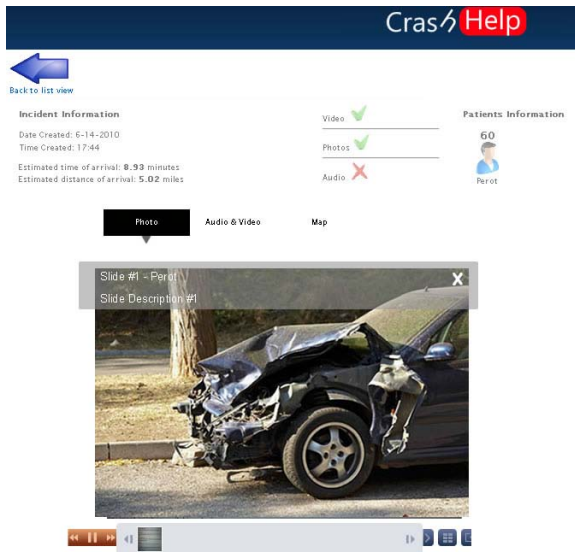
Figure 6. Detailed View with Picture

6.5 ED Application

Some consumer types want to visualize incident information at an oversight level. As such, web services allow for a configurable, web based map view along with aggregate data. Figure 7 displays current (near real-time) aggregate incident information using graphical gauges. Users are able to view information such as the average age of all incident patients, the average response time of all EMS units, and allows for integration of data from other sources, such as the average injury scores as assessed by health practitioners including the glasgow coma score (GCS). An interactive map displays the locations of current incidents and related resources (e.g., hospitals) in the Rochester, Minnesota region. A user may select an icon to view more detailed information about each resource. A user can select from different base map configurations, Google or Microsoft. When the user selects an incident icon, the system allows a user to "drill down" and display detailed incident information.

Figure 7. Aggregate View for Oversight

Similarly, when a Fire Station or Hospital symbol is selected, detailed information about that resource are displayed. Various icons represent combinations of age and response time indicators to represent "alerts" to practitioners.

6.5.1 Data Layers for Analysis and Oversight

A-10

The ED Application provides detailed resource information such as incidents, fire stations and hospitals, cell phone service areas, locations of traffic cameras, fatal crash hot-spot statistics, and current weather information. These features allow for post-incident analysis, training, and medical reviews across incidents. When a user selects a view of incidents, hospitals, fire stations or traffic cameras, the CrashHelp system displays a resource icon on the map. When a user selects a view of cell phone service areas, fatal crash hot spots, or current weather, the CrashHelp system displays colored area boundaries.

7. CrashHelp Evaluation

Several themes from qualitative analysis emerged when the prototype was presented to EMS stakeholder groups. These groups included academics from the Public Health Informatics program at the University of Utah; EMS practitioners and researchers from the Federally sponsored Inter-Mountain Injury Prevention and Control research center; practitioners and policy makers from two State level EMS Agencies (Minnesota and Utah); practitioners from an EMS professional organization (EMS Safety Foundation), and practitioners from the case study location (Mayo Clinic Medical Transport).

First, the visual "list" view and GIS graphical display combined with performance indicators and dashboard gauges were viewed as valuable for providing situational awareness about the emergency and trauma system service demands, for providing important information for making timely emergency care decisions for individual patients, and for Quality Assurance / Quality Improvement activities during post incident reviews. Additionally, the GIS interface was viewed as a user-friendly platform for accessing needed information. The "YouTube"-like display and function of photo and video galleries was appreciated and spurred discussion about the potential value of "mining" emergency pictures and video for educational purposes.

The ability to capture and display pictures, video, and voice recordings along with time and location information was viewed as potentially the most significant feature of the prototype. While EMTs continue to be wary of the time it takes to use technology during an emergency, there was significant interest, particularly from younger EMTs, to take pictures and video. Younger EMTs felt the handheld device and application followed trends from industry technology companies (e.g., iPhone, YouTube). Older EMTs likewise thought the younger EMTs would think the device was "cool." These features were viewed as valuable for enabling ambulance teams to "get back out on the street faster" and for affording trauma teams the information needed to help determine when to assemble a trauma team (or not) prior to patient arrival. Most believed the multimedia information could be helpful to provide better patient care.

Participant discussions also revealed the value of minimizing the amount of manual data capture required out in the field. Simply capturing age, gender, name, incident number, and injury level indicators were thought to be "good enough." This data together with location, image, voice, video, and automated emergency response time stamps were believed to be highly useful. Many participants continued to look for ways to reduce the number of clicks and touches in the interface and believed the application functionality needed to be scaled back even further.

