The Impact of Personal Digital Assistants in Emergency Medical Services Providers' Response to Traumatic Injuries

by

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ABSTRACT

Problem Under Study: The use of personal digital assistants (PDA), such as Palm Pilots and Hand Spring Visors, is proliferating among EMS agencies. However, controlled trials concerning the efficiency and effectiveness of these devices have been lacking. One of the issues that has confounded evaluation efforts is that there are a myriad of potential applications for the devices. These include: global positioning/global information systems; references and referral material; two way digital communication; and patient information collection and retrieval, to name a few.

Objective: The purpose of this project was to compare the effectiveness of the proposed scannable paper-based/ desktop patient information system against a PDA-based/ desktop system and the previous hand written reports for issues of timeliness, accuracy, completeness and legibility of data, and inclusion or exclusion of prehospital records from the patient's hospital medical record. Also examined were the relative system costs of deployment, training and maintenance, along with user satisfaction.

Method: Convenience samples of two EMS response areas were selected to participate in the study. These two communities are similar in EMS system configurations such as level of care provided and general community configuration. Orientation and training was provided relative to the process and procedures associated with each community's respective data collection system. Community one was provided with the scannable bubble form and the associated software to scan the form into the agency's PC. Community two was assigned 16 personal data assistants (PDA), infrared capable laser printers, and the software needed for data collection with the PDA. Deployment of the new data collection software commenced after the training sessions and continued for six months. A five-member independent review panel was assembled to review each EMS patient care record. Each member of the review panel examined, rated and ranked the prehospital care record, including the narrative description for issues of completeness, legibility, essential patient information, usefulness in continuity of care or treatment, and a description of the injury event or mechanism. These questions were ranked using a modified Likert scale ranging from 1 (absent, not at all helpful) to 5 (very complete, helpful). A review form was developed for the panel to ensure consistently of scoring. All prehospital reports were blinded of patient's identification, EMS agency, provider treating the patient, location of injury incident, and hospital transported or transferred to prior to review by the panel. All data from the review panel was entered into a database and analyzed in SPSS version 11 by the project director. Cost and user satisfaction data were also added to the database. Descriptive and non-parametric testing was completed ($p = .05$).

Results: Both methods of electronic data collection, scannable bubble sheets and PDA data collection, performed better than the previous paper-based written patient contact forms in measures of completeness, legibility, patient information, care/treatment and mechanism of injury descriptions. The scannable bubble sheets and PDA systems performed similarly in all measures except legibility where the PDA excelled.

Conclusion: Both of the electronic data systems performed better than traditional paper-based record keeping for prehospital personnel. The improvements in record keeping during the prehospital phase of trauma care could have an impact on the eventual outcome of injured patients allowing for greater continuity of care. The benefit of having prehospital data available electronically in near real-time for quality improvement, research and to drive injury prevention activities is thought to be substantial.

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1. INTRODUCTION

When transportation systems fail due to environmental, engineering or human factors, Emergency Medical Service (EMS) providers serve as the last bastion of hope for the survival of the trauma victims. Most often these victims are injured in motor vehicle crashes, which is one of the leading causes for unintentional injury in the United States for all ages. As such, EMS agencies and providers are an important part of the public safety component of intelligent transportation systems and the trauma system continuum of care.

The use of personal digital assistants, such as Palm Pilots and Hand Spring Visors, is proliferating among EMS agencies. However, controlled trials concerning the efficiency and effectiveness of these devices have been lacking. One of the issues that have confounded evaluation efforts is that there are a myriad of potential applications for the devices. These include: global positioning/global information systems; references and referral material; two way digital communication; and patient information collection and retrieval, to name a few.

One of the most persistent and onerous challenges facing crash victims, EMS providers and hospital medical personnel in Montana has been the timely and accurate transmission of patient information gathered at the crash scene and in the back of the ambulance to emergency department personnel receiving the patient. The current paper-based form provided by the Montana Department of Public Health and Human Services' EMS Section is more than 25 years old and typically contains information that is of limited value to the receiving medical team, the EMS agency or the patient. Not only does the lack of timely information interrupt the continuity of care and negatively impact patient outcome, it also creates a void of information that would be useful in the ongoing refinement of transportation systems.

