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Research and Applications

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# Implementation of electronic charting is not associated with significant change in physician productivity in an academic emergency department

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## ABSTRACT

**Objectives:** To compare physician productivity and billing before and after implementation of electronic charting in an academic emergency department (ED).

**Materials and methods:** This retrospective, blinded, observational study compared the 6 months pre-implementation (January to June 2012) with the 6 months post-implementation 1 year later (January to June 2013). Thirty-one ED physicians were recruited, with each physician acting as his/her own control in a before-after design. Productivity was measured via total number of encounters and "productivity index" defined as worked relative value units divided by the clinical full-time equivalent. Values for charges, encounters, and productivity index were determined during each study period and separately for procedures, observational stays, and critical care.

**Results:** No differences were found for total productivity index per month (758 [623-876] pre-group vs. 756 [673-886] post-group; $P = 0.30$). There was, however, a 9% decrease in total encounters per month (138 [101-163] pre-group vs. 125 [99-159] post-group; $P = 0.01$). Significant decreases were seen across all observation stay categories. Conversely, significant increases were seen across all critical care categories. There was no difference in total charges per month.

**Discussion:** This is one of few studies to demonstrate minimal disruption in physician productivity after transitioning to electronic documentation. The reasons for these findings are likely multi-factorial.

**Conclusion:** In this study, implementation of electronic charting was not associated with decreases in productivity or billing for total ED care, but may be associated with increases for critical care and decreases for observational stays.

**Key words**: electronic health records, efficiency, organizational, emergency service, hospital/organization & administration, emergency service, hospital/economics, hospital information systems/utilization

## BACKGROUND AND SIGNIFICANCE

Electronic health records (EHRs) have been touted as a way to reduce medical error, improve quality of care, and increase provider efficiency [1–5]. The Institute of Medicine supports the use of health information technology in Emergency Departments (EDs) to improve patient flow and patient safety [6]. Despite this backing, adoption of fully functional ED information systems (EDIS) has been slow over the past decade [7]. However, as part of the American Recovery and Reinvestment Act in 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act

provides $19 billion in incentives to hospitals and physicians who demonstrate "meaningful use" of EHRs. While there has been a steady increase in the number of physicians utilizing EHRs, the real world impact of EHRs on healthcare delivery is not fully understood as there is a shortage of research particularly in the ED setting [8, 9].

The current literature, while limited, has primarily focused on efficiency and patient flow metrics associated with EHR implementation in the ED [4, 7]. Additionally, much of the available literature contains some significant limitations as many institutions do not have an enterprise EHR which includes a fully integrated EDIS. Aside from EPIC© (Verona, WI, USA) and Cerner© (Kansas City, MO, USA) enterprise EHRs, many institutions have a hybrid system which includes either a home grown or commercial EDIS that allows for tracking board functionality and electronic documentation, but is not fully integrated into the hospital inpatient EHR. According to a 2015 study using the ED component of the "National Hospital Ambulatory Care Survey," only ~30% of EDs had health information technology systems with advanced IT capability including decision support and ordering components such as electronic transmission of prescriptions to a pharmacy [10]. The literature thus far has primarily focused on electronic whiteboards and computerized physician order entry (CPOE), or have been qualitative in design [11, 12].

The effect of EHR implementation, specifically in regards to electronic documentation, on ED physician productivity is not adequately understood due to limited number of studies primarily conducted in the inpatient and ambulatory settings [3, 5, 6]. Per a 2015 systematic review, there is mixed data on the impact of EHR implementation on documentation time, with some studies showing increased documentation time and others showing no change [13]. Studies specifically evaluating documentation time pre- and post-implementation of electronic charting is limited in the ED setting. This is unfortunate given that physician productivity is vitally important to a functional and efficient ED where there is often little or no control over other factors affecting patient flow such as the acuity level of patients, interruptions, and crowding [9, 14]. Additionally, concerns have been recently raised that the usage of an electronic charting method may result in "upcoding" and increased billing [15, 16]. Moreover, there is literature to suggest that electronic charting is more time intensive than paper charting in the ED [17]. Thus, there are many unanswered questions about how electronic documentation will affect physician productivity and billing in the ED.