The prototype elicited discussion about potential interactive features, such as communicating between users at an incident location and the hospital. Though several ideas were discussed (e.g., 2-way video conferencing), users were unsure how such features could be incorporated into CrashHelp. Most importantly, both in-the-field emergency response technicians and emergency room doctors expressed strong interest in establishing a direct communication between them, and valued the opportunity to give and receive information. Finally, participants believed an important next step would be to further develop and pilot the application and evaluate its ability to enable timely and quality information handoff across pre-hospital and hospital settings.

8. Implications and Next Steps

We believe that this study has contributed to research and practice. In terms of research, it illustrates a multi-method approach to analyzing and developing an ISDT drawing upon both emerging consumer-oriented approaches and more traditional goal-oriented, process improvement approaches. The use of ISDT as a guiding framework enforced the systematic inclusion of "hard" and "soft" factors in the design. The hard factors included the

quantitative analysis approach to requirements gathering and process improvement. The soft factors included the consumer-oriented approach and interaction with stakeholders motivated by socio-psychological needs.

From a methodological perspective, a contribution of this research is an illustration of the use of multiple research methods to iteratively design, develop, and prototype an innovative system for the exchange of information across a traditionally disparate multi-organizational setting. The next important step is to determine if and how these expressed desires to utilize the system can be translated into actual utilization and satisfaction thereof. Plans for such testing are underway.

In terms of practice, this research offers an ISDT for a new type of IT system; an inter-organizational, consumer-oriented information system for EMS drawing generally from social-psychological aspects rooted in healthcare ethics and intrinsic motivation. An ISDT is an important contribution as it guides system developers and sets an agenda for academic research. The paper also offers guidelines for developers of information systems that involve exchanging sensitive information and data visualization in near real-time settings. Finally, the paper presents a set of development tools (middleware) and methodologies that provided the CrashHelp team with sufficient flexibility to build a highly customizable and consumer-oriented system.

Future work may consider expanding the design of this system to include other consumer types. For example, patients and bystanders are important emergency medical actors. CPR instructions to bystanders over the phone have been associated with a 50 percent improvement in the odds of survival compared with cases in which no CPR is administered before the arrival of EMS [39, 40]. How could these consumer types interact with information during emergency scenarios? Second, while this research elicited consumer responses using a variety of methods, much work is required to discover the most appropriate mix of methods for multi-organizational consumer-oriented design. Future research should seek to evaluate the utility of other robust approaches.

9. Acknowledgements

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Appendix B: CrashHelp Screenshots