Recognizing this fact, the Montana EMS Section is currently in the final design phases of a scannable paper form and companion desktop software system. The deployment of this system provides an excellent opportunity for a side-by-side comparison of paper-based and personal digital assistant data collection.

1.1. Project Purpose

The purpose of this project was to compare the effectiveness of the proposed scannable paper-based/ desktop patient information system against a PDA-based/ desktop system and the previous hand written reports for issues of timeliness, accuracy, completeness and legibility of data, inclusion or exclusion of prehospital records from the patient's hospital medical record. Also examined were the relative system costs of deployment, training and maintenance, along with user satisfaction.

1.2. Research Questions

There were six null hypotheses that were asked in this project. They included:

1. The proportion of hospital charts that include prehospital trauma injuries i.e. motor vehicle crash records, will be the same between the community using the personal digital assistant and the community using the scannable paper form.

2. The mean number of errors on prehospital trauma records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

3. The cumulative mean rating for legibility on prehospital trauma injuries records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

4. The cumulative mean rating for utility of prehospital trauma injuries records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

5. The cost of the use of personal digital assistants to record prehospital patient data will be the same as that associated with scannable run forms

6. Prehospital provider satisfaction associated with use of personal digital assistants to record prehospital patient data will be the same as that associated with scannable paper run forms.

2. METHODOLOGY

2.1. Participants

A convenience sample of two EMS response areas was selected to participate in the study. These two communities are similar in EMS system configurations such as level of care provided and general community configuration. Both communities are rural with a small hospital of limited specialty capacity for immediate care and resuscitation of trauma patients. More critically injured patients are secondarily transported to Level Two trauma Centers, was located approximately the same distance from the community. Both communities expressed willingness to participate and were within a three-hour drive to the research team. Community one was located in central Montana, and Community two was located in southeast Montana.

2.2. Procedures

Project descriptions, a confirmation of willingness to participate and consent forms that provided assurances of access to EMS records were distributed and signed by both EMS agencies, the local hospitals, and the Level Two trauma hospitals in each of the communities. Orientation and training was provided relative to the process and procedures associated with each community's respective data collection system as well as deployment of equipment needed. The research team and an expert in each form of data collection conducted the training session in each community for all EMS providers that were available. Those EMS providers who could not make the training session were trained at an alternative time by their respective-training officer. Community one was provided with the scannable bubble form and the associated software to scan the form into the agency's PC. Community two was assigned 16 personal data assistants (PDA), 4 IR capable laser printers, and the software needed for data collection with the personal data assistants. Deployment of the new data collection software commenced after the training sessions and continued for six months.

Sixty days after the study period, both EMS agencies were contacted for a list of those patients treated for injuries and transported by their agency from July 1, 2002 to June 30, 2003. Patient records dating July 1, 2002 to December 31, 2002 and before the deployment of the new systems will service as baseline reports. Patient records from January 1, 2003 until June 30, 2003 was considered part of the study period.

A five-member review panel was assembled to review each EMS patient care record. This panel consisted of a two trauma surgeons, one emergency department physician, one Advanced Life Support (ALS) prehospital provider/nurse, and one Basic Life Support (BLS) prehospital provider. Each member of the review panel examined, rated and ranked the prehospital care record, including the narrative description for issues of completeness, legibility, essential patient information, usefulness in continuity of care or treatment, and a description of the injury event or mechanism. These questions were ranked using a modified Likert scale ranging from 1 (absent, not at all helpful) to 5 (very complete, helpful). A review form was developed for the panel to ensure consistently of scoring. All prehospital reports were blinded of patient's identification, EMS agency, provider treating the patient, location of injury incident, and hospital transported or transferred to prior to review by the panel. A survey of the EMTs and agency directors satisfaction with the new data collection system and demographics of the providers was conducted at the end of the project.