## OBJECTIVE

To our knowledge, there are limited studies that quantitatively examine the effect of implementation of electronic charting on emergency physician productivity. In our academic ED, attending productivity is defined as the total number of patient encounters over a given time as well as the attending's work relative value units divided by the allotted time they are required to work clinically. This is in line with a national survey evaluating the assessment of faculty productivity by academic Department Chairs [18]. The purpose of this study was to compare physician productivity and billing pre- and post-implementation of an electronic charting in an academic ED setting. Assuming external factors such as patient acuity, physician interruptions, and crowding are constant before and after implementation, we hypothesized that there would not be a significant difference in productivity and billing before and after the transition to electronic charting.

## MATERIALS AND METHODS

### Study design

This is a retrospective, blinded, observational study comparing physician productivity and billing during the period immediately before and after the ED transition to electronic charting from standard paper charting, which occurred on June 13, 2012. The product implemented was Cerner Powernote ED© (Cerner, Kansas City, MO, USA). The 6 months prior to implementation of electronic charting (January 2012 to June 2012) was compared with the equivalent 6-month period 1 year later (January 2013 to June 2013). The study design was approved by our Institutional Review Board (IRB) as exempt status, and consent was waived by the IRB.

### Study setting and population

Thirty-one ED physicians were recruited, with each physician acting as his or her own control in a before-after design. Participants were faculty physicians who worked in the Adult, Pediatric, and Fast-Track sections of an urban academic ED with at least 6 months of productivity data collection before and after implementation of electronic charting. No additional participant contact took place outside of the routine data collection on physician productivity. Participants were identified and enrolled on a monthly basis via retrospective review of data. Faculty physicians must have worked at least 6 months before and after implementation of the electronic charting to be included in the study.

### Key outcome measures

The primary outcome was attending productivity, measured using 2 parameters for each individual: (i) total number of encounters and (ii) the "productivity index" defined as worked relative value units divided by the clinical full-time equivalent (wRVU/cFTE). Additionally, a secondary outcome measure of charges was obtained, and defined as a compilation of bills sent to all patients seen by each individual physician. Data for encounters, productivity index, and charges were determined for the total care of patients during each study period. Data specific for procedures, observational stays, and critical care were also separately studied as these individual components may have various effects on the primary outcomes. Data points were collected on a monthly basis.

### Primary data analysis

Data were entered into SPSS© (IBM) and the productivity and charge measures were compared between study groups using descriptive statistics and a Wilcoxon rank sum analysis.

## RESULTS

### Characteristics of study subjects

Demographic characteristics of the 31 ED physicians included in the study are shown in Table 1. Of the 31 ED physicians in the study, 61% were male, 64% were less than 50 years of age, and 52% were Assistant Professors. Many of the physicians worked in various areas of the ED including the Adult, Pediatric, and Fast-Track sections. Thirty-five percent of the physicians shared a portion of their cFTE at an affiliated hospital, which is a private rather than academic setting and which shares the same EHR system as the primary site.

We continued to follow the trends in these variables during the entire 18 months encompassed by the 2 study periods. The 6 months

**Table 1.** Demographics

| Physicians ($n = 31$) | *N* (%) |
|---|---|
| Sex | |
| Female | 12 (39) |
| Male | 19 (61) |
| Age | |
| <40 | 6 (19) |
| 40–50 | 14 (45) |
| 50–60 | 4 (13) |
| >60 | 7 (23) |
| Position | |
| Professor | 8 (26) |
| Associate Professor | 7 (23) |
| Assistant Professor | 16 (52) |
| Clinical setting | |
| Adult ED | 23 |
| Pediatric ED | 18 |
| Fast-track | 21 |
| cFTE | |
| <0.25 | 5 |
| 0.25–0.44 | 10 |
| 0.45–0.64 | 10 |
| >0.65 | 6 |

in between the 2 study periods showed some downtrends that may be due to the presence of new residents or the early learning curve in the EHR. Figure 1 shows the actual monthly trend over the entire study period in total charges.