1. **CrashHelp Homepage**

2. **CrashHelp Login Page**

3. List View

4. Map View

5. Additional Map View

6. Map Analysis View
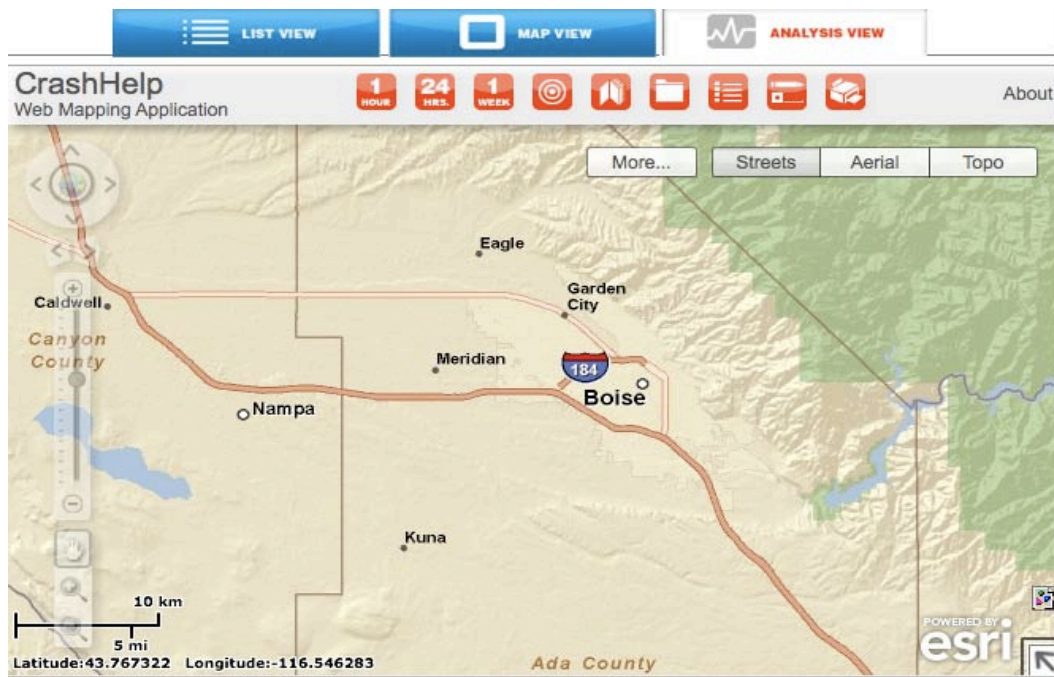
7. Technical Assistance Page

Appendix C: Idaho Pilot Project

The Idaho Pilot project is made possible through collaboration between the Idaho State EMS Bureau, Canyon County Paramedics, Ada County Paramedics, hospitals in the Boise, Idaho, region, and researchers at Claremont Graduate University and the University of Minnesota. The pilot will be a test of the "CrashHelp" software system in Idaho with EMS practitioners across emergency medical response and hospital organizations. The CrashHelp system is aimed at assisting with the collection of basic pre-hospital information and visualizing key information points to EMS and Emergency Room / Trauma Center providers.

The pilot project objectives are:

- Obtain practitioner feedback on CrashHelp prototype prior to pilot testing

- Refine the CrashHelp prototype according to local Idaho practitioner needs and requirements

- Gain required approvals to conduct pilot

- Implement pilot version of CrashHelp to be used as follows:

- Onboard Ada County and Canyon County ambulances (approx. 20 devices).

- Within 6 Boise area hospitals including: West Valley Hospital, St. Luke's Meridian, St. Luke's Boise, St. Alphonsus Boise, St. Alphonsus Eagle, St. Alphonsus Nampa.

- At the Idaho State EMS Bureau by state EMS administrators.

- Conduct "alpha" pilot test of CrashHelp in increments (approximately 90 days each)

- Evaluate pilot test

- Construct and submit grant proposal for multi-year research funding

The project will investigate the usefulness of the CrashHelp Android Smartphone application and the website to better emergency response times and provide better patient care. The CrashHelp system is aimed at assisting with the collection of basic pre-hospital information and visualizing key information points to EMS and Emergency Room / Trauma Center providers.

- The expected benefits from the CrashHelp system are:

- Improved information collection by on-scene EMS personnel

- Improved communication between pre-hospital transport and hospital organizations (ED / Trauma)

- Improved care decision making by hospital personnel (for some incidents)

- Improved resource utilization by hospital personnel

The Idaho pilot project will provide information such as emergency medical response times, patient information, and locations. Theses data findings will be analyzed and used by the CrashHelp team to determine the usefulness of this Android Smartphone application. This data will be explained in a technical paper. Based on success of this pilot, we would hope to expand the project to other cities and states. Once the project is completed we will be able to determine the next steps for the CrashHelp project.

Appendix D: User Manuals

CrashHelp User Manual

For Android Crash Help (V.2.0.26)

Table of Contents:

Getting Started:

- **Install the Application:**
  Before you can use CrashHelp on your mobile device, you must first download it. You will be given a temporary password to use to download the application. You will receive a text message containing a link to download the application. Click the link and you will be prompted to enter the temporary password. Once you have entered the temporary password you will be prompted to change your password to one of your choosing. Enter your current temporary password, your new password, and confirm your new password. After changing your password, you will be given another link where you can finally download the application to your phone.

- **Open the Application:**
  In order to use the CrashHelp application you must first turn on your phone. Once the phone is on, you will view the "Home" screen (Inset Below Left). This screen shows some programs and information on the phone. Click the Green power button to view icons for all of the programs installed on the phone (Inset Below Right). Find the CrashHelp application (icon highlighted on right) and select it by tapping the icon on the screen. Now that the application is open you are ready to begin managing information.

- **Main Menu**:
  When you first open the CrashHelp application you will be
  viewing the Main Menu. On this screen you have four
  choices: New Incident, Resume Incident, Settings, and Exit
  (Inset Right). To select one of these choices simply tap on
  the box of the function.