Inclusion criteria was all patients receiving prehospital care as a result of incidents of injuries (e.g. motor vehicle crashes) and subsequently transported to the hospital, of a copy of the EMS record could be located in the patient's hospital chart. Final analysis was of those EMS reports for injured patients that were found in the patient's hospital record. All data from the review panel was entered into a database and analyzed in SPSS version 11 by the project director. Cost and user satisfaction data were also added to the database. Descriptive and non-parametric testing was completed ($p = .05$).

2.3. Human Subject Protection

This research project was reviewed and approved by the Human Subject Institutional Review Board at Montana State University and the Billings Area Indian Health Service Human Subject Institutional Review Board. Additional approval was obtained from the individual hospital's Human Subject Institutional Review Boards.

3. RESULTS

H_{01}: The proportion of hospital charts that include prehospital motor vehicle crash records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

Table 1

Total Cases (N = 107)

Community	Baseline	Study
Community One	13	4
Community Two	52	38
Total	65	42

One hundred and thirty-eight prehospital records were received from the two communities. Of these 31 failed to meet inclusion criteria due to missing prehospital reports in the patient's hospital chart. One hundred and seven (N=107) cases were analyzed for this report. Table 1 shows the total number of prehospital records that met inclusion criteria that were collected in both the baseline and study period from each community. A non-paramedic chi-square was performed to find differences in the ratio of prehospital records included in the patient's hospital chart between the community one and community two. There was no statistical difference found (x^2 = .762, p = .414) this resulted in failure to reject the null hypothesis 1.

H_{02}: The mean number of errors on prehospital trauma records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

In comparing the scannable paper form to the PDA system for times that information was not recorded in the following area: general patient information, BLS/ALS treatment and vital signs, the review panel reported that the number of errors were similar in both communities. The review panel reported 17 errors out of 89 possible responses for community one and 130 errors out of 799 possible responses for community two. A non-parametric chi-square revealed no difference the ratio of errors between the two systems (x^2 = .042, p = .868), this resulted in failure to reject null hypothesis 2.

H_{03}: The cumulative mean rating for legibility on prehospital trauma records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

Independent *t*-tests were performed between the scannable bubble form and PDAs for completeness, legibility, patient information, care or treatment, and mechanism of injury event. However, only legibility was statistically different (t = 7.255, df 40, p < .001, CI -.5316 - .2892) between the scannable and palm based system with the digital system excelling in this category. This finding resulted in rejection of null hypothesis number 3.

H_{04}: The cumulative mean rating for utility of prehospital trauma records will be the same between the community using the personal digital assistant and the community using the scannable paper form.

The review panel's rating for utility of the prehospital record scores were examined using an independent *t*-test. This analyses of prehospital records resulted in no significant differences reported between the scannable paper form and PDAs for overall utility. This finding resulted in failure to reject null hypothesis 4.

H_{05}: The cost of the use of personal digital assistants to record prehospital patent data will be the same as that associated with scannable run forms.

Table 2 outlines the costs associated with each of the new systems. These costs include both those absorbed by the research foundation and those expended by each of the agencies associated with the project. These costs are associated with initial startup and the six-month study period.

Table 2

Costs Associated with New Systems

	Scannable Bubble Form		PDA	
	Local Agency	Research Project	Local Agency	Research Project
Form Printing	$0.00	$1,000.00	$750.00	$0.00
Hardware/Software	$0.00	$1,400.00	$0.00	$16,000.00
Personnel Time (training)	$250.00	$0.00	$250.00	$0.00
Administration	$250.00	$0.00	$250.00	$250.00
Total	$500.00	$2,400.00	$1,250.00	$16,250.00
Overall Total	$2,900.00		$17,500.00	

Based on initial and short-term costs, null hypothesis 5 rejected the hypothesis.

