EMERGENCY PHYSICIAN DOCUMENTATION QUALITY AND COGNITIVE LOAD: COMPARISON OF PAPER CHARTS TO ELECTRONIC PHYSICIAN DOCUMENTATION

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fulfillment of the requirements for the degree of Doctor of Philosophy.

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DEDICATION

"What a long strange trip its been." – Jerry Garcia

I dedicate this dissertation to my family, especially …

To my husband, Carey, for being a constant source of support and encouragement during the challenges of graduate school and life. I couldn't have done it without you.

To my parents, Pat and John Bolstad whose good examples have taught me to work hard for the things I aspire to achieve and encouraging me to take advantage of every opportunity to learn (even though sometimes that can get you into trouble, and yes, I would still do it again).

To my daughters, Kelsey and Tyler – may you also be motivated and encouraged to fulfill your dreams.

They say a PhD is the 'terminal degree' and is the end of formal education. I hope it is just a jumping off point for the next adventure. When we stop learning, we stop improving and I still have a long way to go. There is much yet to learn, explore and experience.

I may not have gone where I intended to go, but I think I've ended up where I needed to be.
- Douglas Adams

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Emergency Physician Documentation Quality and Cognitive Load: Comparison of Paper

Charts to Electronic Physician Documentation

Reducing medical error remains in the forefront of healthcare reform. The use of health

information technology, specifically the electronic health record (EHR) is one attempt to

improve patient safety. The implementation of the EHR in the Emergency Department

changes physician workflow, which can have negative, unintended consequences for patient

safety. Inaccuracies in clinical documentation can contribute, for example, to medical error

during transitions of care.

In this quasi-experimental comparison study, we sought to determine whether there is a

difference in document quality, error rate, error type, cognitive load and time when

Emergency Medicine (EM) residents use paper charts versus the EHR to complete physician

documentation of clinical encounters. Simulated patient encounters provided a unique and

innovative environment to evaluate EM physician documentation. Analysis focused on

examining documentation quality and real-time observation of the simulated encounter.

Results demonstrate no change in document quality, no change in cognitive load, and no

change in error rate between electronic and paper charts. There was a 46% increase in the

time required to complete the charting task when using the EHR. Physician workflow

changes from partial documentation during the patient encounter with paper charts to

complete documentation after the encounter with electronic charts. Documentation quality

overall was poor with an average of 36% of required elements missing which did not improve during residency training.

The extra time required for the charting task using the EHR potentially increases patient waiting times as well as clinician dissatisfaction and burnout, yet it has little impact on the quality of physician documentation. Better strategies and support for documentation are needed as providers adopt and use EHR systems to change the practice of medicine.

Brian E. Dixon, Ph.D., Chair

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LIST OF ABBREVIATIONS

ABEM	American Board of Emergency Medicine
ARRA	American Recovery and Reinvestment Act
CMS	Centers for Medicare and Medicaid Services
COW	Computer on wheels
CPOE	Computerized Physician Order Entry
CPR	Cardiopulmonary resuscitation
DOB	Date of Birth
ED	Emergency Department
EKG	Electrocardiogram
EHR	Electronic Health Record
EM	Emergency Medicine
ePD	Electronic Physician Documentation
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
IUSM	Indiana University School of Medicine
IV	Intravenous fluids
MRN	Medical Record Number
NASA-TLX	National Aeronautics and Space Administration – Task Load Index
PE	Physical exam
R1	First year resident – PGY-1
R2	Second year resident – PGY-2
R3	Third year resident – PGY- 3
RRC	Residency Review Committee
RSI	Rapid sequence intubation
SEIPS	Systems Engineering Initiative for Patient Safety
SimLab	Simulation Laboratory
WOW	Workstation on wheels

SCIENTIFIC BACKGROUND

"To err is human" the 1999 IOM report brought patient safety to the forefront of medicine

(1). The culture of medicine has changed with diverse interventions from assessing

patients for fall risks and standardizing handoffs to medication reconciliation and electronic

health records in an attempt to decrease medical error. Some of these interventions solve

safety problems but also can introduce unintended safety consequences. Introduced in

2009 as part of the American Recovery and Reinvestment Act, Health Information

Technology for Economic and Clinical Health (HITECH) was aimed at modernizing the

health care system through health information technology as a way to improve the quality

of health care while lowering costs and reducing preventable medical errors (2). HITECH

provides incentives for physicians and hospitals through Medicare and Medicaid for

"meaningful use" of electronic health records (EHRs) (2, 3). Meaningful use requires EHR

systems to support data capture, tracking of clinical outcomes, reporting clinical quality

measures, interoperability, lab reporting and e-prescribing, decision support and patient

engagement (2, 3). Implementing EHRs without meeting meaningful use guidelines does

not qualify the hospital or provider for additional incentives (2, 3). The United States

government has committed over $20 billion to training, research and incentives for HITECH

(2).

Projected benefits of EHRs include improved patient safety, disease prevention, chronic

disease management, improved efficiency, and decreased cost through communication,

coordination, and decision support (2, 4). Cost savings for healthcare in the United States is

estimated at $81 billion annually (5, 6). The initial studies of EHR implementation have

mixed results (7). Some results support the claims of improvements in billing (8),

improvements in accuracy of documentation (9-11), decreases in repeated testing (12, 13),

decreases in medication errors (4, 13), and decreases in preventable medical error (4, 14).

Other results illuminate the unintended consequences of the EHR, including increased

provider time at the computer (8, 11, 15-18), little impact on recording specific quality

measures (smoking, BMI, immunization status) (19-21), increased inaccuracy of

documentation (22-24), information overload (23, 25), billing fraud (26), and increased

medical error (14). The driving force for electronic medical records has been increasing

revenue through improved billing (22, 27). Payers require physicians to record certain data

sets before they approve reimbursement for services rendered (22, 27). These data sets are

often not necessarily required to document the care of the patient nor are they necessary to

telling the story of the healthcare encounter (8).

Medical Records and Communication

> Florence Nightingale observed, "In attempting to arrive at the truth, I have
> applied everywhere for information, but in scarcely an instance have I been
> able to obtain hospital records fit for any purposes of comparison. If they
> could be obtained, they would enable us to decide many other questions
> besides the one alluded to. They would show subscribers how their money
> was being spent, what amount of good was really being done with it… if wisely
> used, these improved statistics would tell us more of the relative value of
> particular operations and modes of treatment … and the truth thus
> ascertained would enable us to save life and suffering, and to improve the
> treatment and management of the sick and maimed poor." (28)

Hippocrates developed the first medical record in the fifth century B.C. to do two things:

accurately reflect the course of disease and indicate the probable cause of disease (29).

From this humble beginning, medical records have evolved through paper folders to

electronic records to electronic records integrated with decision support, billing

information, alerts, and ordering systems (29, 30). "The medical record is an electronic or

paper document containing factual information regarding a patient's health status and the

corresponding medical opinions based on that information" (31). Physicians document

patient encounters in the medical record during and following a visit. The modern medical record is used for communication, billing, planning, recording, and legal defense (31, 32). It is no longer just a place to document the cause and course of disease and sometimes it seems that it is only for billing purposes (7).

Communication of patient data including medications, treatments, past history, allergies, comorbidities, and treatment plan should be the primary function of the medical record rather than a secondary function (8). Accuracy of the medical record is vital to patient safety (33) and to develop evidence based practice (EBP) guidelines. Recording tasks and communication failures have been identified as primary factors in medical error (34, 35). Documentation is worse at times of care transition like discharge from the emergency department (ED) or transfer to the inpatient setting (34). Communication of care delivered in the ED, especially at care transitions is paramount to continuity of care and patient safety (35). Communication issues at care transitions account for an estimated 70 - 80% of medical errors affecting 49% of patients discharged from hospitals (35). For ED patients, the medical record is often the only communication between the ED and other physicians caring for the patient (34).

Documentation Strategies

Physician documentation has evolved over time from simple record keeping to healthcare team communication, research, legal defense, and billing documents. Many strategies have been employed to improve documentation for these secondary purposes including templates and most recently electronic documentation modules in EHRs (36-38). Studies designed to evaluate template driven charting versus freeform charting support the potential benefit of improved documentation with EHR systems (34, 36, 37). Several

studies have addressed the issue of improving documentation in medical record using

different input methods like template driven charts, dictation, voice recognition software,

bar coding, and scribes (36-40). Dictation or voice recognition appears to be faster and

more accurate (39, 40). Interface design research supports the idea of improved job

performance when matching system capabilities to operator needs (41). This would

include EHR workflow, data display, and ease of input method (42).

Clinical documentation in the ED ranges from notes taken on scrub pants, sheets or paper

towels to detailed narrative notes in the EHR system (34). The unpredictable acuity, census

and workflow in the ED often requires practitioners to complete clinical documentation at

the end of a shift based on notes taken during the patient encounters or from memory (43).

The traditional electronic physician documentation (ePD) may not be ideal for ED

physicians who need a place to jot notes to remind them of what was done so they can write

the notes when there is time.

Design and Usability of EHR

Usability testing is essential to ensuring patient safety when HIT is implemented in the

clinical environment. Usability testing for HIT primarily occurs in two phases, prior to

implementation (laboratory testing) and post implementation (in situ) (44-46). Laboratory

usability testing is done to ensure that the HIT does what it is suppose to do, is "easy" to

learn, and is useful to the end user. In situ testing is done to identify workflow issues, ease

of use, as well as usefulness to the end user and focuses on workflow and integration of

clinical decision support into the workflow (47, 48). Usability testing for HIT in situ

generally includes ethnographic observations, questionnaires, focus groups, and interviews.

A recent case report describes the feasibility of HIT testing in high fidelity simulation

laboratories as an alternative to developing artificial cases in the laboratory or observation in the clinical environment (45). The advantage of using the simulation environment is a realistic setting, clinical scenarios that can be controlled and repeated, and access to the training environment for the HIT application (45). The results of usability studies are mixed with some reporting improvements in workflows and guideline adherence (49) and others reveal unintended consequences like increased time required to complete tasks in the EHR (8, 11, 15-18).

Physician Documentation Training

Physician training prior to EHR implementation varies from voluntary to mandatory and on the job training to twelve or more classroom hours depending on the system and workplace mandates (8). Often training takes place many months prior to the "go-live" which theoretically allows time to practice in the training environment, but more likely allows time to forget what was learned in training. It is difficult for many physicians to justify time away from patient care to train in a system that will not be in place for many months and that they do not believe will be beneficial to them.

Historically, medical students and residents receive little formal training related to communication of patient care in the medical record which often results in incomplete documentation (50). Just 68% of US medical schools formally teach students what to document and how to write progress notes in the medical record (51). Isoardi found 20% of EM physicians and 5% of interns had formal medical documentation training when conducting interviews about intern documentation (52). Lack of training is magnified by lack of practice with the adoption of EHR systems. Over 50% of US medical students are not

permitted to write notes in EHRs (51). As EHR adoption grows, the need for teaching

documentation skills is more critical to ensure good communication between providers.

EHR and the ED Physician

As of this writing, there are more than 150 different EHR vendors. The majority focus on

inpatient or ambulatory care but only a few have ED-specific applications (8). The ED

interacts with all hospital units including registration, billing, inpatient services, laboratory,

radiology, and pharmacy (53) as well as outpatient clinics and private physicians.

Emergency department services encompass all medical specialties, integrate triage notes,

mechanisms of injury, serial focused exams, and notes from several consultants into the

EHR, and involve multiple simultaneous providers caring for multiple simultaneous patients

(34). Time is a precious commodity in the ED and can often be the difference between life

and death or significant mortality. In studies of ePD implementation, physicians self-report

increased time needed to document following EHR introduction (18, 54-56). The data

elements required for an electronic information system that supports the ED model of

medical care are different from both inpatient and ambulatory care systems (53, 57).

ED Physicians have different time pressures and information needs than both inpatient and

ambulatory care physicians (34). The information need in the ED is often narrow and

problem focused (34). ED physicians focus solely on the present illness or injury and do not

worry about preventative guidelines for the majority of their patients. For example, ED

physicians do not need to know about screening colonoscopy orders, pap smears or

smoking cessation programs, but do need up to date tetanus status, medications, and

advanced directives. The patient has no previous relationship with the ED physician and in

the past has been the only source of past medical history leaving the physician with often

unreliable and incomplete information (34). The introduction of the EHR into the ED can bridge the gap and provide access to the required information (7). The ED physician needs rapid access to an accurate overview or summary of past medical history, medication history, allergies, advanced directives, and recent healthcare encounters to adequately care for the patient (53). ED physicians often work in more than one hospital and as such can encounter different EHRs requiring them to learn to navigate multiple systems with multiple requirements. A recent survey of those entering their first year of emergency medicine residencies (not yet published) revealed that medical students encounter an average of 3-5 different EHRs during their clinical years in medical school (58).