### Main results

Pre-post comparison of productivity and charges for total care, procedures, observation stays, and critical care between the pre-implementation time period and the post-implementation time period (January to June 2012 vs January to June 2013) may be found in Table 2. Of note, while data are reported as aggregate in the table, all analyses were completed comparing results for each subject as their own control. For instance, for change in total productivity (758 vs 756 in Table 2), when each subject's total productivity was compared with their own baseline in a pre-post design, 55% decreased and 45% increased. The significance represents whether there was any directionality in the results using a Wilcoxon rank sum test. The *P*-value reported is a non-parametric significance indicating the presence of directionality of the results.

There were no significant differences for total charges or productivity index between pre- and post-implementation groups. There was a significant decrease in total number of encounters ($P = 0.01$). Additionally, decreases were seen across all observation categories, specifically a 45% decrease in observation charges ($P < 0.01$), a 60% decrease in observation encounters ($P < 0.01$), and a 52% decrease in observation productivity index ($P < 0.01$). There was also an across the board increase in critical care, specifically a 71% increase in critical care charges ($P < 0.01$), 114% increase in critical care encounters ($P < 0.01$), and a 103% increase in critical care productivity index ($P < 0.01$).

## DISCUSSION

This study provides new quantitative evidence on productivity and charges before and after the transition to electronic charting in an academic ED. To our knowledge, this one of few studies in the emergency medicine literature that such a transition has been evaluated. Interestingly, we found there was no significant difference in total productivity or billing before or after implementation after a 6 month period. This is contrary to published studies where there is typically a 10–20% decrease in productivity [21–24]. However, one ED based pilot study in 2012 found similar results to our study, demonstrating no significant disruption in physician productivity or charges when transitioning from paper to electronic charting [25]. The stepwise approach used at our institution for implementation of a fully functional EDIS may explain the lack of change in productivity and billing observed after the transition from paper to electronic ED notes. Prior to the initiation of electronic charting at our institution, there was an extended period where CPOE as well as an inpatient EHR had been established and already in use by physicians. A speech-to-text dictation method was also implemented concurrently with electronic documentation, which may have contributed to the ease at which physicians adapted to the new charting process. Nevertheless, it should be noted that the use of such a dictation system in one study did not decrease the amount of physician time spent charting [20].

Of note, there was an interesting fluctuation in activity in the 6-month time frame between the 2 study periods. During this time period, there were overall drops in charges, encounters, and productivity index that could be attributed to a new resident group, time of year or a long learning curve in the use of the EHR. Interestingly, a recent study by Yun et al. [26] concluded that attending documentation prevented down-coding of resident charts only 3% of the time. Although these results were not significant, they suggest the attending impact on electronic charting may be minimal at an academic institution and support our hypothesis that a new resident group impacted the decrease in charges and productivity immediately after implementation. The above factors were pointed out in Figure 1 which trends the entire study period. This decrease in charges and productivity stabilized after 4–6 months and is why we believe that using the two 6-month periods at the beginning of each year is a more appropriate comparison. In addition, we believe evaluating physician productivity 6 months after the implementation allows for more accurate evaluation of the long term effects of transitioning to electronic charting, rather than the immediate short term.

Similar to other recent reports, we also found a significant increase in critical care productivity and billing [15, 16]. We believe that such results are likely multi-factorial and related to better documentation of the critical care services already being provided. It is unlikely that our patient population or the severity of disease treated over the course of this study changed significantly, although this was not specifically examined. Rather, we suspect the increase in critical care billing is due to improved documentation practices between paper charting and electronic charting. In the paper charting method, a single sheet of double-sided paper with a generic template was used for all ED encounters. Conversely, in electronic charting, providers have access to templated notes for various presenting complaints, which may allow for more detailed documentation. As it applies for critical care encounters, the paper method only had enough physical space for the physicians to note the critical care time. The coders were expected to review the note and surmise why the patient required critical care. In electronic charting, however, there are specific areas where providers are able to narrate their rationale and the critical care provided. We believe this richer narrative allows for increased critical care capture under the new system. Critics of electronic documentation might argue that it facilitates

