

# Impact of implementing an EMR on physical exam documentation by ambulance personnel

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## Keywords

Documentation, quality improvement, emergency medical technicians, universities, emergency medical services, electronic health records

## Summary

**Objective:** Georgetown University has a student run Emergency Medical Services (EMS) organization with over 100 emergency medical technicians (EMTs). We set out to determine whether implementing an electronic patient care report (ePCR) system was associated with improved physical exam documentation.

**Methods:** This study evaluated documentation of the physical exam on prehospital patient care reports (PCRs). An ePCR system was implemented. ePCR documentation was compared to that of the previously used paper PCRs. This study looked retrospectively at 154 PCRs. 77 were hand written PCRs from before the electronic system. The PCRs involved chief complaints that were primarily respiratory, neurologic, or both. 77 ePCRs of matching chief complaint categories were used for comparison. Each chart was reviewed for completion of certain physical exam findings. The mean percentage of documented components from the ePCRs was compared to that of the hand written PCRs. The null hypothesis was that the absolute increase in the mean was not more than 20 percent. The two exclusion criteria were PCRs completed by study investigators after the design of the project and partially or completely missing PCRs.

**Results:** The absolute increase in mean physical exam component documentation was 36% (95% CI = 29–43%). A weighted kappa of 0.894 showed very good agreement between chart reviewers.

**Conclusions:** This study rejected the null hypothesis that the ePCR system was associated with a mean increase of no more than 20%. It observed increase in physical exam documentation. Limitations of this study included the inability to determine whether documentation of physical exam findings reflected performance of the physical exam, and what components of the ePCR system bundle were responsible for the increase in physical exam component documentation.

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## 1. Background

According to the National Collegiate Emergency Medical Services (EMS) Foundation there are more than 200 registered collegiate basic life support (BLS) EMS organizations [1]. The nature of their student membership predisposes them to having relatively inexperienced emergency medical technicians (EMT) with a high rate of turnover. As protocol driven organizations, EMS groups require quality improvement (QI) programs to increase the procedural adherence of their providers [2, 3]. One particular area of this quality improvement is in the providers' documentation. Lack of physical exam documentation by ambulance personnel has been associated with increased in hospital mortality [4]. Although no industry norms exist for completion of physical exam documentation, a study on documentation by BLS and advanced life support (ALS) ambulance personnel demonstrated a failure to document vital signs 17–19% of the time [5]. A large proportion of research dealing with improved documentation uses personal feedback of the medical director to individual providers [2, 6, 7]. That quality improvement strategy may be less than ideal in the collegiate population.

Since 1982, Georgetown University has had a student run BLS EMS organization. It currently consists of over one hundred active members, all undergraduate students with EMT-B certification. EMTs document care provided in the field on a Patient Care Report (PCR). The information they record affects the patient's destination within the local EMS system and serves as part of the patient's medical record. Chart review had revealed significant deficiencies and inconsistencies in the manner that the physical exam was being documented. In the absence of universal observation of the provision of care by the EMTs, the chart's documentation must serve as its proxy. Four months prior to the change in the charting system, the organization's membership was notified once both in writing and verbally of certain required physical exam components for chief complaints involving particular organ systems. This quality improvement effort focused on chief complaints involving the respiratory system and neurologic system. Respiratory chief complaints required documentation of the respiratory rate, auscultation, visual appearance of the work of breathing, and quality of speech. Neurologic chief complaints required documentation of the Glasgow Coma Scale (GCS), pupillary exam, motor strength, and sensation. Prior to this study, a pilot sample of 50 PCRs demonstrated a mean completion rate for these elements of 54% with a 95% CI of (46%–62%). The organization later switched from a hand written PCR system to an ePCR system in order to utilize a system that is compatible with the National EMS Information System and improve its QI process.

When compared to a paper PCR system, ePCR systems have the potential to provide a much more dynamic documentation platform [8, 9]. This includes customizable prompts by chief complaint, fields that require completion prior to signing, and automatic quality assurance triggers based on predetermined criteria, such as reported protocol violations, equipment malfunctions, or complaint classes that are being tracked. Prompts have been shown to increase documentation in the prehospital environment [10]. In addition, ePCRs should allow for much more robust quality assurance (QA)/QI analysis. Crew members and supervisors can initiate QA flags, which automatically notify the PCR-writer of any issues or missing criteria. Electronic storage of documents allows charts to be sorted and grouped based on a variety of criteria, such as complaint class, physical exam findings, transport decisions and interventions. The electronic platform is flexible, allowing EMS organizations to add or remove prompts for important criteria, and create dynamic PCRs which prompt for different criteria based on specific complaints; ePCR systems have however been shown to increase call length [11]. Whether or not all of these features lead to better documentation of the patient record remains to be definitively demonstrated in the literature.