Workflow Changes and Cognitive Load

Humans are very good at pattern recognition. Studies of "expert" physicians suggest that physicians rely on patterns of data to make accurate diagnoses (59). The EHR offers new opportunities for important data to be overlooked by the physician because it appears on another screen or is imported by a mouse click and not reviewed by the harried provider (22). The 1999 Institute of Medicine Report, "To Err is Human," sparked sweeping changes in the patient safety culture throughout the United States. Understanding the factors involved in medical error help guide preventative measures (14). Studies have identified communication, interruption (60), change in cognitive load (10, 14), and simple calculations as potential factors in medical error (61, 62). Interruption studies in the ED show physicians are interrupted 50% of the time while charting or reviewing information, but only 15% of the time while on the telephone (35, 60). Reduction of medical errors will require a system that reduces interruptions and distractions in the ED (63). Changing cognitive patterns causes error, which can lead to patient harm (14). The introduction of the EHR directly changes cognitive patterns in physicians (8, 14). EHR implementation also

requires a change in documentation practice and data input methods (8). As a result, patient safety may be adversely affected. Surrogate measures for patient safety improvement including decreased cognitive load, improved documentation quality and better efficiency are suggested in human factors and psychology research (62, 64).

Measuring Cognitive Load

The NASA Task Load Index (TLX) has been used by NASA and others for over 20 years and has been validated for use in many fields including aeronautics, health care, computer interface design, automobile drivers, and portable electronics users in both real and simulated environments (35, 65). Users of the TLX have evaluated the task load of activities ranging from flying to communication, decision-making, computer usability, and teamwork (35, 64). The TLX scale is used as a benchmark for the validation of other measures, theories and models of subjective task load (66).

The TLX assessment (appendix 1) is a multi-dimensional scale that measures workload score based on the weighted average of six subscales (perceived mental demand, physical demand, temporal demand, performance, effort, and frustration) (65). Human factors researchers suggest that perceived cognitive load is an important factor in error prevention (14, 41).

Document Quality

There have been numerous studies conducted to evaluate the impact of electronic health records on billing and coding, physician satisfaction, and documentation of specific health prevention activities (like smoking status and BMI) (19-21). Studies of document quality after EHR implementation have had mixed results with some showing improved coding and

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billing (37) and others no change in coding and billing (67, 68). CMS and other insurance

billers require certain data elements to be documented for each patient encounter for

billing purposes that do not add to the clinical picture for the patient. The need to include

these non-essential data elements encourages providers to copy and paste from previous

documents to avoid typing the same information over again and as a result, many of the

documents in the EHR are never reviewed by anyone other than the author (18). Since the

medical record is primarily for communication between health care providers, the

important question is whether the EHR improves the quality of clinical data. There are few

studies reported in the literature that prospectively evaluate clinical document quality and

none that compare paper charts to ePD. Bergrath used simulated patient scenarios to

evaluate electronic document quality for ambulance crews and found 40% of charts had

errors in documentation when evaluated based on the videotape of the simulation

encounter (69). The study postulated that electronic records, quality management and

training might improve documentation and suggested future research confirm this

hypothesis (69). A 2009 Canadian study evaluating physician documentation by obstetrics

residents following a simulated operative delivery documented that 71% of the correct

elements (based on a standard required data set) were found on the chart (70). This study

concluded that simulation can be used for formative evaluation of documentation skills and

help identify deficiencies (70). A study by Carroll in 2003 evaluating resident progress

notes found documentation errors in 2/3 of the resident notes (71). A 2008 Australian

study compared electronic documentation to paper charts using simulated asthma patients

and found improved documentation of critical events in electronic documentation (49).

Simulation and Medical Training

Medical simulation is designed to educate physicians and other healthcare providers and broaden their experiences with critical patients (72). The simulation scenario is set-up, monitored, and controlled based on the learner's actions. Medical simulation began in the 1980's with anesthesia training and recently is becoming the norm for medical education in other specialties (73-79). The simulation environment allows the learner to practice evaluations and procedures, "see" patients with rare diseases, and make diagnostic and treatment errors without harming real patients. The high fidelity mannequins used in simulation labs allow the learner to do a complete physical exam with appropriate finding for the simulated clinical scenario including heart and breath sounds, pupil response, pulses in extremities, and voice response to questions. The simulation laboratory environment looks and feels like a real exam or hospital room including access to working oxygen and suction setups, telephones, computers, crash carts with defibrillators, airway boxes, bedside monitors, IV pumps, and ventilators. Multispecialty scenarios include nurses, physicians, pre-hospital providers, respiratory care, and pharmacy technicians to improve the realism of the environment. There are currently 149 healthcare simulation centers in the US registered with the Society for Simulation in Healthcare with 33 of them fully accredited.

The Indiana University School of Medicine (IUSM) Emergency Medicine residents complete up to 60 different simulation scenarios during the three years of residency and IUSM medical students complete three simulation scenarios during the required EM clerkship. The simulation scenarios compliment clinical training by providing experience with rare or complicated disease processes in a setting where the consequences of trainee actions are not harmful to patients. Medical students learn basic procedural skills at the beginning of third year before embarking on clinical clerkships in the simulation center. In addition to

the required simulation scenarios, EM residents learn airway management, ultrasound, and managing multiple patients in the simulation lab. The simulation center is an ideal setting to study the changes in workflow with the implementation of the EMR into the workplace without jeopardizing patient safety (45).

Figure 1 - Simulation Lab Patient Room

RATIONALE

The purpose of this study was to evaluate the impact of ePD on ED physician documentation quality and perceived cognitive load. Communication of ED patient care upon transition to inpatient or outpatient follow-up is essential for continuity and patient safety. It is important to understand the change in documentation quality when an ePD is implemented in the workflow in the ED in order to minimize any negative impact on patient safety. There are no previous studies evaluating the impact of the clinical documentation requirements of ePDs on physician cognitive load and documentation quality in the ED setting. *The results of this study will inform ePD and EHR design, training, and adoption with the goal of minimizing cognitive load, maximizing efficiency, and improving document quality in order to improve patient safety in the ED. Document quality results can be used to direct future educational efforts in medical record documentation.*

OBJECTIVES

The overall question motivating this study is what happens to the quality of clinical documentation after the implementation of an ePD in the emergency department of a large urban teaching hospital including physician cognitive load and time requirements. The hypothesis is that the use of ePD will improve document quality, but will increase cognitive load and time requirements when compared to paper charting.

The Indiana University Institutional Review Board approved this study. The IUSM Emergency Medicine Residency Directors and the IU Emergency Medicine Chair approved the involvement of EM residents in this study.

STUDY CONTEXT

Organizational Setting

This study was conducted at The Simulation Center at Fairbanks Hall (SimLab) located in Indianapolis, Indiana. The simulation center has 10 clinic exam rooms, 8 classrooms, 8 debriefing rooms, operating room and OR support rooms, ER and ICU rooms, flexible room, transport room (with a complete ambulance body), 5 bed inpatient suite with nurses' station, pharmacy, laboratory and respiratory care, and an OB suite. The center has computer workstations in each of the patient rooms, in a physician workroom and the nurses' station in the inpatient suite, as well as computers on wheels (COWs) that are connected to the training domain for the Cerner applications (including FirstNet) used in IU Health hospitals. The patient and environment closely resembles an actual ED room complete with nursing support, telephone support for consultants, pharmacy, respiratory therapy, laboratory, social work, etc.
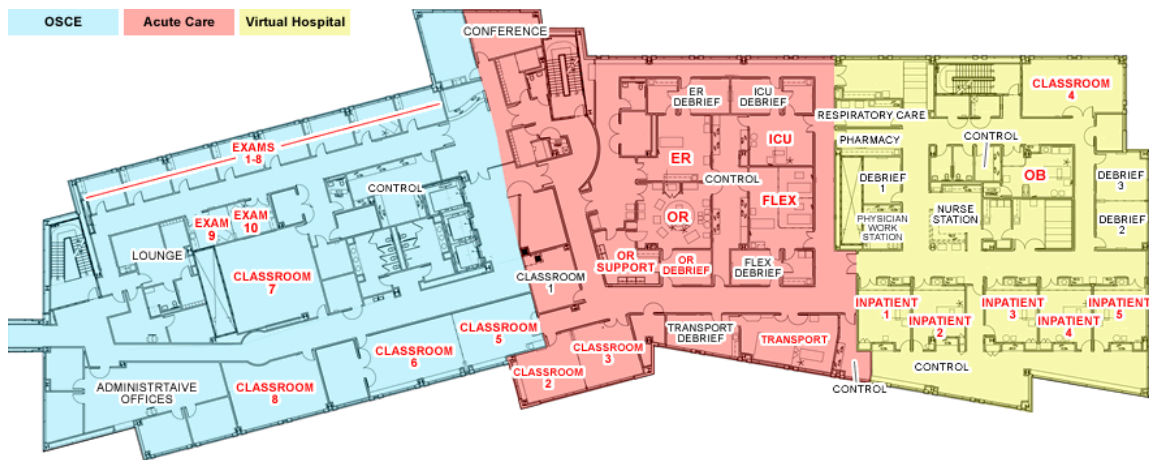
Figure 2 - The Simulation Lab at Fairbanks Hall

The EM faculty have developed over 60 scenarios of patient encounters for teaching EM residents (example in Appendix 2). The simulations were used as written for this study

with the charting task added. EM residents are required to document training progress through evaluation of milestones that include, among others, clinical judgment, physical exam skills, history taking, medical knowledge, interpersonal and communication skills, professionalism, cognitive procedural skills, technical procedural skills, and use of technology to deliver safe patient care. These skills are evaluated both in the simulation center and during clinical shifts in the ED. To facilitate this project as well as milestone evaluations, residents were asked to complete either a paper chart or an electronic chart following the debriefing session. EM faculty and upper level resident volunteers work with professional SimLab staff to conduct the simulation scenarios. Nursing students or ED nurses frequently volunteer to provide nursing support during simulation scenarios. Residents are regularly scheduled in the SimLab as part of their curriculum so there were no scheduling problems with this study. A complete simulation case file including the storyboard is included in Appendix 2.

The Indiana University School of Medicine emergency medicine residents are being used as subjects as they routinely participate in simulation sessions during their training. The EM Residents have two primary ED training sites, IU Health Methodist, a large urban tertiary care teaching hospital (over 100,000 patient visits/year) and Wishard/Eskenazi Medical Center, the public teaching hospital (over 100,000 patient visits/year). The training sites use different EHRs, Cerner at IU Health Methodist, and a homegrown system (G-3) at Wishard/Eskenazi. The paper charts and the ePD (Cerner FirstNet) from IU Health Methodist were used in the simulation center for this project.

System Details and System in Use

As mentioned above, the paper charts used in this study are from IU Health Methodist ED.

They were presented and used exactly as they were used in the clinical setting including

order sheets. The electronic clinical documentation was done in the Cerner FirstNet

training environment. The FirstNet ED physician documentation module was deployed at

IU Health Methodist in May 2013. All ED faculty physicians and residents use it for ED visit

documentation. IU Health Methodist trained all users prior to implementation for an

average of 4 hours. The FirstNet training environment is no different than the production

environment except that individual user macros are not available and the system is cleared

each day so there is little historical information about the patient included in the records

available to the trainees. The documentation is done in a blank generic note with no

diagnosis specific templates. Initial data included in the chart when opened is patient name,

DOB, MRN, allergies, primary physician, and sometimes height and weight.

METHODS

Study Design

This study is a quasi-experimental comparison study to determine whether there is a difference in document quality, error rate, error type, cognitive load and time when EM residents use paper charts or electronic physician documentation. The use of resident trainees produces a homogeneous group with less potential for bias or confounding due to variability in experience, age, or computer skills. This study uses simulated patient encounters as a unique and innovative method to evaluate EM physician documentation of the care provided based on real-time observation of the encounter. Attempting to evaluate patient encounters and documentation in clinical practice is difficult due to the nature of patient flow in the ED, including interruptions and patient privacy concerns. The simulation lab is a realistic controlled environment in which studies such as this can be done with no disruption of patient care or adverse impact on patient safety. In addition to measurement of cognitive load, the documentation quality can be assessed by videotaped review of the simulation encounter. The simulated environment allows researchers to control events based on provider actions and evaluate the complete patient care encounter. All EM residents participate in simulation scenarios as a part of their training and thus all have an equal opportunity to participate in the study eliminating selection bias. Each arm of the study was conducted over the course of the training year from June to May so both groups are equal in level of experience through out the study. Simulation scenarios are training year specific and usually completed in the same order each year.

Theoretical background of the study

This comparative study was designed to test whether there is a difference in document quality, cognitive load, error rate, and time requirements between paper charts and ePD.

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The SEIPS model developed by Carayon is used as the foundation for this study(80) (80). The SEIPS model is used to understand error and patient safety in healthcare environments by including environment, individual, technology, organization, and tasks in the problem analysis (figure 3).