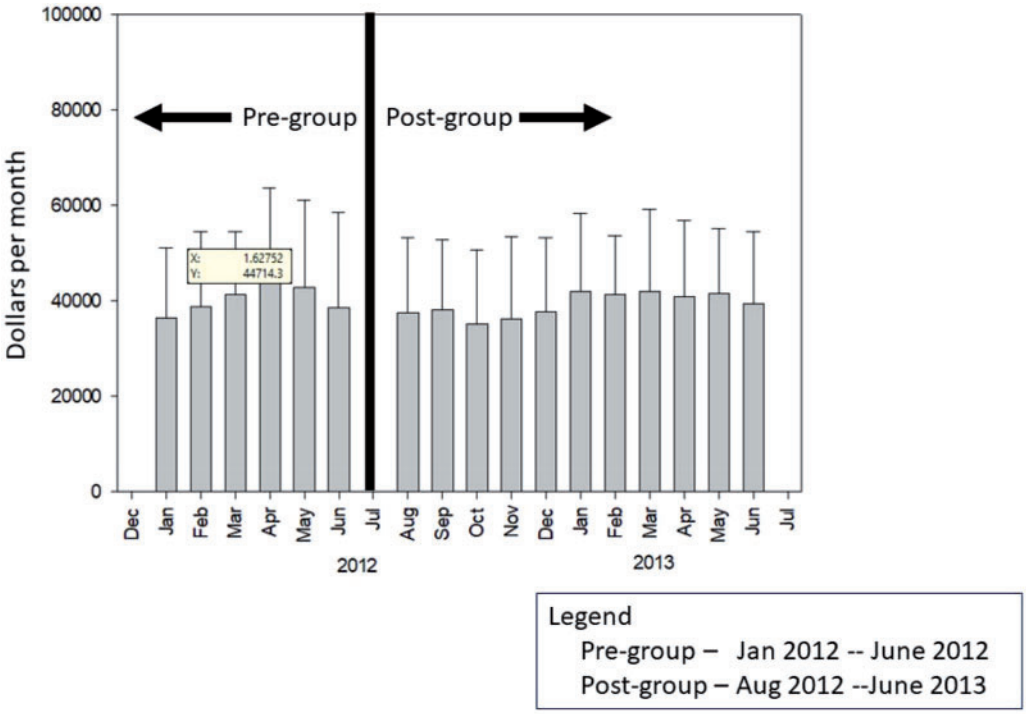


**Figure 1.** Total charges over the course of the study.

**Table 2.** Comparison of 6 months (January–June) 2012 pre-EMR to (January–June) 2013 post-EMR group

| | Pre-group, median (IQR) | Post-group, median (IQR) | Difference | *P*-value | Change (%) |
|---|---|---|---|---|---|
| Charges | | | | | |
| Total (×1000) | 42(29–48) | 44(33–50) | +2.0 | 0.91 | +5 |
| Procedures (×1000) | 2.3(1.6–2.6) | 2.6(2.3–3.8) | +0.3 | <0.01 | +13 |
| Observation (×1000) | 1.1(0.6–1.7) | 0.6(0.4–0.8) | −0.5 | <0.01 | −45 |
| Critical care (×1000) | 1.7(1.0–3.2) | 2.9(1.9–5.0) | +1.2 | <0.01 | +71 |
| Encounters | | | | | |
| Total | 138(101–163) | 125(99–159) | −12 | 0.01 | −9 |
| Procedures | 10(7–13) | 10(7.5–13) | 0 | 0.57 | 0 |
| Observation | 5(3–6) | 2(1–3) | −3 | <0.01 | −60 |
| Critical care | 14(6–29) | 30(18–48) | +16 | <0.01 | +114 |
| Productivity index | | | | | |
| Total | 758(623–876) | 756(673–886) | −2 | 0.30 | 0 |
| Procedures | 26(20–33) | 36(24–44) | +10 | 0.02 | 38 |
| Observation | 25(16–36) | 12(7–13) | −13 | <0.01 | −52 |
| Critical care | 29(20–58) | 59(26–84) | +30 | <0.01 | +103 |

Values are all based on average per month results.