- **Create a New Incident:**
  When responding to an incident, you will want to create a new incident. After selecting New
  Incident on the Main Menu, you will be asked to begin entering information about the
  patients at the scene. The initial information you are asked to enter will be based on what is
  selected as your Initial Tab (For additional information on Initial Tabs, see Settings)

- **Enter Information:**
  Once you have selected a New Incident, you will be
  presented with the Tabs screen where you may choose
  Camera, Audio, or Patients. These tab options will be
  displayed across the top of the application. The default
  selected Initial Tab is Patients (Inset right shows Initial Tab
  as Camera). You may move between the tabs by clicking
  on the one you would like to enter information on. (If you
  would like to select a different Initial Tab setting, see
  Settings).
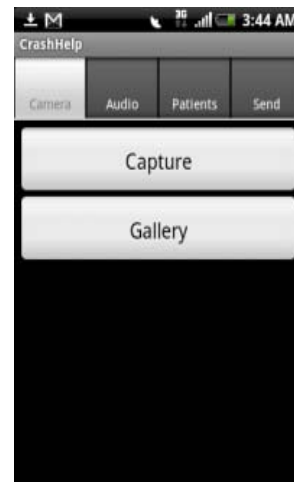
    o *Patients:*
      The Patients Tab allows you to enter information about the patient(s) you are treating.
      If Patients is not your Initial Tab, you may select it from the Tabs screen.   This tab
      presents the option of New Patient (Below Left). Select this to begin entering patient
      information. You will enter information for patients one at a time. The Patients
      screen will have you enter three pieces of information: gender, age, and name (Below
      Right). To select the patient's Gender, by clicking on the circle to the left of the
      correct option. A green circle to the left of Male or Female indicates a selected

gender. To enter the age click inside the text box and enter the correct age using the keyboard of the phone. To enter the Name of the patient click inside the text box and enter the name using the keyboard of the phone. Once you have entered the gender, age, and Name for your patient choose Done to return to the Tabs screen or choose View Tags to view photographs and audio that correspond to that patient. (For more information on View Tags, see View Tags).
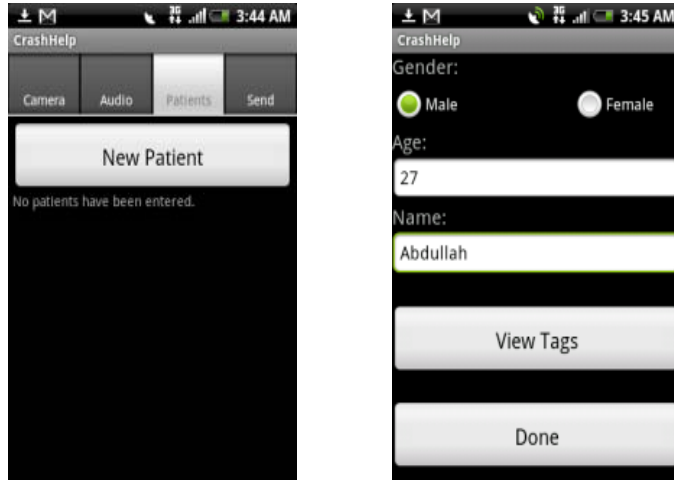

o *View Tags:*
   You may View Tags of pictures, video, or audio you have taken in the Gallery. If you have previously entered photographs of video for this patient they will show up here. If you have not yet entered photographs or audio for this patient no tags will be available until you do so. (For more information, see Gallery).

o *Audio:*
   The Audio Tab allows you to record important information about the scene that may not be clear from or explained by the photographs or video functions. The Audio tab can be found and selected on the Tabs screen by tapping on it. The Audio screen will show a Start Recording button and the acronym VOMIT that suggests the type of information to be included in your audio recording (Inset Below Left):
   > V: Vital signs of the patient
   > O: Origin of the incident (hospital or scene)
   > MI: Mechanism of injury (vehicle crash, blunt object, etc.)
   > T: Treatments given.
   Select Start Recording to record the information from the scene (Inset Below Left). Once selected the text of the button will change to Stop Recording (Inset Below Right). Select Stop Recording once you have recorded all the audio information needed. Now the screen will show the new recording labeled by the date of the incident and the duration of the recording. (For more information, See Send Information).
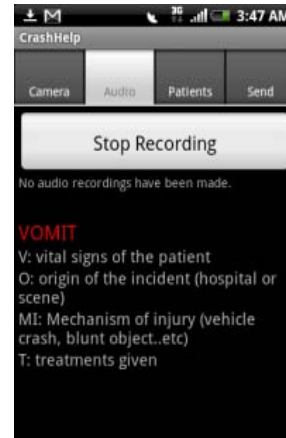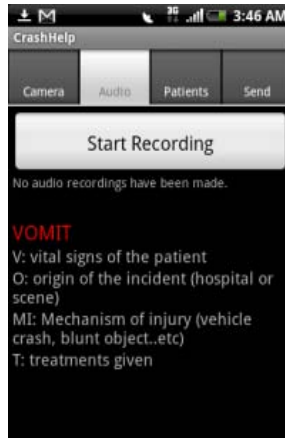
o *Camera:*