Substituting the simulation lab for the ED environment simplifies the model by removing the uncertainty of provider-patient ratios and interruptions. The organization (IUSM and IU Health), the technology (Cerner FirstNet), the task (physician documentation), and the individual (EM residents) remain the same as seen in situ in the ED. Using this model allows us to focus on documentation error rates when comparing paper documents to electronic documents in the context of the work system. The NASA TLX (Appendix 2) was selected for measurement of cognitive load, as it is the "gold standard" for perceived cognitive load validated across many industries including health care(66) (66) and has been used in health informatics studies to compare interfaces, system design and introduction (41, 81).   The NASA-TLX uses 6 domain scores that are weighted based on perceived importance of the domain to the task. Individual domain scores in mental demand, physical demand, temporal demand, performance, effort, and frustration level are calculated as well as an overall total score.
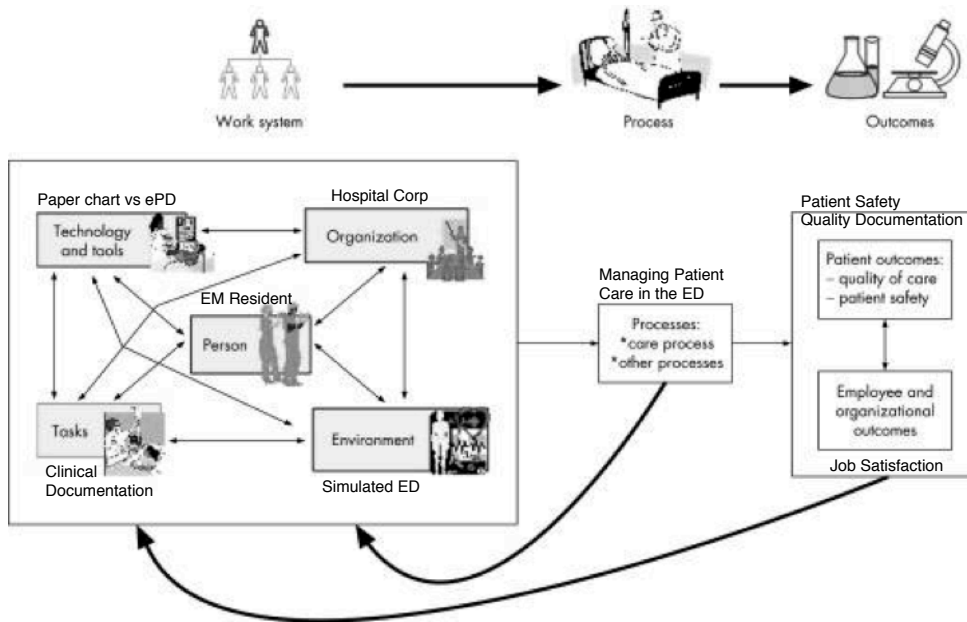
Figure 3 - Annotated SEIPS Model for Documentation Study

Technology & Tools	Organization	Environment	Person	Tasks
ePD vs Paper Charts	Hospital Corp	Emergency Department	EM Physicians	Clinical Docuementation
Study Outcomes Quality Errors Cognitive Load Time		Study conducted in the Simulation Lab		
Guides EHR development, implementation, & training	Guides training and staffing expenditures	Guides workflow and staffing	Guides education and training	Highlights quality and likely errors

Figure 4 - Study Outcomes and Consequences in the SEIPS Work Model

Participants

IUSM EM residents participating in scheduled exercises in the SimLab from July 2012 – June 2014 were eligible for entry into the study. During the study period, there were 124 EM or EM/Peds residents that were eligible for participation. Each EM resident visits the SimLab six times per year for a total of 60 different simulations over the course of their training program. Each simulation session consists of three cases in which one or two residents actively participate while the others watch and evaluate the scenario from the debriefing room. The active (primary) participant writes the chart following the simulation scenario. Consent was obtained during the first simulation session of the year prior to participation, but subjects were blinded to the outcome measures and to the interventions being studied. All studies were done in the course of curriculum-scheduled visits to the SimLab.

EM PGY-1 residents attend IU Health Cerner training before starting clinical shifts in June 2013. Upper level residents attended IU Health Cerner training prior to the implementation of clinical documentation and CPOE in spring of 2012.

Sample Size Considerations

Sample size was calculated based on the 40% error rate reported by Bergrath (69) and an anticipated difference score of 5 in chart quality. A minimum of 18 subjects per group is required to detect a difference of 5 in document quality score with 80% power and 95% confidence (82).

Study Flow

The protocol for this study was developed in the fall of 2011. The IRB submission, made in January 2012, was approved in March of 2012. The first group, 2012-2013 resident class, was consented and data collection begun in June 2012. The first group charted using paper charts through May 2013. The second group, 2013-2014 resident class, was consented and data collection begun in June 2013. Data collection was completed in May 2014. CPOE started at the IU Health Methodist training site in November 2012 and ePD started in May 2013 in the ED.

Mar 2012	Study approval obtained from Indiana University Institutional Review Board
Jun 2012	Consent subjects for the first year of studies
Jun 2012	Data collection begins for paper charts
Nov 2012	CPOE implemented at IU Health Methodist (resident training for Cerner FirstNet)
May 2013	Electronic physician documentation (ePD) implemented at IU Health Methodist
May 2013	Data collection ends for paper charts
Jun 2013	PGY-1 residents attend Cerner training and begin clinical shifts in the ED
Jun 2013	Consent subjects for second year of studies
Jun 2013	Data collection begins for electronic documentation
Jun 2013	PGY-1 class uses paper charts for first simulation session

Jul 2013	All documentation in Cerner FirstNet
May 2014	Data collection ends

Table 1 - Study Timeline

Outcome Measures

The **primary outcomes** tested are:

1. Compare documentation quality score for paper and ePD;

2. Compare perceived cognitive load for use of paper and ePD;

3. Compare error type and frequency for paper and ePD;

4. Compare time necessary to complete documentation for paper and ePD.

5. Observe changes in workflow between paper and ePD.

The **secondary outcomes** tested are:

1. Compare efficiency, accuracy, and delta scores for paper and ePD;

2. Evaluate training level differences in primary outcomes;

3. Compare error domains for paper and ePD.

Methods for Data Acquisition and Measurement

Study subjects participate in videotaped simulation scenarios in the SimLab as part of their EM residency curriculum. The simulation scenarios were developed locally by EM faculty and were unchanged for this study. To improve the realism in the simulation lab, the EM residents began documenting the simulated patient encounters on paper charts in 2012-2013 and using ePD for 2012-2013. The charting task was completed immediately during or following the simulation encounter debriefing session. Study participants document simulated encounters using the paper ED chart in use at IU Health Methodist Hospital or in Cerner FirstNet, the EHR in use at IU Health Methodist Hospital. The 2012-2013 residents used the ED paper charts and the 2013-2014 residents used ePD. The IU Health training site implemented CPOE (Fall 2012) and electronic clinical documentation (Spring 2013) for all physician documentation in the 2012-2013 training year. Study subjects consented to

participating in the study as well as being videotaped during their simulation scenarios but were blinded to the outcome measures for the study.

Immediately following the charting task, subjects completed the NASA TLX (online version) to evaluate perceived cognitive load with regards to the charting task and ignoring the difficulty of the simulation scenario. The NASA TLX was completed on iPads during the first year of the study and on the COW the second year. Results were collected and stored in the RedCap (83) database.

A priori 'gold standard' documentation elements were identified from the simulation scenario standards by expert EM physicians with a combined 45+ years of experience in EM and resident education for each of the simulation scenarios. The gold standard document score (GoldTotal) was based on the number of elements required to effectively communicate the story of the patient encounter for communication and medico-legal purposes (example in Appendix 5). Billing requirements were deliberately ignored for this study. The total number of required elements in each of five domains, history, physical exam, procedures, medications and medical decision making were tallied, totaled, and used as the gold standard score for each scenario. As a result, each scenario has a unique score based on the complexity and length of the simulation case. Required documentation for an ED patient encounter varies with the presenting complaint and the complexity of the patient.

Domain	Elements included
History	History of present illness, age, gender, mode of arrival, person providing history, pain scores, primary care physician, past medical history, past surgical history, review of systems, social history, family history, allergies, medications, and immunizations.
Physical Exam	Vital signs, repeated vital signs, physical exam, repeated physical findings including seizure, unresponsiveness, etc. after initial exam.
Procedures	Monitor, oxygen, cardioversion, defibrillation, CPR, procedural sedation, intubation, delivery, central lines, EKG, labs ordered, procedural time out, etc.
Medications	All medications and IV fluids administered (RSI drugs considered as a single medication).
Medical Decision Making	Consultants contacted, disposition of patient, differential diagnosis, final diagnosis, prior records reviewed, condition of patient, and response to therapy.

Table 2 - Chart domains

The charting domains were established *a priori* to reflect usual documentation practices for

paper charts. Not all of the elements are required for each simulation scenario. The paper

or ePD chart was evaluated for the number of elements present in each domain, totaled, and

used as the ChartTotal score. The gold standard required elements were identified from the

total number of elements present in each domain and totaled for the ReqTotal score. This

process produced two sets of numbers for each chart called ChartTotal and ReqTotal that

were used in calculating the difference score, reliability, efficiency, accuracy, and delta

scores. The simulation videos were transcribed while viewing by writing a list of the actions

taken or verbalized during each of the simulation scenarios. Each action charted on the

paper or ePD chart was verified against the written list and errors identified.

The errors were put into domains and classified into one of the three error categories

(omissions, falsifications or mistakes). Correctly documented elements were either actions

completed or verbalized as completed during the scenario. Vital signs could be documented

by checking a box or typing "vital signs per nurses' notes" or actually written into the chart.

If vital signs were written, correct documentation was considered to be SBP ±10 mmHg, HR ±10 beats/min, RR ±4 breaths/min, SpO_2 ±2%, and BS ±10mg/dL. Medications were considered correct if either total dose or exact individual doses were recorded. IV fluids must include type and total amount ±10%. Procedures, medical history, follow-up plan, and physical exam must all be exact to be considered proper documentation. Incorrect documentation of required elements (documentation errors) will be noted in three categories:

1) Omission – required element completed but not documented;

    a. Rectal exam done by not documented or IV fluids given but not documented

2) Mistake - element completed but mistake in documentation;

    a. Breath sounds equal but documented as decreased on the left

3) Falsification - element not completed but documented as done;

    a. Pupils equal and reactive is documented but eye exam not completed

Documentation errors were separated into those made for required elements and those made chart elements present but not required. This project was not designed to evaluate correctness of action during the simulation scenario, so an incorrect action documented correctly is not considered an error for the purposes of this project. Incorrect actions documented incorrectly are considered an error in one of the categories above.

Performance was measured by evaluating time required to complete the charting task. Charting time for paper charts was measured by timing exactly the amount of time that the participant spent charting including charting that occurred in the room during the simulation scenario. Charting time for ePD was recorded by the participants as start and

stop time for the charting task. They were asked to record start time when they started

logging in to Cerner FirstNet and to record stop time when they submitted the final version

of the ePD. Researchers randomly observed the recording of times to verify accuracy.

Workflow was measured by observing and recording when the resident interacted with the

chart (paper or ePD) during the simulation session.

Methods for Data Analysis

Participants and gold standard scores were compared by group to ensure homogeneity for

both participants and scenario complexity. Participants were compared using their

American Board of Emergency Medicine (ABEM) in-service exam scores on exams taken in

April 2013 and April 2014 to ensure there was no difference in EM knowledge between the

groups. The means of Gold standard scores, both total and by domain were also compared.

Primary data collection includes total document elements, error type and frequency,

cognitive load score, and performance measured as time difference in completing the

charting task on paper or electronically. Secondary data collection includes error domain

(history, physical exam, procedures, medications and medical decision making) evaluation.

Overall document quality, reliability, efficiency, delta score, accuracy, error type, and

domain error scores were calculated for use in statistical analysis. The study sample was

stratified by training level (R1, R2 and R3) to examine differences resulting from experience.

Exploratory analyses were also conducted to explore possible relationships between error

category and training level.

Calculations

Quality Score

To compare the overall quality of the chart, a quality score between 0 and 100 was computed with 0 being a perfect score. The quality score indicates the difference between the gold standard score and the ReqTotal score for each of the charts. The document quality score was calculated by computing a difference score using the formula,

$\frac{\text{GoldTotal-ReqTotal}}{\textit{GoldTotal}} \times 100$, where ReqTotal is the number of gold standard required elements

identified from the chart. Difference scores were used to normalize the scores generated when comparing scenarios with differing numbers of required elements.

Reliability

Reliability is the ratio of the required elements to the gold standard total elements. Perfect reliability (R = 100) is achieved when all of the required elements are present in the chart. Reliability was calculated using the formula $\frac{\text{ReqTotal}}{\text{GoldTotal}} \times 100$. Reliability analysis is included to measure the dependability of the chart data to include the required elements. This is also used as a measure of chart quality.

Delta Score

In order to assess whether there is a difference in the number of extra elements that were documented, delta scores were calculated by subtracting the required element total from the chart total score. Delta scores were calculated for domains as well. Performance (measured by time to complete charts) can better be assessed by including the absolute number of extra elements that are charted in addition to the required elements to determine if any extra time is related to extra elements.