## 2. Objectives

The study aimed to assess whether the implementation of an ePCR system in a collegiate, all volunteer EMS organization was associated with an improvement in physical exam documentation.

### 3. Methods

#### 3.1. Study Design

This study involved a retrospective PCR review. It primarily assessed whether there was a change in the documentation of certain elements of the physical exam when utilizing an ePCR system as compared to a hand written PCR system. PCRs were selected in a consecutive manner based on chief complaint.

#### 3.2. Population and Setting

This study was conducted in a collegiate volunteer BLS rescue squad. The squad has two BLS ambulances that respond to medical emergencies on and near the university's campus. The ambulance is dispatched by a campus public safety dispatch center. It runs approximately 1,000 calls annually. All of the subjects were undergraduate students with National Registry of Emergency Medical Technicians (NREMT)-Basic certification. The inclusion criteria were charts with certain chief complaints completed by members of the rescue squad during a certain time period. The two exclusion criteria included PCRs authored by study investigators after the study's creation and PCRs that could not be located.

After 28 years of using paper PCRs, in June, 2010 the organization began using the ePCR system, emsCharts (emsCharts, Pittsburgh, PA). The paper PCR system did have certain fields demarcated for completion such as respiratory rate, pupillary exam, and lung auscultation. However, the majority of the paper PCR involved freehand narration.

A tablet computer was obtained for each of the organization's ambulances to complete the ePCRs. emsCharts is a proprietary software program designed for out-of-hospital patient care documentation. It has several customizable features. Several of the studied physical exam components were formatted as drop down selections or fill in the blank fields. The ePCR had prompts for lung sounds, respiratory effort and rate, GCS, pupillary response, sensation, and motor function. None of these fields required completion for the ePCR to be signed by the EMT.

The program also allowed for automated quality assurance criteria that forwarded particular charts to the administrator for further review. These criteria centered on reporting broader issues such as protocol violations and equipment malfunctions. Although possible with the software, none of the physical exam criteria examined in this study were designated to flag a chart for QA review.

Another feature of emsCharts was the ability to pre-load prompts based on a specific chief complaint. Complaints such as cardiac arrest or fall were programmed to automatically generate a specific set of fields. These fields did not contain or reiterate any of the physical exam points that this study examined.

The EMT typically begins completing the ePCR during transportation, after assessing the patient. Quantitative values such as blood pressure are entered in real time. It is completed either while waiting to triage the patient in the emergency department (ED) or after transferring care to emergency department personnel. Information is initially inputted into the tablet hard drive. The information is uploaded to the emsCharts website from the ambulance office and a printed copy of the PCR is carried to the ED. emsCharts does not have any interoperability with Georgetown University Hospital's EMR. Organizational policy requires a printed copy of the PCR to be left at the ED within one hour of transfer of care.

#### 3.3. Experimental Protocol

Data were collected in a retrospective manner. The preintervention dataset included the same number of PCRs as that of the postintervention dataset and was obtained by moving in reverse chronological order in a consecutive manner from the date of the electronic PCR's launch. The PCRs were from December 2009 through May 2010. The ePCRs were from July 2010 through December 2010. Members of the organization were aware that a study involving documentation was planned, but they were not aware of the study design.

The rescue squad organizes charts by presenting problem, using a predefined list of presenting problems. Presenting problems are more focused than chief complaints, but more varied than the description of a single organ system. For this study, three categories of PCRs were defined and analyzed, based on the a priori inclusion of certain presenting problems. The charts were reviewed separately based on their category. Each category assessed physical exam components important to its type of complaint. The first category consisted of PCRs with presenting problems that primarily addressed respiratory dysfunction: airway obstruction, allergic reaction, respiratory arrest, respiratory distress, and chest pain. These charts were assessed for documentation of the respiratory rate, visual appearance, quality of speech, and auscultation.

The second category of PCRs contained presenting problems that primarily addressed neurologic dysfunction: cerebrovascular accident (CVA), headache, behavior, and substance abuse. These charts were assessed for documentation of GCS, pupillary exam, strength, and sensation.

The third category included PCRs with presenting problems that addressed both systems. These presenting problems included cardiac arrest and gunshot wound (GSW). Each of these was assessed for all 8 components.

PCRs with the presenting problem “illness” with a chief complaint involving the respiratory system or the thorax were placed in the first category. Those with a chief complaint involving the central nervous system were placed in the second category. Those with a chief complaint or list of chief complaints that included both the central nervous system and the respiratory system or thorax were placed in the third category.

PCRs authored by study investigators after the date of the project’s inception were excluded. Two investigators independently evaluated each PCR. They were blinded to the chief complaint, date of service, patient demographic information, and completing EMT’s identity. Each PCR was assessed for the percentage of the studied aspects of the physical exam documented. The percentage was the total number of physical exam features mentioned in the PCR out of the 4 or 8 features required for that PCR’s presenting problem category. As this project focused on documentation of physical exam components based on organizational requirements, not comparing the documentation between organ systems, the percentages for the three chart types were weighed and treated the same, not analyzed separately as subgroups.