"upcoding" by using macros and point-and-click charting. We feel this is unlikely to contribute to increased critical care billing specifically, as macros and point-and-click charting are generic by nature and rarely provide enough clinical context or specificity to support the additional charge. This was not examined in this study and may be an area of future investigation.

The significant decrease in observation stay productivity and billing may be due to lack of physician familiarity with the ED note process for observation patients. A new electronic note must be added for these observation patients, whereas the critical care and procedural documentation are embedded within the original ED note. Finally, the total number of encounters decreased significantly by 9%. Interestingly, the average ED daily census during the 2012 study period was 246 patients, which was similar to the 2013 study period of 248 patients. The average daily left without being seen rate actually improved from the pre-study period of 37 to the post-study period of 27. This suggests that providers were seeing the same number of patients as before the electronic documentation implementation; however, some encounters were not being billed. Again, previous studies have been mixed with regards to throughput metrics during implementation of an EHR with some showing increases in length-of-stay and decreases in average patients seen per hour, and others showing improvements in throughput [4, 12, 21, 24].

There are several limitations to our study. First of all, this study was not designed to describe or qualify the workflow changes that will occur as a result of new documentation practices though this may be an interesting follow up study. Furthermore, given its retrospective, observational design there may be biases that could not be controlled. A new academic year with new residents began shortly after implementation, which could hypothetically affect productivity for the period immediately following implementation. We attempted to limit this historical bias by comparing the same 6 months before (January 2012 to June 2012) and after (January 2013 to June 2013) implementation of electronic charting. In addition, the small sample size of participants studied ($n = 31$) may influence the results. It should be noted that the sample size in this study is consistent with previous literature of EHR implementation [19, 20]. Moreover, the faculty worked in various locations in the ED (Adult, Pediatrics, etc.) and had different schedules; therefore, not all faculty members may have had equal time distribution between locations during the transition, which may lead to a lag time for those providers that worked less during the transition period to the new electronic documentation. Similar heterogeneity in scheduling, anticipated, or unanticipated, should be expected in any ED group that may be undergoing a transition to electronic charting and reflects real-world conditions. Furthermore, because the study setting is an academic ED, this study may not be generalizable to private groups, multi-hospital systems, groups implementing non-enterprise EHRs, and/or community settings, and additional investigation will be needed to further understand the consequences under these different conditions. Finally, while this study evaluates the overall impact of electronic charting on physician productivity for a group of physicians, it does not address individual factors that may affect productivity including but not limited to individual comfort with change, ability to type, and adaptability to new technology.

According to federal regulations, providers will be penalized beginning in 2015 if they do not meet the criteria for meaningful use [8]. Early reports show a steady increase in the number of providers utilizing EHRs [8]. We believe that in order to realize the full benefits of EHRs, the manufacturers of these systems will have to focus on usability, functionality, and interoperability. Much of the current focus is on proper coding and billing. While these are important functions, a well-rounded system in all of the above mentioned areas may lead to better documentation and improved quality of care. More study is required to fully analyze and optimize the use of EHRs in the ED setting.

## CONCLUSION

In summary, this implementation of electronic charting was not associated with significant changes in total productivity or total billing in our academic ED 6 month post-implementation. Significant increase in productivity and billing for critical care and a significant decrease in productivity and billing for observational stays was observed during this implementation. Additional studies are needed in ED settings to quantify the effect of the implementation of an electronic documentation system on physician productivity in both academic and non-academic settings.

## CONTRIBUTORS

All authors made substantial contributions to the conception, design, execution and analysis of this investigation and associated manuscript. All authors approve of this version of the manuscript and are accountable for all aspects of the work and questions pertaining to it.

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