Efficiency

In this study, efficiency is a measure of the ratio of required elements to the total elements charted. Perfect efficiency (E = 100) is achieved when everything written in the chart is a required element and there are no extra elements. Efficiency was calculated using the formula $\frac{ReqTotal}{ChartTotal} \times 100$. This ratio is included in the analysis to evaluate the dataset for changes in charting productivity.

Accuracy

Accuracy is a measure of how well the chart reflects the participant's actions during the simulation. Accuracy was calculated using the formula, $\frac{ReqTotal + ReqOmission}{GoldTotal}$. Perfect accuracy (A=100) is achieved when all of the required elements are included in the in either the written required element total and the observed required omissions from the video review. This is a good measure of what the chart quality would be if the participant had documented the omissions.

Percent Error

The percent error was calculated for overall charting errors by taking the ratio of total errors and total required elements. The formula for calculating the Percent Error is $1 - \frac{ReqTotal - ErrorTotal}{ReqTotal} \times 100$. This ratio was used to compare charting error rates between the groups.

Statistical Analysis

Statistical analysis was done using SPSS (Version 21 for Mac). In addition to descriptive statistics, independent sample *t*-tests were done to compare paper to ePD including error analysis. Two-way ANOVA was done to explore the influence of training level as well as personal characteristics such as in-service exam scores. Independent sample *t*-tests were used to determine differences between charting methods in cognitive load. Linear regression with document quality as the dependent variable and cognitive load, training level, and documentation method as covariates to assess the importance of these factors on the quality score was also done. Linear regression was done to assess the effect of total elements charted on charting time.

RESULTS

Participant Selection

There were 225 individual simulations and 120 multiple simulations during the two-year

data collection period. Of the total individual simulations performed, we selected 128

individual simulations because they possessed completed charts for both collection periods

and had video available for review. The R3 training year has a multiple patient simulation

session that accounts for 120 simulations, which were not included because they require

the resident to chart on 3 patients for each session.
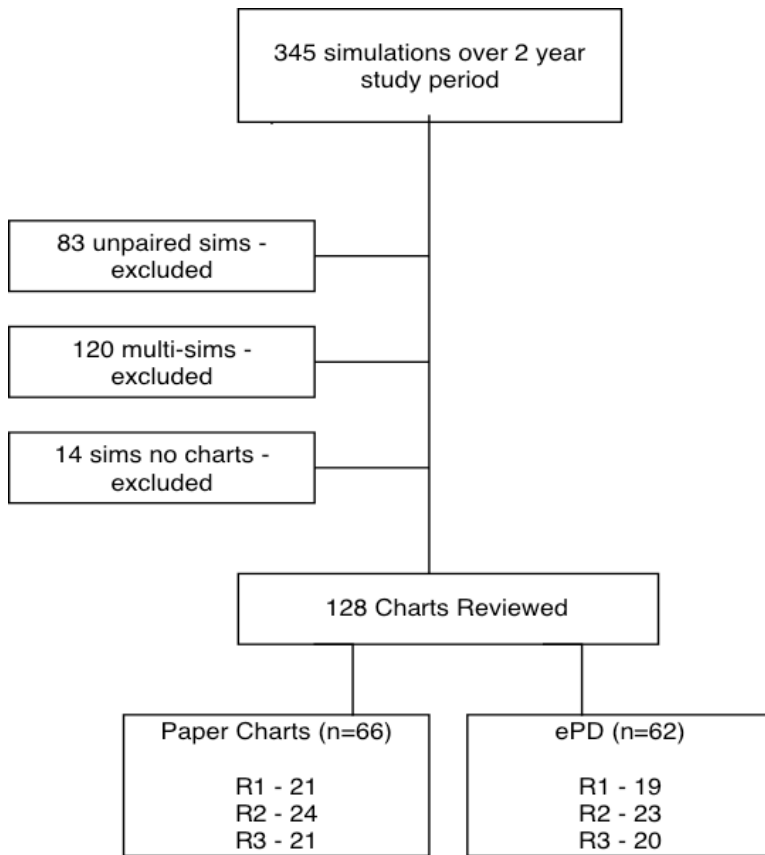
Figure 5 - Participant Selection

The selected simulations all required the patient to be admitted to an intensive care unit

(ICU) and contact with a consultant from another service. The multiple patient simulations

require the resident to care for three patients at a time and then complete charts at the end of the debriefing session. The 120 multiple patient simulation charts were eliminated because they are substantially different from the regular simulation sessions. There were 83 simulations that did not have available video, or were unpaired (the case was not used in one of the data collection periods or changed substantially between data collection years). Paired cases are important for this study as the gold standard mean for both periods should be the same so charting time can be compared. There were 14 simulations with no charts available due to Cerner errors, lack of time, or loss. It is unlikely that the 97 eliminated simulations are materially different from the included cases and they are equally distributed between paper and ePD.

Participant Analysis

ABEM in-training exam scores were used to compare the 2012-2013 class (paper charts) to the 2013-2014 class (ePD) of residents (Figure 6). Although there were small numerical differences in the mean exam scores between resident classes, the differences were not statistically significant (p = 0.396). There were small, but expected differences between training years with the R1s scoring significantly less than the R2s and R3s (p < 0.001). There was no significant difference between R2s and R3s (p = 0.579).
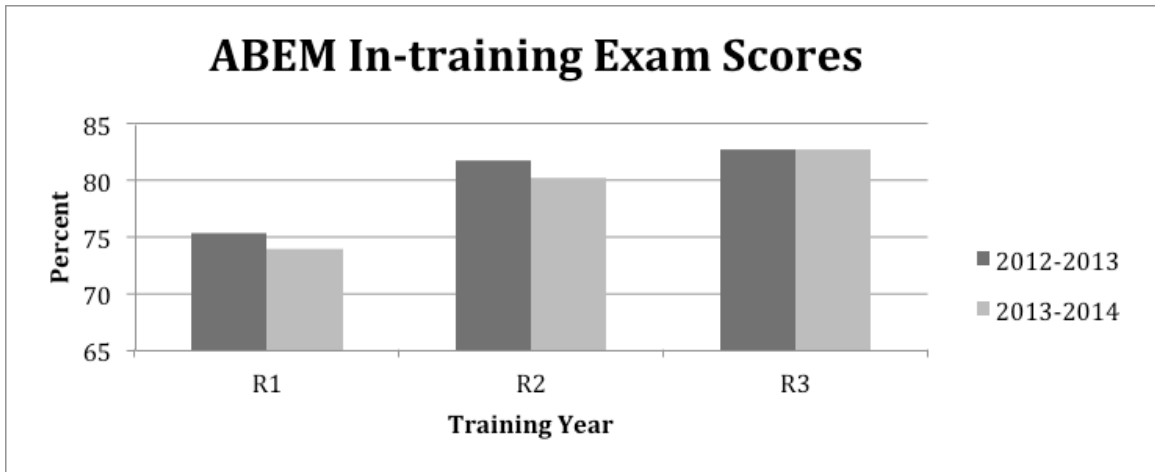
Figure 6 - ABEM In-Training Scores

Gold Standard Analysis

Paper charts had a slightly lower mean (M = 36.7, SD = 7.8) than ePD charts (M = 37.8, SD = 8.4) however; the difference was not statistically significant (p = 0.476). The domain level gold standard scores were also not significantly different between the groups (Figure 7).
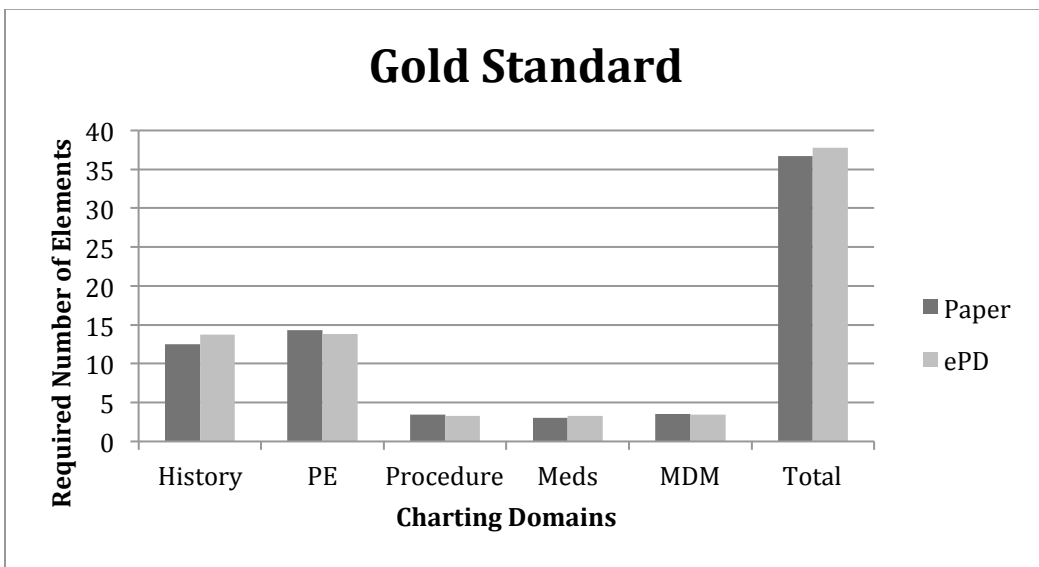
Figure 7 - Gold Standards

Primary End Points

Document Quality

Document quality was assessed using difference scores (Figure 8) and calculated reliability scores (Figure 9). Overall, participants using ePD had slightly lower difference scores (M=36.6, SD = 13.4) than those using paper charts (M = 37.4, SD = 14.9). This difference was not significant p = 0.745. The individual domain difference scores were also not significantly different. On average, ePD histories (M = 19.6, SD = 18.4) were lower than paper histories (M = 24.5, SD =17.1). However, paper documentation of procedures (M = 37.6, SD = 31.4) and medications (M = 24.8, SD = 37.5) were better than ePD procedures (M = 40.0, SD = 31.8) and medications (M = 30.6, SD = 31.3). Reliability scores for ePD (M=63.4, SD = 13.4) were slightly higher than paper charts (M = 62.6, SD = 14.9). The difference in reliability scores was not significant (p = 0.745).
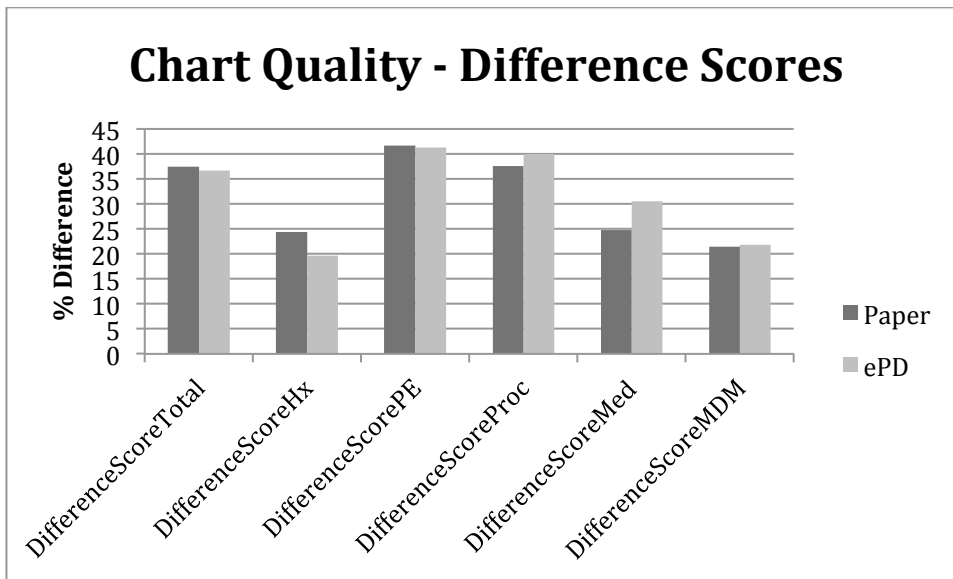
Figure 8 - Difference Scores
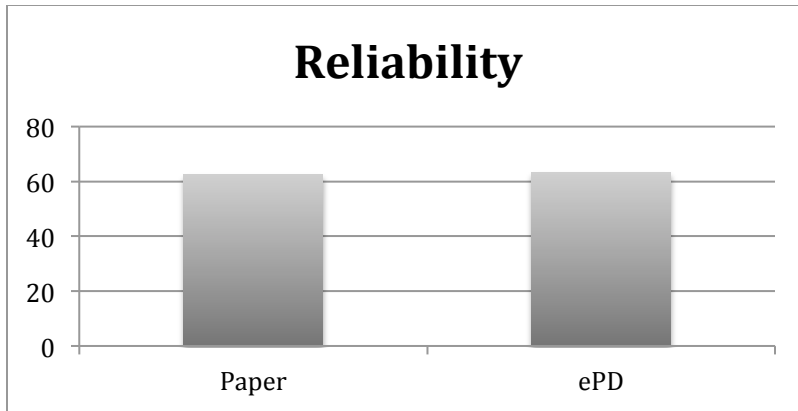
Figure 9 – Reliability

Cognitive Load

The NASA-TLX total cognitive load was slightly lower in the ePD group (M = 56.9, SD = 15.0) than the paper chart group (M = 60.2, SD = 10.8) (Table 3). This difference was not significantly different between the groups (p = 0.94). The domain sub-scores for mental demand (paper M = 43.3, SD = 23.5; ePD M= 27.3, SD = 27.3; p = 0.001) and frustration (paper M = 27.6, SD = 25.1; ePD M = 35.8, SD = 26.8; p = 0.043) were significantly different between the populations with paper charts more mentally demanding and ePD more frustrating. NASA-TLX scores were not significantly different between training levels in the total score or any of the domain sub-scores.