### 3.4. Primary Outcome

The mean completion percentage of the pre intervention (hand written) PCRs was compared to that of the post intervention (electronic) ePCRs to assess if there was an absolute increase in the mean completion percentage by at least 20%. A kappa measure of agreement between the two scoring investigators was calculated. The increase of 20% mean completion percentage was chosen as the researchers believed that this magnitude would both be a significant difference from a quality improvement standpoint and could be powered for, using the available number of PCRs for the study.

### 3.5. Study Power

The study was powered to detect relative effect size of 0.4, or an absolute change of 20% from the previously calculated mean completion rate of the population. For an alpha value of 0.05 and a power of 0.8, the study required a total sample size of 150. Power calculation was determined using G\*Power 3.1.2 [12]. Data analysis was performed using Microsoft Excel 12.2.4 (Redmond, WA, USA), and Minitab 16.1 Statistical Software (State College, PA, USA) was used to execute unpaired t tests of the results. Minitab 16.1 was also utilized to calculate t tests and chi squared analyses of the two groups’ background characteristics.

## 4. Results

A total of 154 charts were included. There were 77 paper PCRs and 77 ePCRs selected based on the chief complaint’s major organ system. Fifty-nine PCRs in each group had neurologic chief complaints, seventeen PCRs in each group had respiratory chief complaints, and one PCR in each group involved both organ systems.

During the process of identifying PCRs chronologically, four neurologic PCRs were excluded because the records could not be located. One neurologic ePCR was excluded because it was completed on paper secondary to lack of availability of the laptop computer. One PCR and 24 ePCRs were excluded because a study investigator had authored them after the date of the study's inception. One additional neurologic PCR was excluded because it involved a mutual aid call that was primarily run by a different provider organization.

Several background characteristics were compared between the paper PCRs and ePCRs to determine whether the patient groups were different in terms of chief complaints, patient history and physical exam components (► Table 1). Of the 35 compared characteristics, patient age, dizziness/lightheaded, syncope/near syncope, and advance life support (ALS) activation were statistically different. The analysis revealed patients in the paper PCR group were older, less likely to present with the chief complaint of dizziness/light headed, or syncope/near syncope, and more likely to result in an ALS activation. Overall, there was a larger mean completion of the selected physical exam components in the ePCR group. Mean completion of the required physical exam components on the paper PCRs was 43% and 79% for the ePCRs, for an absolute increase in the mean completion of 36% (95% CI = 29–43%).

## 5. Discussion

This study showed an association with the use of an ePCR system and improved documentation of several physical exam components. The organization's medical director had previously identified these studied elements as targets for quality improvement. As the medical director cannot observe the performance of the physical exam on all runs, documentation served as a proxy for completion of the physical exam. The literature has documented several unintended consequences of electronic medical records (EMR), including entry errors and adverse events [13]. Computerized order entry, interruption while caring for multiple patients, and the need to navigate through multiple screens were identified factors for these errors, which do not apply to this ePCR. However, the potential risk of cognitive overload from data entry fields was present [13]. The PCR had 9 physical exam data fields to complete and the ePCR had 18. Although no data were collected on this adverse effect, we do not believe this created an excessive burden to ambulance personnel. Alert fatigue is also a recognized concern when implementing EMRs [14]. The organization's ePCR was not set up to utilize alert messages.

To our knowledge, this is the first study published looking at the documentation improvements of switching to an ePCR system for ambulance personnel, and it is the only study that has looked at documentation of a collegiate EMS organization. A qualitative study recently indicated EMS medical directors believe ePCRs will improve their quality assurance process. The major concerns that existed with their adoption were the fear of lengthened documentation times, difficulty integrating with local hospital EMR's, and lack of funding [15]. Several studies have previously looked at documentation by ambulance personnel during the implementation of a quality improvement initiative with chart review and direct feedback [6, 7]. They demonstrated that these efforts led to significant improvements in several areas of patient care documentation. Although collegiate EMS organizations are composed of a unique type of prehospital care provider, the organizations themselves are not rare. With over 200 collegiate EMS organizations, they compose a significant population of providers with common challenges. Without the intention of endorsing a particular ePCR product, the results of this study give the organizations' medical directors a tool to address lack of standardization of physical exam performance and inexperience in provider groups with high membership turnover.