H_{06}: Prehospital provider satisfaction associated with the use of personal digital assistants to record prehospital patent data will be the same as that associated with scannable run forms

Eighty percent of community one and 57% of community two returned the provider survey, which contained a question about overall satisfaction when using the new system. No differences were found between community one and community two. Satisfaction was ranked at a mean of (2.2) and (2.1) respectively (Likert Scale, 1 low – 5 high). Analysis results of an independent *t*-test for satisfaction reported ($t = .213$, $df = 19$, $p = .834$) and therefore failure to reject null hypothesis 6.

4. DISCUSSION

Both methods of data collection preformed significantly better than the previous hand-written paper-based system. The two systems were rated similarly in four of five categories evaluated by the independent review panel. The PDA system proved to be superior for legibility of the prehospital record. Since the prehospital patient care report was printed directly from the PDA through an infrared port on a laser printer at the time of patient delivery the report was generated in typed textual fashion. This factor alone could potentially improve the continuity of care for the trauma patient. Although a handwritten prehospital narrative may contain all the vital information concerning individual trauma patient, the legibility of the report can influence its being perceived as valuable information to the emergency department staff at the time of arrival of the patient.

A particular note of interest in the project was the difference between the prehospital care providers in the two communities and the independent review panel in measures concerning accurateness, legibility, and completeness of the prehospital records. Community one personnel ranked the new system reports at "only acceptable" to the pre-study paper-based reports, while community two ranked the new system reports at "minimally acceptable" to the previous method of recording keeping. However, the review panel found both new systems superior in every category. The prehospital care providers' perceptions may have been based more on a comfort level than on an objective analysis of the data being gathered by the new systems.

While both communities abandoned the specific trial systems per se, community one has chosen to integrate several of the attributes and fields into the paper-based recording system. Community two, has adopted another vendor's tablet version of an electronic system. These post study decisions suggest that while neither system was immensely popular among individual prehospital providers, there is some recognition that there were positive attributes to both of the systems, indicating that the dislike may have related more specifically to form rather than function. It also speaks to the reality that prehospital data collection will continue to migrate towards digital solutions in the future.

4.1. Limitations

There are two key limitations to this study. First, due to ongoing challenges pertaining to issues of patient confidentiality and subsequent delays from various IRB, the project evolved more slowly than had been anticipated. Whereas a full year's worth of data had been projected at the project's outset, the actual study period was reduced to six months. These delays were at the core of both of the studies primary limitations. The first of these is the small sample size. While we are confident that all major effects are fairly reported in the report some smaller nuances between the paper-based system, the scannable bubble form and the PDA system may not be apparent due to Type II error. The unusually low number of transports by community one was unexplainable by the agency. Issues such as a decreased number of tourists during the study period due to fire dangers in the State of Montana during the summer could have had some bearing on this small sample size.

The second primary limitation is one of familiarity and comfort level by the individual EMS providers. Personnel in both communities ranked their systems low for overall satisfaction. There was an unkown, but presumably substantial learning curve associated with either system and proficiency and an overall comfort level may not have been attainable during the shortened study period.

5. CONCLUSIONS

Both forms of electronic data collection (scannable and PDA) resulted in superior patient care reporting when evaluated by an independent panel of experts. The PDA was rated highly by the panel in the area of legibility.

While user satisfaction was similarly low for both systems this appears to have been a function of a shortened study time-frame that did not allow for the users to attain a level of sufficient familiarity and comfort with the respective system. However, the fact that both communities choose to retain portions of or substitute a similar system indicate that they recognize some of the benefits associated with an digital data collection system. Without the opportunities to try the systems that were provided by this research project, the transition to digital formats may not have occurred.

Additional research is warranted to confirm the findings of this project on a larger sample and among a wider variety of rural EMS agencies. The search for an acceptable balance between the "learning curve", user satisfaction and the improved output afforded by digital recordkeeping needs to be attained.

6. RECOMMENDATIONS

Additional research on real-time patient record keeping using PDA, tablet, laptop or other emerging technologies needs to be conducted in rural areas of the U.S. While this research project was narrowly focused, the impact of PDA technology on the collection and transmittal of patient information the potential benefits and applications are numerous. These include improved responses using GPS/GIS systems, reference databases, and electronic transmission of scene data such as photos and patient vital signs.