NASA-TLX Domain		Mean	SD	p - value
Total Score				
	Paper	60.2	10.8	0.094
	ePD	56.9	15.0	
Mental Demand				
	Paper	43.3	23.5	**0.001**
	ePD	27.3	27.3	
Frustration Level				
	Paper	27.6	25.1	**0.043**
	ePD	35.8	26.8	
Physical Demand				
	Paper	8.3	13.3	0.176
	ePD	5.8	11.0	
Temporal Demand				
	Paper	39.8	22.4	0.784
	ePD	40.8	25.5	
Performance				
	Paper	32.7	15.9	0.418
	ePD	34.9	20.1	
Effort				
	Paper	28.9	15.9	0.255
	ePD	26.1	16.4	

Table 3 - NASA-TLX Scores

Linear regression with chart quality as the dependent variable and predictors of mental demand and frustration was not significant and thus did not explain the variability in the scores with R^2 = 0.029. Linear regression with chart time as the dependent variable and predictors of mental demand and frustration was not significant and did not explain the variability in the scores with R^2 = 0.151.

Errors

There were an average of 10 errors (paper M = 10.4, SD = 4.7; ePD M = 10.4, SD = 3.9) in the required elements per chart (Figure 10). The majority of the errors were omission errors (paper M = 8.6, SD = 4.3; ePD M = 8.5, SD = 3.6). Mistakes were the next most frequent errors (paper M = 1.0, SD = 1.1; ePD M = 1.2, SD = 1.2) followed by falsifications (paper M = 0.89, SD = 1.5; ePD M = 0.69, SD = 1.2). There were no significant differences in error rates

between the groups in any category. On average, there was a higher percent error on paper

charts (M = 46.0, SD = 28.6) than for ePD (M = 43.2, SD = 21.4), however this difference was

not significant (p = 0.553).
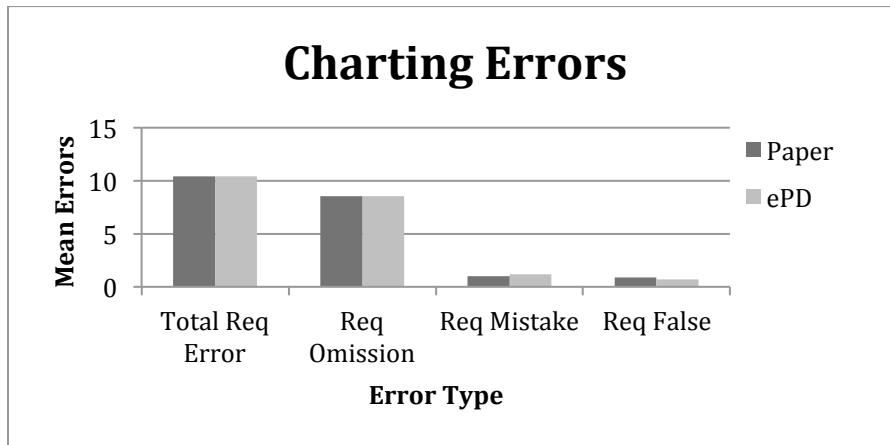
Figure 10 - Charting Errors

Performance

Performance was measured by evaluating time required to complete the charting task. In

the first phase (paper charts), the documentation time was measured directly from the

video of the encounter and debrief. In the second phase, the resident was asked to record

start and stop times for the charting task. There is a significant difference (p<0.001) in

documentation time with ePD averaging 9.2 ± 2.8 minutes and paper averaging 5.0 ± 1.5

minutes per chart with a large effect size (r=0.67) (Figure 11). There was an average of a

46% increase in charting time when residents used ePD compared to paper charts. Linear

regression with chart time as the dependent variable and total elements as the predictor

was not significant with R^2 = 0.029.
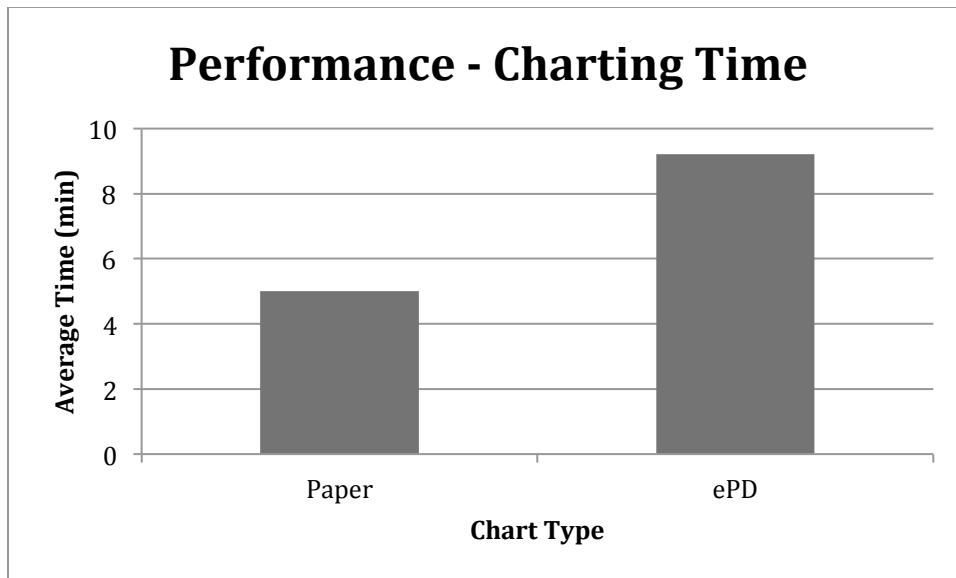
Figure 11 - Performance (charting time)

Workflow

Charting workflow was observed in the 128 simulation videos (approximately 47 hours) that were reviewed for this project. Simulated patients are all acutely ill and require substantial attention from the primary provider. The majority of residents using paper charts wrote notes on the chart as they were taking a patient history and the nurses asked them to write orders on the chart as they were given. The residents using ePD did not write notes or enter information into the computer even though the patient ID and login information were provided at the beginning of the simulation session. The nurses did not ask the resident to write orders, but instead wrote them down in a notebook at the bedside if there were multiple simultaneous orders. Following the simulation session, residents using paper charts would often write during the debriefing to finish the charting task. Residents using ePD completed the entire charting task after the debriefing session during the next simulation.

Secondary Endpoints

Error Domain Analysis
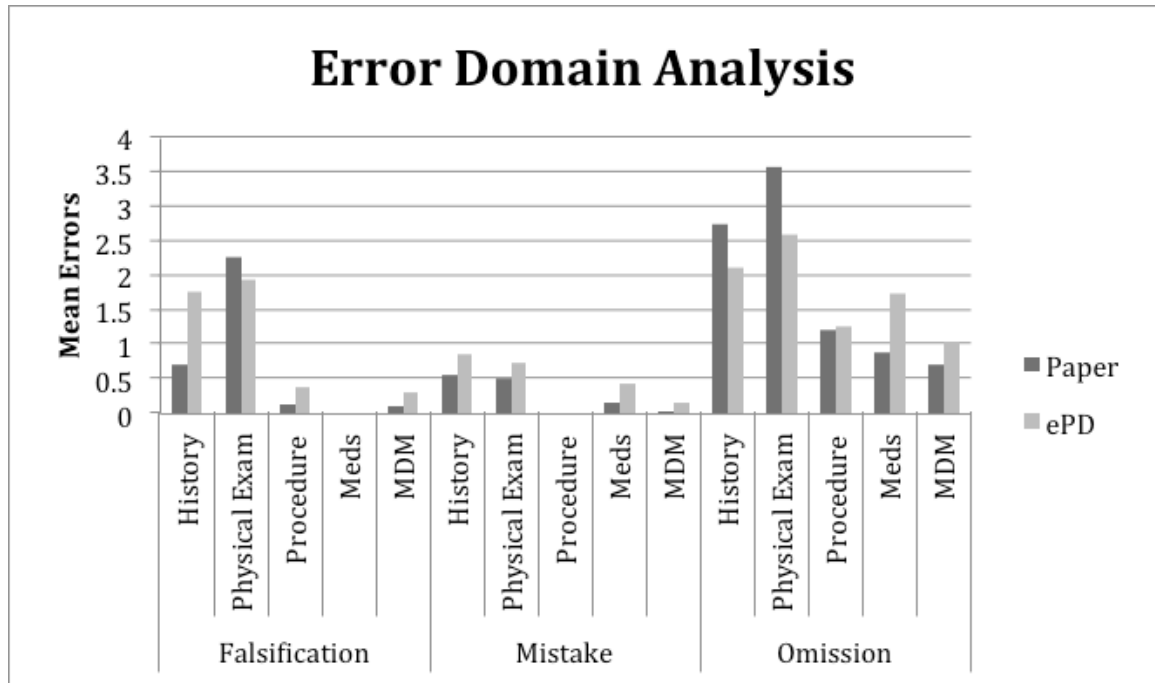
Figure 12 - Error Domain Analysis

The charting errors were coded into category (omission, falsification, and mistake) and into

domains (history, physical exam, procedures, medications, and medical decision making)

within the categories (Table 4). The categorical analysis appears above (Figure 10) in the

primary endpoint analysis. There were significant differences found for falsification in

procedures (p = 0.018) and mistakes in procedures (p = 0.044). There is a non-significant

increase in falsification for physical exam for paper charts (M = 2.26, SD = 1.8) when

compared to ePD (M=1.94, SD 2.26). The majority of mistakes occurred in the history and

physical exam, but those were less than one per chart. There were no significant differences

in omissions for any domain. The majority of omissions occurred in history and physical

exam for both chart types. Paper charts had higher omissions in history and physical exam

and ePD had higher omission errors in procedures, medications and medical decision-making (Figure 12).

Error Type	Domain	Paper (SD)	ePD (SD)
	Physical Exam	2.26 (1.8)	1.94 (2.26)
Falsification	History	0.69 (1.26)	1.75 (2.33)
	Procedure	**0.11 (0.00)**	**0.37 (0.00)**
	Meds	0.00 (0.09)	0.00 (0.35)
	MDM	0.08 (0.06)	0.28 (0.30)
Mistake	History	0.54 (0.57)	0.85 (0.96)
	Physical Exam	0.49 (0.05)	0.72 (0.82)
	Procedure	**0.00 (0.07)**	**0.00 (0.26)**
	Meds	0.13 (0.11)	0.43 (0.37)
	MDM	0.02 (0.00)	0.13 (0.00)
Omission	History	2.75 (2.81)	2.10 (2.28)
	Physical Exam	3.56 (3.22)	2.58 (1.94)
	Procedure	1.20 (1.46)	1.25 (1.24)
	Meds	0.87 (1.13)	1.72 (1.25)
	MDM	0.69 (0.56)	1.03 (0.66)

Table 4 - Error Results

Impact of Training Level

Two-way ANOVA was used with main effects of training year and chart type for all analyses. The main effects were not significant for quality score (p = 0.696), reliability (p = 0.696), error total (p = 0.422), or mistakes (p = 0.229).

Main effects were significant for efficiency (p = 0.037). There is a non-significant main effect of chart type (0.696) and a significant main effect of training year on efficiency (p < 0.001). Bonferroni *post hoc* test revealed that the efficiency was significantly lower for R1s compared to R3s (p = 0.031). Efficiency was no different for R2 compared to R3 or for R1 compared to R2. There was a non-significant interaction effect between training year and chart type (p = 0.447).

Main effects were significant for accuracy ($p < 0.001$). There is a non-significant main effect of chart type ($p = 0.676$) and a significant main effect of training year on accuracy ($p < 0.001$). Bonferroni *post hoc* test revealed that the accuracy of R1s is significantly better than R2s ($P < 0.001$) and the accuracy of R3s is significantly better than R2s ($p < 0.001$). There is no difference between R1s and R3s.

Falsifications were significantly influenced by the main effects ($p = 0.017$). There is a non-significant main effect of chart type ($p = 0.478$). There is a significant main effect of training year ($p = 0.004$) and the Bonferroni *post hoc* test revealed that R1s have fewer falsifications than R2s ($p = 0.021$), R3s have fewer falsifications than R2s ($p = 0.004$), and no significant differences between R1s and R3s. The interaction of training level and chart type is non-significant for falsification.

The main effects were significant for omission errors ($p = 0.024$). There is a non-significant main effect of chart type on omission errors ($p = 0.874$), a significant main effect of training year ($p = 0.004$), and a non-significant interaction effect ($p = 0.411$). Bonferroni post hoc tests reveal R2s have fewer omission errors than R3s and there is no difference between R1s and R3s or between R1s and R2s.