The Camera Tab allows you to capture photographs and videos of the Incident and the Patient(s) or view a Gallery of captured photographs. If Camera is not your Initial Tab, you may select it from the Tabs screen. The Camera Tab has two options: Capture or Gallery (Inset Below Left). To capture photographs of the scene, select Capture. This selection will open the camera function, which will have four options along the bottom of the screen: Capture, Video, Patient and Close (Inset Below Right).
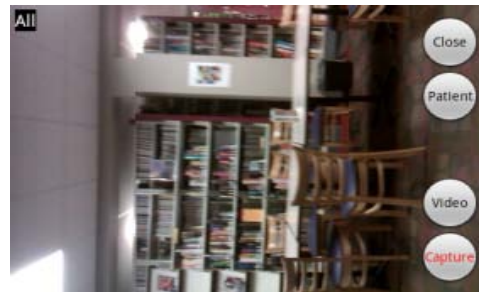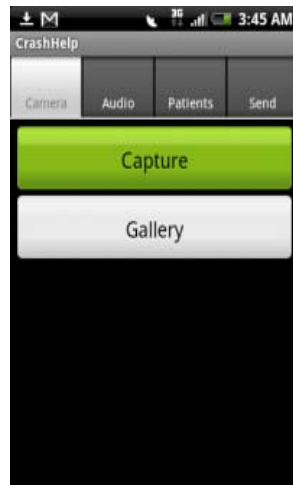
1. Capture: Take a Photo: Selecting Capture will allow you to take still photos of the incident and patients (Inset Above Left).

a. Gallery: To view photographs that have been collected select Gallery. Here you can view photos, audio, and video that you have collected at the scene. You

can check to make sure that all of this data is tagged correctly. If they are not tagged correctly you will have a chance to do this now by selecting the photo and then Tag. You also have the option of deleting photos here if they are unclear or unneeded.

2. Video: Record a Video: Selecting Video will begin video recording the incident and patients. The text on the Video button will change to Stop once you have begun recording. Film what you would like and select Stop to stop recording. Once you have finished recording you can select Tag to tag the patient of the incident by selecting New Patient or an existing patient as indicated by the name of the patient on this screen. If you need to view this video or the tags it can be seen in the Gallery. To exit the video press Done.

3. Patient: Tag a Patient: You should select Patient after you have taken a photograph using Capture or recorded a video using Video. Selecting Patient will allow you to tag the image or video for the corresponding patient. Selecting Patient will present you with three new options: Back, Tag to New Patient, or Tag to [Name of Patient you previously entered] (Inset Below).

> **a. Back**: Selecting Back will take you back to the Camera where again you can Capture, Video, Patients, or Done.

> **b**. **Tag to New Patient**: Selecting this option will allow you to tag to a patient you have not yet entered. If you have Camera as your Initial Tab you will probably select this.

> **c**. **Tag to [Name of Patient you have entered]:** Selecting this option will allow you to tag the photograph or video you have just captured to the patient you entered on the Patients screen. If you have previously entered information for a patient then they will show for a tagging option. If you have not entered patient information yet, you can select New Patient and enter their information now (To enter a New Patient's information, see Patients).

> Note: This option will only show up if you have already entered a Patient's information, likely because you have Patients selected as your Initial Tab. (For more information on Initial Tabs, see Settings)
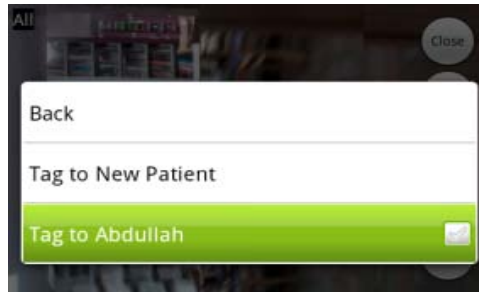
4. Close: Selecting Close will allow you to return to the Camera Tab.

- **Send Information:**
  The Send option is shown across the top of the screen. Selecting the Send tab will take you to the Send screen. Once you have completed entering all the information – Patient, Audio, Video, and Photographs – select Send to visit the Send screen. The Send screen will first ask for an Incident Number. Enter the Incident Number by clicking in the text box and typing the number via the phone keyboard. On this screen you can also select the hospital that the patient will be going to from a drop down menu (Inset Below Left). Once you have entered the incident number and selected a hospital, you can now select the Send Data button. This Send Data button will send all the information – patient, audio, video, and photographs – to the receiving hospital (Inset Below Middle). Selecting the Send button will automatically prompt for your unique pin number* in a pop-up window (Inset Below Right). To enter your pin number place the cursor in the text box and type it in using the phone's keyboard.   The pin number will validate the server for the sent data. After entering your pin number, press send to send your information to the hospital you have selected.