This study has several limitations. Previous studies have indicated poor documentation is associated with inferior patient care. However, only some of the physical exam elements chosen for this study have been shown to affect patient mortality [4]. Given the low annual call volume and low rate of hospital admission for the rescue squad's patients, we were unable to power for associations between documentation and patient centered outcomes. Several of the baseline characteristics of the two patient groups were statistically different. The mean age difference between 26 years in the paper PCR group and 21 years in the ePCR group was not clinically significant. Given the available list of chief complaints, this conclusion was likely also true for the dizziness/light headed and syncope/near syncope characteristics.



The difference in the number of ALS activations was both statistically and potentially clinically significant. It suggests that overall the patients in the paper PCR group had a higher level of acuity than the ePCR group. Higher acuity patients often require more intensive care during transport. This may have altered the EMTs' workflow, resulting in the documentation of a larger portion of the ePCR after the call's completion. Whether patients who appeared to be more ill would receive a more or less thorough exam and documentation remains to be determined.

There were no significant differences in call volume or staffing between the two study time periods. Both the PCRs and the ePCRs underwent quality assurance review for the same data elements in parallel to this study. The ePCR system however, facilitated a more expedited feedback process, when compared to the annual one for the PCRs. This change may have influenced documentation patterns for the ePCRs. It is possible that the new system initially resulted in an increased attention to documentation by the providers. However, we do not believe this effect would have persisted over the six months of ePCR data collection.

A major future challenge is preventing the organization's leadership from relying solely on the ePCR system as a substitute for a robust quality assurance program.

This study leaves many questions for future exploration. The results cannot predict whether these associations are generalizable to many or all of the proprietary ePCR systems. The researchers also acknowledge that differences in crew configuration, provider experience, and level of provider training vary wildly. As a result, these findings may not be extrapolated to other provider groups such as community volunteer or career municipal organizations.

## 6. Conclusions

This study gives collegiate and perhaps other volunteer EMS organizations reason to consider switching from a paper to an ePCR system. It showed a significant improvement in several elements of the patient care physical exam documentation following implementation of an ePCR system. Given prior research on ambulance personnel documentation, this may represent an improvement in patient care [4]. These findings may allow collegiate EMS organizations to improve physical exam documentation.

## Clinical Relevance Statement

This research demonstrated an association between the implementation of an ePCR system and improved documentation of the physical exam. Documentation is the best routine proxy for performance of the physical exam in the field. Improving completion of the physical exam is both challenging and necessary for organizations composed of providers with limited experience.

### Conflicts of Interest

The authors declare no conflicts of interest in the study. The study looks at a particular electronic patient care report system, but none of the researchers have any financial disclosures to make in regards to the company that markets the particular product. This project received no grant support, and was not presented at any conferences or proceedings.

### Protection of Human and Animal Subjects

This study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects. It was approved by the Georgetown University Hospital institutional review board (IRB). The approval number was GU IRB 2010–631. The need for written consent was waived by the IRB.

**Table 1** Patient history and physical exam components.

Characteristic	Paper PCRs	No. of Paper PCRs without data element	ePCRs	No. of ePCRs without data element	Absolute difference (95% CI)	Chi-Square	p value
Age (mean $\pm$ SD) – yr	26.4 $\pm$ 16.5	1	21.2 $\pm$ 7.8	0	5.21 (1.06, 9.37)	0.935	0.014
Male gender – no. (%)	41 (53.2)	0	35 (45.5)	0			0.334
Heart rate (mean $\pm$ SD) – bpm	93.1 $\pm$ 19.8	4	92.5 $\pm$ 20.2	0	0.55 (-5.90, 7.00)		0.866
Respiratory rate (mean $\pm$ SD) – bpm	16.4 $\pm$ 5.9	7	15.2 $\pm$ 3.4	0	1.19 (-0.41, 2.79)		0.144
Pulse oximetry (mean $\pm$ SD) – SpO <sub>2</sub> %	96.9 $\pm$ 2.8	6	97.1 $\pm$ 2.2	4	-0.24 (-1.07, 0.59)		0.573
GCS (mean $\pm$ SD)	12.7 $\pm$ 1.8	68	13.5 $\pm$ 2.7	0	-0.87 (-2.34, 0.61)		0.224
Eye (mean $\pm$ SD)	-	77	3.6 $\pm$ 0.7	0	-		-
Verbal (mean $\pm$ SD)	-	77	4.2 $\pm$ 1.2	0	-		-
Motor (mean $\pm$ SD)	-	77	5.6 $\pm$ 1.0	0	-		-
Alcohol intoxication by history – no. (%)	33 (49.4)		38 (49.4)			0.65	0.419
Focal neurologic deficit – no. (%)	13 (16.9)		8 (10.4)			1.38	0.240
Respiratory complaints – no. (%)	17 (22.1)		17 (22.1)			0.00	1.000
Neurologic complaints – no. (%)	59 (76.7)		59 (76.7)			0.00	1.000
Respiratory and neurologic complaints – no. (%)	1 (1.3)		1 (1.3)			0.00	1.000

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