Secondary Quality Indicators - Efficiency, Accuracy, and Delta Scores

There were no significant differences between chart types for efficiency and accuracy (Table 5). Delta score was significantly different ($p = 0.02$) with ePD having more non-essential chart elements ($M = 19.6$, $SD = 10.2$) than paper ($M = 15.6$, $SD = 9.0$) (Figure 13).

	Paper (SD)	ePD (SD)	Significance
Delta Score	15.62 (8.98)	19.62 (10.22)	**p = 0.02**
Efficiency	64.91 (14.71)	59.76 (16.67)	p = 0.067
Accuracy	90.64 (9.61)	90.18 (10.82)	p = 0.81

Table 5 - Secondary Quality Measure Scores
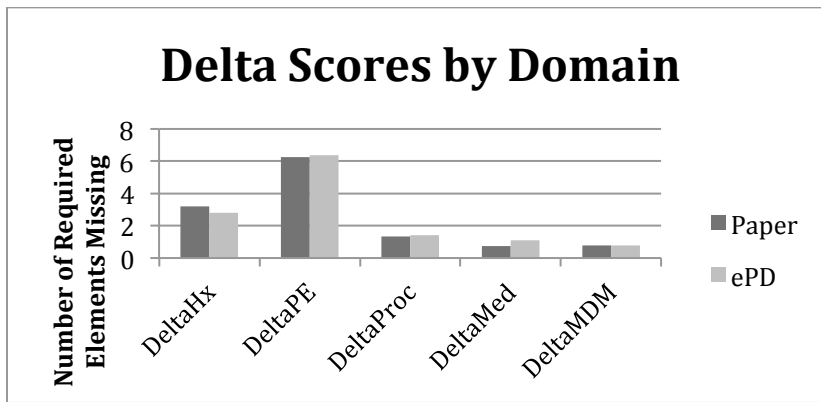
Figure 13 - Domain Delta Scores

DISCUSSION

This is the first study to examine the differences in chart quality and cognitive load between paper charts and ePD without considering the required billing components in the ED. The charts were written following simulation scenarios by R1- R3 EM residents. The scenarios were paired for paper and ePD but were different for each simulation session, so difference scores between the gold standard and the required elements present were used to compare simulation scenarios for chart quality. The results of this study can be used to guide EM resident documentation training and ePD implementation.

This study was an evaluation of 66 paper and 62 ePD charts written by EM residents following simulated patient encounters. The 2012-2013 resident group used paper documentation and the 2013-2014 resident group used ePD. The participant groups scored the same on the ABEM in-training exam and there was no difference in the gold standard total and domain scores between groups. The groups were homogeneous by both participant and by required elements for the charting tasks.

SEIPS Model

The SEIPS model allows evaluation of the total work system including person, organization, technology, tasks and environment when evaluating processes and outcomes. In this study, chart quality, error rate, and cognitive load are used as surrogates for patient safety outcomes. Performance was used as a surrogate for the process of ED patient management by the EM residents. The change from paper charts to ePD was the only change in the work system and thus it can be assumed to be the cause of changes in processes and outcomes. The results in context of the SEIPS model indicate that the change from paper charts to ePD increases the process time of charting by 47% without impacting the chart quality, error

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rate or total cognitive load (Table 6). Isolated, this finding indicates that patient safety is

not affected by the change in charting modalities. However, increasing process time may

severely impact patient safety in the context of the ED environment by delaying care to new

patients.

	Components	Elements	Study Outcomes
Work system	Person	EM residents	
	Organization	Healthcare Corporation	
	Technologies & Tools	Paper vs. ePD	
	Tasks	Clinical Documentation	
	Environment	Simulated ED	
Process	Care & Other processes	ED patient management Information flow	46% increase in time required to chart. Potential for fewer patients seen by each physician
Outcomes	Employee & Organizational	Job satisfaction Profitability	Greater frustration levels Fewer patients seen by providers due to increased charting time = less profitability
	Patient	Patient safety Quality of Care	No change in document quality or error rates Potential for decrease in quality of care due to increased charting time

Table 6 – Analysis of outcomes by conceptual model (SEIPS)

Chart Quality

One of the expected results of the HITECH act was improved chart quality. Several studies

have shown improvement in billing quality, but none have specifically evaluated quality

with respect to communicating the course of patient care. The results of this study do not

support improved documentation quality. The overall quality scores for ePD were slightly

better than paper charts, but the score differences were not significantly different. The average reliability score was 63% for both paper and ePD. Reliability is the ratio of required elements to gold standard elements.

The percent difference score between the gold standard and the required elements present in the chart had an average of 37%. The difference score indicates that there are a significant number of required elements missing from both paper and ePD charts. The domains of history and physical exam have the greatest number of missing elements (3 and 6 respectively). The domains of procedures, medications and medical decision-making averaged one missing element per chart. The majority of missing physical exam elements in this study were vital signs and repeated exam elements. Failure to document all of the required elements of the physical exam including changes over the course of the patient visit can adversely effect communication of the course of the patient's disease. There was no difference in chart quality between training years indicating that there is no improvement in documentation quality over the course of the EM residency training period.

Accuracy scores averaged 90% for both paper and ePD charts. When the omitted elements (completed tasks not recorded) were added to the ReqTotal, we were able to gain a sense of what the reliability of the chart would be if all tasks were charted. Video review of the simulation scenarios reveals that residents perform the appropriate required actions, but fail to document them in the patient chart. After accounting for omissions, there remains an average of 3 missing elements in physical exam. The gold standard required elements were determined to be essential to communicating the care of the patient in the ED. There are still a number of important missing elements in the chart even after accounting for omissions.

The results of this study imply two specific changes to current practice in order to improve documentation. First, improvements in documentation training are necessary regardless of ePD. Second, the EHR could be enhanced to support better documentation of omitted elements. Automated vital sign capture from bedside monitors integrated into ePD systems could eliminate the majority of missing elements in the physical exam domain and would provide a forcing strategy to the physician to address changes in vital signs and thus record the repeated exam findings. The majority of medical students and residents have no formal training in clinical documentation and it is clear from this study that it is imperative to include formal training during EM residencies (50-52). In the simulation environment, it might be helpful to include structured templates to assist the resident in documenting the required elements for each simulation case. This would reinforce the formal documentation training in the simulated environment without forcing the structure in the clinical environment. Reliable documentation of the course of treatment is essential to patient safety and continuity of care since the ED chart is often the only communication between health care providers for both admitted and discharged patients.

Performance

Performance was measured by evaluating the time needed to complete the charting task for this study. Paper charts took significantly less time (5 minutes) to complete than ePD (9.5 minutes). The increase in charting time was not related to the increase in the number of elements included on ePD charts. The ePD time includes logging in to the system and typing time, while the paper charts only include writing time. Self-reported typing skills are better than average for both groups of residents in this study. Charting workflow changed from partial completion during the case with paper charts to total completion after the case with

ePD even though computers were available during the case. In ePD sessions, nurses had to take notes for multiple simultaneous orders rather than having the physician write orders on a paper chart at the bedside. Increased charting time with ePD is reported in several studies (16, 84-86). Locally, a soon to be published study at the IU Health Methodist ED asked both faculty and residents to self-report the amount of time spent after shifts in charting tasks. On average, one year after implementation of ePD, faculty spend 41 minutes and residents spend 55 minutes more time after shifts than they spent charting with paper charts, which supports the increase in charting time when ePD is used (written communication with Melanie Heniff, MD on June 15, 2014).

A 46% increase in charting time and the changes in workflow observed in this analysis, when translated into clinical practice, have significant implications for EM physicians and ED patients. EM physicians are staying after their shifts (unpaid) or postponing charting tasks for hours or days (also unpaid time) in order to minimize wait time for patients. Residents skip conferences and stay late after shifts (work hour violations) to complete charting tasks. (87) Unlike other physicians caring for outpatients, EM physicians have no control over patient entry into the ED. EM physicians must manage the patient load by postponing less important tasks (like charting) or increasing staffing to prioritize patient care. Increasing staffing increases cost, but does not compromise patient safety or chart quality. Delaying the charting task may affect the quality of the data and could lead to more errors further decreasing the chart quality, as the physician has to rely on memory of the patient encounter. Physician wellness and job satisfaction are adversely affected by the addition of unpaid time required to complete charts (88). In addition to improved chart quality, a proposed benefit of EMR was to decrease the cost of healthcare and increase

efficiency.(88). In addition to improved chart quality, a proposed benefit of EHR was to improve efficiency in documentation. The results of this study do not support these claims.

Cognitive Load

Changes in workflow cause changes in cognitive load. A change in cognitive load can lead to increased risk of medical error (8, 10, 14). This study was designed to compare self-reported cognitive load between the paper chart and ePD groups. The NASA TLX was chosen to evaluate cognitive load as it is well validated in many fields including healthcare and technology use (65, 66). Study participants completed the NASA TLX after the charting task and were asked to think only about the charting task. The total cognitive load score was not different between the groups, however the domains of mental demand and frustration were significantly different. Temporal demands, performance, effort, and physical demand were unchanged between groups. There was no relationship between chart quality and mental demand or frustration.   There was no statistically significant relationship between time needed to chart and either frustration or mental demand. Mental demand was significantly higher in the paper chart group when compared to the ePD group. Higher mental demand is likely from the relative lack of prompts on the paper chart when compared to ePD. For example, the clinician is not prompted for each item in the list of pain evaluation on the paper chart. The ePD chart has clear sections for each of the required charting elements so the structure is present and it is only necessary to answer the questions or check the boxes. It is possible that the decrease in mental demand caused by the increased structure is responsible for the increase in the frustration domain for the ePD charts.   The ePD chart requires the clinician to answer the same questions more than once, which is clearly evident when evaluating the delta scores.

Error Analysis

With the increase in ePD use in EDs, there has been a significant increase in Medicare and

Medicaid billing with an investigation into possible fraud (89).   The concern is that the ePD

chart makes falsification errors more likely due to templates, copy/paste, and checkboxes.

This study was designed to evaluate errors in the three categories of omission, mistake and

falsification. The error rate was the same for both paper and ePD charts with an average of

10 errors per chart and the majority being omission errors (8 out of 10). Mistakes and

falsifications averaged one per chart for both groups. Paper charts had a higher error rate

per required element (by percent error) but the difference was not statistically significant.

The majority of errors occurred in the history and physical exam domains, mirroring the

results of a Finnish study on document quality (90). This is likely because clinicians know

what they usually ask during a history and what they usually do during a physical exam and

chart it even if they did not ask the question or do the action. There was a significant

difference in the procedure domain for both falsifications and mistakes, however the mean

for both types of errors was less than 0.37 so the difference is unlikely to be a clinically

significant difference.   Falsification errors in the history domain were higher in ePD charts,

which might be a result of the need to fill in the blanks on the semi-structured chart with

answers that make sense and are probably correct even though the question was not asked.

Physical exam domain errors were higher on paper charts and appear to be the result of

check boxes on the physical exam including details that were not addressed during the

exam. The most frequent falsifications for physical exam were eyes, abdominal exam, and

extremity exam. For example, the checkbox for extremity exam includes pulses intact, but

the clinician rarely checks pulses in all four extremities.

The results of this study do not support the claim that ePD has increased falsification errors. It is likely that the increase in ED billing after implementing ePD is more likely due to increase of legitimate elements included in the chart. The delta scores indicate significantly more elements included when using ePD over paper charts.

Training Level Effects

Training level (R1 – R3) had no effect on reliability, quality score, total error or the error category mistakes. As one might expect, R1s were less efficient than R2s and R3s, which indicates that they include more information on average than is required to communicate the condition of the patient. There is no difference between R2 and R3 residents in efficiency. Accuracy was significantly better for R1s and R3s when compared to R2s. Accuracy is an indirect measure of omissions and indicates that both R1s and R3s are more likely to complete required actions, but are less likely to document them than R2s. Error analysis supports this in that R2s have significantly fewer omission errors than R3s. Falsification errors were significantly higher for R2s than for R1s or R3s. This indicates that R2s know what they should be doing or know what they usually do, and chart the action as if it were done even if they did not do the action.

The training level effect appears to be a natural progression of learning from the R1s charting everything, R2s knowing what should be done, but forgetting to do it, to R3s failing to chart everything that they did. Extending this study to faculty EM physicians would be interesting to compare their error rate to the R3 residents.

Workflow

There is a noticeable change in workflow with the transition from partially charting at the bedside during the patient encounter with paper charts to completely charting at the computer after the patient encounter with ePD. The fast pace and acuity of the simulation patients does not allow the clinician time to log in to the ePD workstation during the patient encounter which is likely the same as the clinical environment when caring for acutely ill patients. The nurses often requested that the physician write orders on the paper chart during the simulation, but with ePD, the nurses wrote the orders down themselves on a notepad during the simulation. The inability to quickly write notes and orders in the electronic record increases the memory burden on the clinician and when caring for multiple patients, has the potential to increase documentation errors.