  *Pin numbers are distributed individually, your pin is unique to you; the pin number ties the data you enter and send to you for organizational purposes.
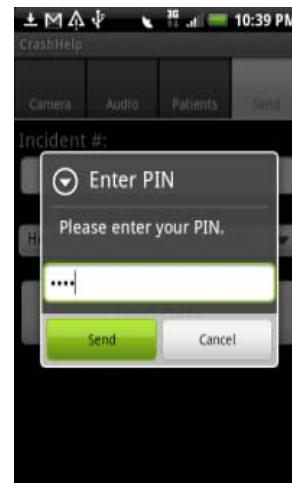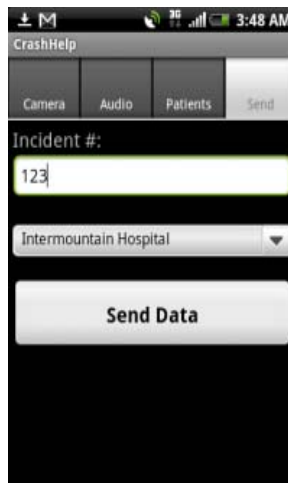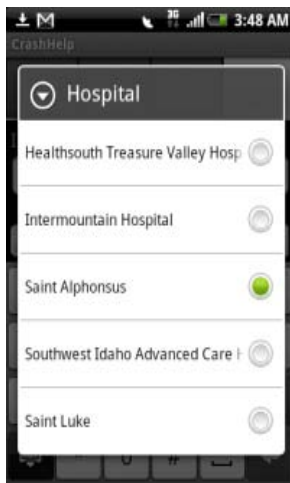
- **Confirmation:**

After entering your pin and sending the data via the Send tab, a message will appear at the bottom of the Send screen indicating the data was sent successfully. Information sent via the Send tab is encrypted (Inset Below).
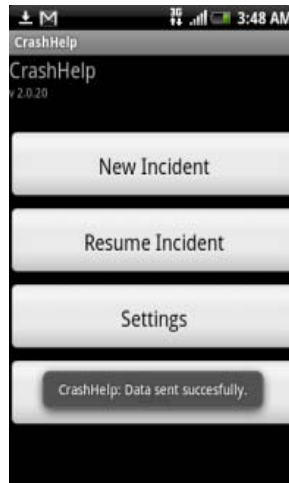

- **Resume an Existing Incident:**
  If you would like to go back to an incident you were entering before closing the application previously, you can select Resume Incident (Inset Below). You may only resume working on an incident that has not yet been sent. After choosing Resume Incident on the Main Menu, you will be able to edit information you entered previously. Incidents are encrypted 10 minutes after you begin, they will only remain on the phone for one hour.

  Warning: One hour after the incident has been created it will be deleted, *whether it was sent or not*.

  Note: If the incident has not been sent after 10 minutes, it will automatically become encrypted. Once you have sent information it becomes encrypted.
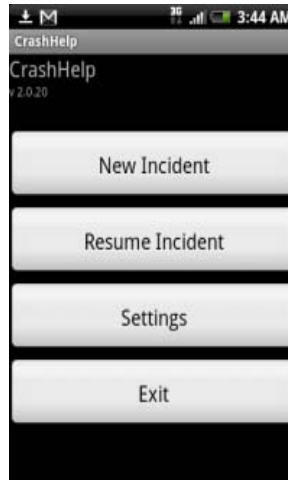
- **Settings:**
  This function gives you a drop down menu to set up your individual preferences for the application. You can choose your Initial Tab – Camera, Audio, Patients or Send. The Settings screen also offers a button to purge all incident data. This should only be done for security. The server URL is shown at the bottom of the Settings screen, there is no reason to change this (Inset Below).
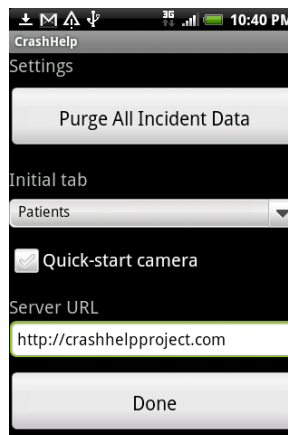
- *Initial Tab:* One of the options in the drop down menu is the Initial Tab. By default the initial tab of a new incident will be Camera. The drop down menu for the Initial Tab allows you to choose the Camera, Audio, Patients, and Send (Inset Below). To select which tab you would prefer as your Initial Tab, tap that option. Once the option has been selected a green circle will show to the right of your selection. To select a different Initial Tab simply tap that option instead. Again, your selected option will show a green circle to the right hand side. To return to the Main Menu select Done at the bottom of the page.