LIMITATIONS

This study presents a best-case scenario evaluation of chart quality by limiting the charting task to a single patient without interruptions. ED physicians care for multiple patients simultaneously and often see 16 to 24 patients during an eight to ten hour shift so it is likely that repeating this study in situ in the ED would yield significantly higher error rates and lower chart quality.   Examining a mannequin is different than examining a live patient and may have impacted the documentation of the history and physical exam. The gold standard elements were selected by two EM physicians from the same practice and may not reflect the entire practice of EM. The study only evaluated EM resident charting at a single institution with a single EMR so the results may not be generalizable to other institutions or specialties.

FUTURE DIRECTIONS

The logical extension of this study is to evaluate the multiple patient simulation charts for

changes in error rate, cognitive load and quality followed by delaying the charting task 24 to

48 hours after the simulation session to better simulate the routine practice of charting at

home following a busy shift. With the focus of hospital corporations and ED groups on

billing, it would be interesting to compare chart quality to billing quality and look for

overlap in errors. The results of this study stress the need for formal training in clinical

documentation for EM residents to improve the quality and reliability of charts.

CONCLUSION

The high fidelity simulation environment is an excellent laboratory to study the impact of EHR implementation in the ED. It is possible to evaluate charting errors that would not be possible to elucidate in the clinical environment. Charting time can be accurately measured without interruptions and multiple patients artificially inflating it. Overall charting quality for ED charts is poor with an average of 37% difference between what is charted and what should be charted to communicate the patient's course in the ED and does not improve during the EM resident training years. Workflow changes with the introduction of ePD, but there is no overall change in cognitive load for ED physicians. The bottom line is that although there is an increase in the time needed to chart using ePD there is no difference in quality measures or cognitive load between paper charts and ePD charts.

With the current system, the HITECH goals of improved quality and efficiency are not being met.   Changes in the current ePD are required to minimize the time differences between ePD and paper charts and maximize efficiency in the ED.   Specific training for clinical documentation to maximize quality as well as billing should be implemented in the ED residency training programs.

APPENDIX 1 – NASA TLX

Instructions for NASA TLX Evaluation given to study participants

NASA TLX - Sources of Workload Evaluation
The evaluation you are about to perform was developed by NASA to assess the relative importance of six factors in determining how much workload you experienced in the charting task you performed. The procedure is simple: You will be presented with a series of pairs of rating scale titles (for example, Effort vs. Mental Demand) and asked to choose which of the items was more important to your experience of workload in the task (charting) that you just performed. Each pair of scales will appear separately. Mark the scaled title that represents the most important contributor to workload for the charting task you just performed. Please consider your choices carefully and make them consistent with how you used the rating scales. There are no correct answers or patterns; we are only interested in your personal experience.

Rating scales
This set of six workload scales was developed by NASA for you to use in evaluating your experiences during different tasks. Please read the descriptions of the scales carefully. It is extremely important that they be clear to you. After your simulation and charting, you will be given a sheet of rating scales in a redcap survey. You will evaluate each task by marking each scale at the point, which matches your experience. Each line has two end point descriptors that describe the scale. Note that "performance" goes from good on the left to bad on the right, which is different from the others. Please consider each scale individually. Your ratings will play an important role in the evaluation being conducted, thus your active participation is essential to the success of this process and is greatly appreciated by all of us.

Mental Demand	How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
Physical Demand	How much physical activity (e.g. pushing, pulling, turning, controlling, activating)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
Temporal Demand	How much time pressure did you feel due to the rate or pace at which the task or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
Performance	How successful do you think you were in accomplishing the goals of the task set by yourself? How satisfied were you with your performance in accomplishing these goals?
Effort	How hard did you have to work (mentally and physically) to accomplish your level of performance?
Frustration Level	How insecure, discourage, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Example of Comparisons used for determining weighted averages

Physical Demand vs. Mental Demand	Temporal Demand vs. Physical Demand	Temporal Demand vs. Frustration
Temporal Demand vs. Mental Demand	Performance vs. Physical Demand	Temporal Demand vs. Effort
Performance vs. Mental Demand	Frustration vs. Physical Demand	Performance vs. Frustration
Frustration vs. Mental Demand	Effort vs. Physical Demand	Performance vs. Effort
Effort vs. Mental Demand	Temporal Demand vs. Performance	Effort vs. Frustration

Example of rating scales used for workload

Mental Demand
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Low   High

Physical Demand
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Low   High

Temporal Demand
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Low   High

Performance
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Good   Bad

Effort
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Low   High

Frustration
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
Low   High
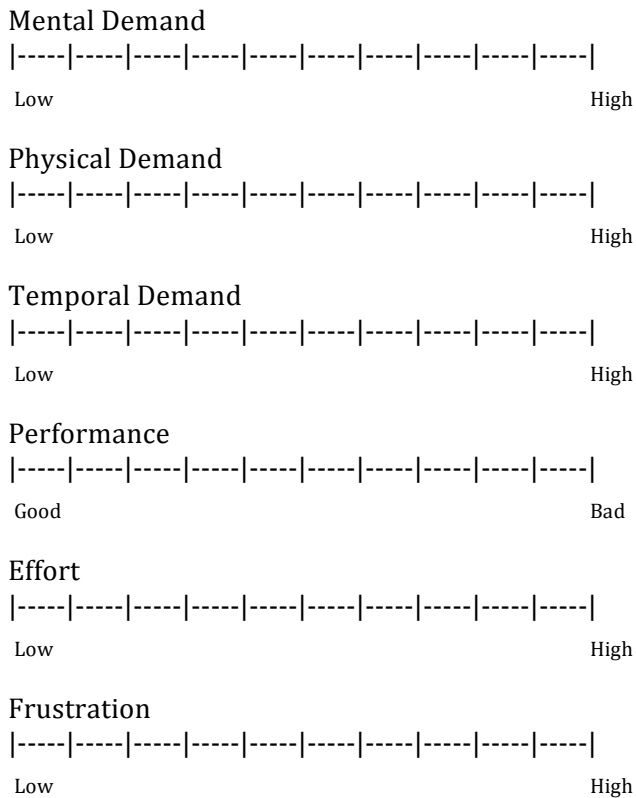
NASA TLX Scoring

Sources of Workload Tally Sheet		
Scale Title	Tally	Weight
Mental Demand		
Physical Demand		
Temporal Demand		
Performance		
Effort		
Frustration		

Total Count = _____ Total count included only as a check for 15 items. No weight can have a value >5.

Weighted Rating Worksheet

Scale Title	Weight	Raw Rating	Adjusted Rating (weight*raw)
Mental Demand			
Physical Demand			
Temporal Demand			
Performance			
Effort			
Frustration			
Sum of Adjusted Rating Column			
Weighted Rating (Sum /15)			

Title
EMER_MED_MS_1_CP

Additional Material
EMER_MED_MS_1_CP_EKG_1.jpg – Initial EKG handed to students
EMER_MED_MS_1_CP_EKG_2.jpg – Second EKG handed to students
EMER_MED_MS_1_CP_CXR.jpg – CXR available for view on monitor

Target audience
R1 Orientation

Brief Summary
55yo M who comes in complaining of chest pain earlier, initially has normal EKG, while in department develops recurrent chest pain and repeat EKG shows STEMI and needs heart catheterization.

Text to be shown on screen prior at beginning of case:
55 yo Mr. Walker presents by EMS after having an episode of crushing substernal chest pain that resolved on arrival of EMS.

Suggested Learning Objectives
General:
- Taking a quick history
- Interacting with consultants
- Patient teaching of therapies
- Reassessing patient when circumstances change

Scenario Specific:
- History taking of chest pain
- Recognize ST elevation MI on EKG
- Treatment of suspected unstable angina and acute MI
- Cardiology consultation/ cath lab activation

Core competencies addressed (Include those that apply to this specific case):
1. Patient care
2. Medical knowledge
3. Interpersonal and communication skills
4. Professionalism

Setting
Emergency Department, patient is sitting in an acute bed. No family members present.. The nurse has left the room to see another patient.

Equipment Required:
Adult mannequin, nasal cannula oxygen, diaphoresis?

Patient Description
Admit Date: 0   Hospital Day: 0

Name: John Walker   Gender: M
Age:55   Race: Caucasian
Weight: 70kg   Height: 5'11"
Religion: none
Major Support: none
Attending Physician: none
History of Present Illness (HPI):
Patient has had several 5-10 minute episodes of substernal chest pain over the last 2 days
that came on while moving some boxes or exerting himself, pain is 8/10 when present,
described as pressure radiating to L arm and jaw. Associated SOB, nausea/vomiting x1. He
has had no prior episodes of this or other chest pain.
Past Medical History:
   Allergies: None
   Medications: metoprolol, furosemide, lisinopril, pravastatin
   Immunizations: UTD
   Medical History: Hypertension, hypercholesterolemia
   Surgical History: inguinal hernia repair 10 years ago
   Trauma: n/a
   Diet Requirements: n/a
   GYN History: n/a
Social History: 20 pk-yr smoking history, investment banker
Family History: Father died of CVA at 60yo, Brother with hypertension
Review of Systems: CP, SOB, nausea/vomiting, otherwise negative
Physical Exam:
   Vital Signs: HR-84; BP-155/69; RR-18; O2-96%, Temp-98.2
   HEENT: wnl
   Neck: wnl
   Chest: tachypneic, CTA B
   Cardiac: tachy, no murmurs
   Back: wnl
   Breast: wnl
   Abdomen: wnl
   Genital/Urinary: wnl
   Rectal: wnl
   Musculoskeletal: wnl
   Vascular: wnl
   Neurologic: wnl
   Integument: wnl

Primary Medical Diagnosis:
   • Unstable Angina/Acute Coronary Syndrome

Diagnostics Indicated:
   • EKG – normal
   • CXR - wnl

Therapy Indicated:
   • ASA
   • O2

- Nitroglycerin if pain returns
- +/- heparin/enoxaparin
- +/- beta blockers
- Admission

Consultants:
- Cardiology

Diagnostics/ Therapy not available to learner: none

Scenario Story Board

Initial Presentation of Patient

Vital Signs / Monitor Readings
HR-84; BP-155/69; RR-18; O2-96%, Temp-98.2
Other
Normal Sinus Rhythm
Assessment Findings
CNS - wnl
Cardio - tachy with pvcs
Respiratory - wnl
GI - wnl
GU - wnl
Integumentary - wnl
Patient Vocal Sounds – speaking easily
Expected Learner Interventions
- Take a quick history of chest pain
- Ask for an EKG
- Initiate chest pain workup and admission for further testing (CXR, CM, CBC, etc.)

Patient Outcomes with appropriate interventions
- After 8 minutes (or students have completed initial interventions), patient will develop more severe and continuous chest pain, becoming diaphoretic and clammy, have nurse say patient looks very sweaty.

Patient Outcomes with inappropriate or lack of interventions
- Patient questions why he was having chest pain earlier
- Same as with appropriate interventions

Cues/Prompt desired
- If students seem stumped with what to do once severe episode of chest pain develops have nurse recommend some nitro and/or a repeat ekg.