Technical Assistance:

- **Online:** To report a software issue or suggest improvements to CrashHelp please visit www.crashhelpproject.com and click on Technical Assistance. To report a lost or stolen phone, please visit http://184.73.240.51/ReportingBugs/BugsLossPhone.aspx, fill out the form completely, and click Submit when finished.

- **Telephone:** To leave a voice message for the Technical Support Team, please call (858) 888-9407.

- **System Administrator:** _____
                                          (Please write in the name of your SA)

  To request a password change, please contact your system administrator.

CrashHelp Website User Manual

<u>Getting Started:</u>

To view the CrashHelp webpage, please visit www.crashhelpproject.com. The CrashHelp website will provide the patient information, maps, and audio, photographs, and video sent from the CrashHelp Android Phone application. When you arrive at the website you will have three choices of drop-down menus: ambulance, hospital, and government. At the bottom of the page you will also find links for About CrashHelp, Technical Assistance, and Contact. (See Inset below.)

- **Drop-Down Menus:**

  - o *Ambulance:* Using the drop-down menu select the ambulance provider you work for. Once you have selected it from the drop-down menu, you will be prompted for a user login and password (See Inset below).
  - o *Hospital:* Using the drop-down menu select the hospital you work for. Once you have selected it from the drop-down menu, you will be prompted for a user login and password (See Inset below).

o *Government:* Using the drop-down menu select the government agency you work for. Once you have selected it from the drop-down menu, you will be prompted for a user login and password (See Inset below).

Ambulance and Hospital Users:

After logging in to the website you should see a refresh update, an option to log out, the name of your company/hospital, and two tabs – List View and Map View.

*Note: Each hospital may only see the incidents sent via CrashHelp to that specific hospital. Each ambulance provider may only see the incidents that their members sent via the CrashHelp application. Users may not see all the incidents, only those sent to or by their specific organization.

- **List View:** This will be the first thing you see on the website after logging in. From left to right you will be presented with three columns per row: Incident, Patient(s), and Media. (See Inset below).

    o *Incident* includes a number (according to chronological order) time, date, estimated time of arrival (ETA), and distance.

- *Patient(s)* will include the Patient information collected on the Android application including name, age, and gender. There is also a place where it explains how much time has elapsed since the beginning of the incident.

- *Media* will show if any photos, video, or audio are available to view or listen to. By clicking on Details you will be able to view or listen to this media.
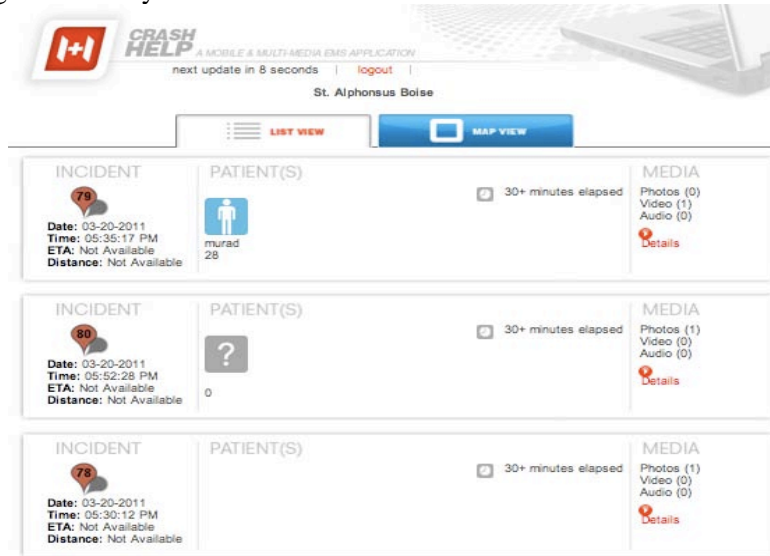

- **Map View:** This is the tab next to List View, where you can view a map with GIS information on the incidents. This view will show where incidents have occurred, where hospitals are located, etc. On the left side of the map you will see the individual incidents listed by number. Those incidents will include time, date, and how much time has elapsed. You also have the choice of selecting boxes for Video, Audio, Photo, or Alerts to view incidents that *only* include these types of information. (See Inset Below).
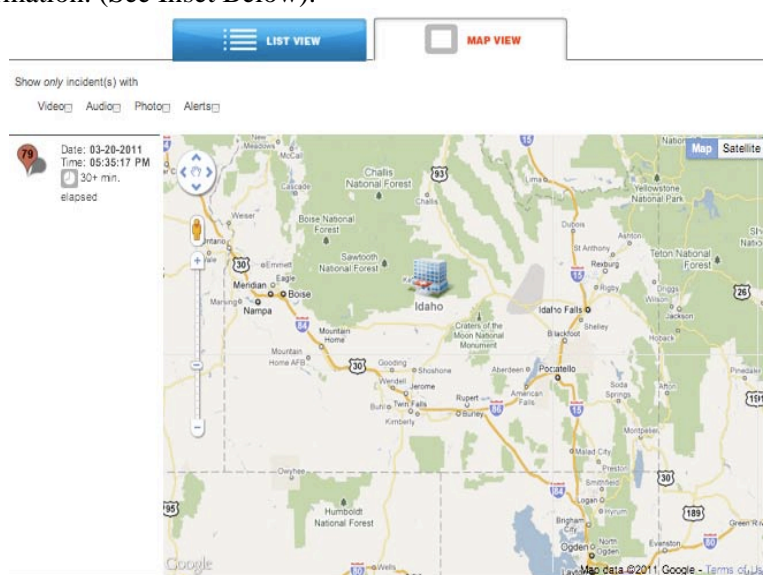
- **Log Out:** To log out, simply click on the Log Out option at the top of the page. Logging out will take you back to the front page with the drop-down menus.

- **Other:** If you want to learn more about CrashHelp, need Technical Assistance or need to Contact the CrashHelp team, you may click on the links along the bottom of the page. You can see more information about these under Links, above.
- **Links:**

  o *About CrashHelp:* Clicking About CrashHelp will provide you information about the CrashHelp project and team (See Inset below).

  o *Technical Assistance:* Clicking Technical Assistance will give you many options for getting help with technical problems you may be experiencing including: Report a Bug, Report a Broken Lost or Stolen Phone, Request a Password, Suggest Improvements, User Manual for Website, User Manual for Android Users, and a voicemail phone number for additional assistance. (See Inset and the Technical Assistance section below for more information).
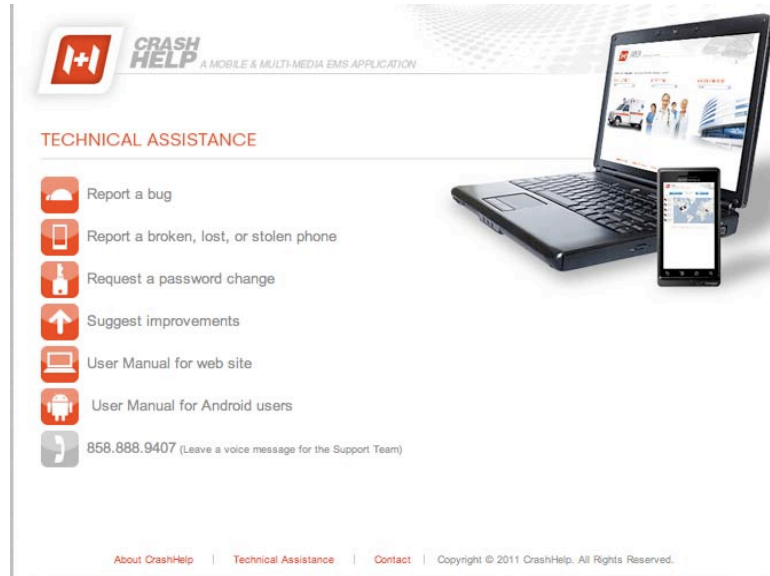
- **Technical Assistance:**

  o *Report a Bug:* to report a bug in your CrashHelp Android application click the link on the Technical Assistance page. Completely fill out the form on the page according to the instructions. When the form is completely filled out click Submit. Submitting this form will send it to the technical support team so that they may address the bug.

o *Report a Broken, Lost, or Stolen Phone:* To report a broken, lost, or stolen phone, click the link on the Technical Assistance page. Completely fill out the form on the page according to the instructions. When the form is completely filled out click Submit. Submitting this form will send an email will be sent to Verizon (to cut off the phone line), send an email to CrashHelp team for the record, and send an email to your System Administrator to report the loss of the phone (See Inset below).

o *Request a Password Change:* If you have forgotten your phone application password you need to speak with your system administrator who can issue you a new one.

o *Suggest Improvements:* To suggest improvements, click the link on the Technical Assistance page. In the technical forum here you may communicate your suggestions, questions, and comments for improvement to the CrashHelp team. Click to create a new thread describing your concerns and a team member will respond as soon as possible.

o *User Manual for Website:* To view this user manual online, click the link on the Technical Assistance page. This will take you to an electronic version of this manual.

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