Transitional Period

Vital Signs / Monitor Readings
HR-108; BP-172/85; RR-29; O2-100% if student put o2 on 2LNC, Temp-98.2

Other
ST elevation MI with frequent PVCs on monitor
Assessment Findings
CNS - wnl
Cardio - tachy with pvcs
Respiratory - tachypneic
GI - wnl
GU - wnl
Integumentary - diapohoretic
Patient Vocal Sounds – speaking in 4-5 word sentences secondary to pain
Expected Learners Interventions
- Appropriately diagnose ST elevation MI on EKG
- Treat Acute MI:
    - ASA-if not already done
    - 02
    - Nitrates
    - +/- morphine
- Initiate reperfusion therapy (card consult for cath or thrombolytics)

Patient Outcomes with appropriate interventions
- Chest pain improves to 2/10
- Patient thanks provider

Patient Outcomes with inappropriate or lack of interventions
- Pain worsens, patient c/o "heaviness"
- increasing PVCs on monitor

Cues/Prompt desired
- Patient verbalizes pain

Telephone Orders
Call Cardiology consult
Conclusion

Vital Signs / Monitor Readings
HR-92; BP-128/69; RR-16; O2-96% 2LNC, Temp-98.2
Other
ST elevation MI with frequent PVCs on monitor
Assessment Findings
CNS - wnl
Cardio – nsr, pvcs
Respiratory - wnl
GI - wnl
GU - wnl
Integumentary – less diapohoretic
Patient Vocal Sounds – speaking in full sentences with less pain

Expected Learners Interventions
- Treat Acute MI per cardiology recs:

- Plavix 600mg PO
- Heparin 5000 units IV then wt based drip (if not given already)
- Discuss need to go to cath lab with patient

Patient Outcomes with appropriate interventions
- Chest pain constant at 3/10
- Patient agrees to cath lab

Patient Outcomes with inappropriate or lack of interventions
- Pain worsens, patient asks why he needs to go to cath lab and why cant you just give me some medicine and to speak to a cardiologist
- Asks to sign out against medical advice

Cues/Prompt desired
- Patient asks how do you treat a heart attack, will he get a heart cath?
- If learner is doing well, patient could initially resist cath

Telephone Orders

Important Scenario Focal Point 1
- chest pain history

Rationale
Focused history and evaluation are essential to emergency medicine practice

Important Scenario Focal Point 2
- Recognize and treat Unstable Angina appropriately
- Recognize change in patient condition and reevaluate and discover STEMI

Rationale
Regardless of future specialty, students should recognize and know how to treat Unstable Angina/acute STEMI

Important Scenario Focal Point 3
- Communication with consultant and patient

Rationale
Essential to future medical practice in any field

Story Board

Initial Presentation of Patient

- Take history of Chest pain
- No present pain
- EKG = non specific changes

Inappropriate or lack of interventions

Expected Learner Interventions

- ASA, o2, initiate workup, +/-enoxaparin

Patient Condition

- Patient questions why he had chest pain,
- Develops more severe episode of chest pain

Patient Condition

- Patient develops more severe episode of chest pain

Inappropriate or lack of interventions

Appropriate Action Taken

- Nitro, repeat EKG (with STEMI), recognize need for reperfusion (cath),

Inappropriate or lack of interventions

Expected Learner Interventions

- Nitro, repeat EKG (with STEMI), recognize need for reperfusion (cath),

Patient Condition

- Patient pain continues
- Patient become more worried demanding explanation and to see cardiologist
- Leaves AMA

Patient Condition

- Transfer to cath lab

APPENDIX 3 – SAMPLE PAPER ED CHART

All information contained in the chart is for a simulated patient

Indiana University Health

RZ-0130-002

22182
CH - 152
(JULY 11)

ARRIVAL TIME

TRIAGE TIME

ROOMS

TIME IN ROOM

CHART #

ROOM

SEEN BY PROVIDER   RELEASED

☐ SEEN ON ARRIVAL

LABEL

Smith, Pearl
LAST NAME   FIRST NAME   M.I.
D.O.B.
SS#

ROS

YES NO CONSTITUTIONAL
☐ ☐ Fever
☐ ☐ Chills
............EYES
☐ ☐ Visual change
☐ ☐ Eye pain
............ENT / Throat
☐ ☐ Tinnitus
☐ ☐ Ear pain
☐ ☐ Epistaxis
☐ ☐ Sore Throat
............CV
☐ ☐ Chest pain
☐ ☐ DOE
☐ ☐ Orthopnea
☐ ☐ PND
☐ ☐ Edema
............RESPIRATORY
☐ ☐ Dyspnea
☐ ☐ Cough
☐ ☐ Phlegm
☐ ☐ Hemoptysis
............GI
☐ ☐ Abdominal pain
☐ ☐ Nausea
☐ ☐ Vomiting
☐ ☐ Diarrhea
☐ ☐ Constipation
☐ ☐ Anorexia
............GU
☐ ☐ Frequency
☐ ☐ Dysuria
☐ ☐ Hematuria
☐ ☐ Difficulty voiding
☐ ☐ Vaginal bleeding
☐ ☐ Vaginal discharge
☐ ☐ Pelvic pain
☐ ☐ Penile discharge
☐ ☐ Penile pain
............MUSCULOSKELETAL
☐ ☐ Myalgias
☐ ☐ Arthralgias
☐ ☐ Back pain
............NEURO
☐ ☐ Headache
☐ ☐ Numbness
☐ ☐ Weakness
☐ ☐ Confusion
............PSYCH
☐ ☐ Stress
☐ ☐ Anxiety
☐ ☐ Depression
............ENDOCRINE
☐ ☐ Malaise
☐ ☐ Weight loss
☐ ☐ Heat/Cold Intolerance
............HEME/LYMPH
☐ ☐ Unusual bruising
☐ ☐ Excessive bleeding
............ALLERGY/IMMUNO
☐ ☐ Recurrent infections
............SKIN
☐ ☐ Rashes
☐ ☐ Sweats

☐ All other systems
reviewed and negative

CC/HPI

☐ MVA ☐ AMB transport
YES NO
☐ ☐ Seat restraints
☐ ☐ Walked at scene
☐ ☐ Driver   ☐ Passenger
☐ ☐ Front seat ☐ Rear
☐ EMS Record reviewed ☐ Nursing Notes reviewed – Agree except as noted below
☐ History unobtainable due to patient's critical medical status
☐ History limited due to ☐ Mental status/confusion ☐ _____

90   ☐ Year   ☐ White   ☐ Male
      ☐ Month ☐ African-American ☐ Female
      ☐ Week   ☐ Hispanic
              ☐ Other_____

CC: AMS

Location

Quality   Per EMS found down

Severity PAIN___/10   in bed.

Timing   Bed bound for > 1 year.

Duration

Context   ? Compliane č meds.

Modifying factors

Associated signs and symptoms +family members present.

DIAGNOSTICS/RESULTS

CBC

Urine   dip

BMP
I-STAT 8   Ca

Pregnancy test   ☐POS ☐NEG

Wet Prep ☐Neg ☐Trich ☐Yeast ☐Clue cells

☐ NSR
EKG: Rhythm_____
INTERP:

RADIOLOGY

Results

PCP:

CIRCLE POSITIVES   STRIKE NEGATIVE

PMH: HTN DM CAD CABG PTCA Stents (CHF) Asthma COPD CVA PUD GERD Seizure disorder CRI ESRD ↑ lipids ↓ thyroid
☐ Immunizations up to date

MEDS ☐ SEE MED REC FORM   Synthroid

ALLERGIES ☐ NKA   Unknown

FAMILY HX: HTN DM CAD Asthma COPD CVA Seizure disorder

SOCIAL HX EtOH Tobacco Cocaine IVDA DV ECF Resident

**EMERGENCY PHYSICIAN
PATIENT CARE RECORD**
Page 1 of 2

ED VISIT RCORDS
B-33

PHYSICAL EXAM

CHART # _____

☐ Initial Vital signs from nursing notes reviewed and noted

VS: BP _159, 76_ P _36_ RR _18_ T _33.4_ SpO₂ _76_ ☐ RA
☐ O₂ ____

LABEL

☐	☐	☐	Awake, alert, and appropriate
☐	⊘	☐	Oriented x ____
☐	☐	☐	Cap refill < 2 seconds
☐	⊘	☐	No meningeal, respiratory distress or dehydration signs
☐	⊘	☐	Eyes: PERRL, EOMI
☐	☐	☐	Fundi: No papilledema, exudate, or hemorrhage
☐	⊘	☐	OP: No erythema, swelling or exudate
☐	☐	☐	Ears: No TM erythema, swelling or loss of landmarks
☐	☐	☐	Head: No calvarial tenderness or evidence of basilar skull fracture
☐	☐	☐	Neck: Supple, no adenopathy
☐	☐	☐	COR: Regular, no murmur, gallop, or rub
☐	⊘	☐	Lungs: Clear to ausc, no rubs
☐	⊘	☐	ABD: Soft, BS active, no G/T/R, no distention or mass
☐	☐	☐	Rectal: No mass or stricture; brown stool
☐	☐	☐	GYN: Normal EG, vault and cervix, no discharge or blood, uterus and adnexa normal
☐	☐	☐	Spine: No midline tenderness or deformity
☐	☐	☐	Lumbar: FROM, LE neuro intact, SLR tests normal
☐	☐	☐	Pelvis: Nontender, clinically stable
☐	⊘	☐	EXTR : FROM, No trauma, no edema or cyanosis, pulses intact
☐	☐	☐	Skin: warm and dry; no rashes
☐	☐	☐	NEURO: CNII-XII intact, sensory, motor & cerebellar WNL
☐	⊘	☐	Psych: Normal affect
☐	☐	☐	Heme/Lymph: No significant lymphadenopathy; no palpable splenomegaly
☐	☐	☐	Neurovascular intact distal to injury

Handwritten notes: Unresponsive, moans
MAC.

A/P.
AMS

Redness @ neck
polyrenia

7 Strods, Synthroid
Fluids,
Intubate

MEDICAL DECISION MAKING

☐ Prior records reviewed
   ☐ Clarian Med Rec
      ☐ EMS   ☐ IMPC
      ☐ ECF   ☐ Referring Hospital
☐ Prior EKG reviewed
      ☐ No significant change
☐ Response to therapy:
   ☐ Improved
   ☐ No significant change
CC TIME: _____ minutes

CONSULTATION

Time _____
Dr. _____ /Traffic requests pt.
Admit ICU
be admitted to Dr. _____

PROCEDURES

☐ Wound debridement
☐ Wound explored, no FB Visible or palpable
☐ Suture repair _____ cm, #
☐ Intubation   ☐ Lumbar puncture
☐ Arterial line   ☐ Central venous line
☐ Nasal packing
☐ I&D   ☐ FB removal from _____
☐ Corneal FB removal, using slit lamp
☐ Procedural sedation

☐ Procedural "Time Out" done

Staff Physician

☐ I have seen the patient and agree with the Medical Student's documented Past Medical, Family and Social History and Review of Systems

☐ The risks, benefits and alternatives (including non-performance) to the procedure were discussed with the patient. The patient understands and consents to the procedure

---

KEY: A - abrasion, D - deformity, R - redness, S - swelling, E - ecchymosis, T - tenderness, L - laceration

STAFFED W/	☐ I have seen and examined the patient. I agree with the note and plan except as noted above.	☐ I was present for the key portion of all procedures performed.	CONDITION

CONDITION: ☐ GOOD ☐ SERIOUS ☐ FAIR ☐ CRITICAL ☐ RHC

CLINICAL IMPRESSION

1	Myxedema Coma	4	Respiratory failure
2	Lactemia	5	
3	Hypothermia	6	

Signatures
MS ▓▓▓▓▓▓▓▓▓▓
Staff MD

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Indiana University Health

R2-0130-002

IU Health
Methodist Hospital EMTC

Start Time	IV#	Vol.	Infusion Bolus/Fluids/IVPB	Mode/ Rate	Total Vol Infused	Stop Time	Int.

Patient Sticker

Smith, Pearl

Allergies:

Weight in kg:

Care Provider Signature	Initials

Time	MD Medication/Intervention Procedures Orders	Provider Signature	Completed By	Completed Time	Pain Pre Post		Time Re √
	Hydrocortisone 100g IV						
	Synthroid 400mcg IV						
	NSTL IV Bolus						
	Rocuronium 100g IV						
	Etomidate 20g IV						

Medication & IV Administration
Documentation & Orders

Orders/Protocols

T-5

77217
CH-2427 (JAN 11)
Page 1 of 1

IU HEALTH Indiana University Health

METHODIST EMERGENCY DEPARTMENT
1701 N. SENATE BLVD
INDIANAPOLIS, IN 46202
PHONE: (317) 962-8355
              (317) 962-1172
FAX: (317) 962-0841

ESD
STAT

LAST NAME	FIRST NAME	M.I.
DOB		

EMTC LAB TESTS

HEMATOLOGY
- ☑ CBC w/ Platelet and Automated Differential
- ☐ CBC w/Platelet

CHEMISTRY
- ☑ Basic Metabolic Profile
  - ☐ BNP - B-type Natriuretic Peptide level
- ☐ Ammonia
  - ☐ Calcium
- ☐ CPK-MB
  - ☐ Hepatic function panel
- ☐ Lipase
  - ☐ Magnesium
- ☐ Serum HCG (Quantitative)

TOXICOLOGY
- ☐ Acetaminophen
  - ☐ Salicylate
- ☐ Blood alcohol

COAGULATION
- ☑ PT/INR
  - ☐ Activated PTT
- ☐ D Dimer
  - ☐ Fibrinogen

URINE ☐ CCMS ☐ CATH IN/OUT ☐ Foley
- ☐ Urinalysis – Machine Dip
  - ☐ Urine Pregnancy/UPT

MICROBIOLOGY
- ☐ RSV
  - ☐ Influenza A and B
- ☐ Monospot
  - ☐ Rapid Strep
- ☐ ***HIV ½***OUCH Line cases only***

Point of Care / I-STAT
- ☐ iSTATCHEM 8
  - ☐ Gastroccult
- ☐ Creatinine
  - ☐ ABG
- ☐ Stool Hemoccult
  - ☐ Troponin

Stroke One Panel
- ☐ CBC w/Plts, PT/INR, aPTT,
  iSTAT Troponin, iSTAT CHEM 8
  - ☐ UPT (If possibility of pregnancy)

EKG
- ☑ EKG
Indication_____

MAIN LAB TESTS

BODY FLUIDS - Urine ☐ CCMS ☐ CATH
- ☑ Microscopic urinalysis
  - ☑ Urine culture

BODY FLUIDS – SOURCE_____
- ☐ Cell Count Fluid   Tube #___
- ☐ Glucose Fluid   Tube #___
- ☐ Protein Fluid   Tube #___
- ☐ Culture   Tube #___
- ☐ Other_____

MICROBIOLOGY
- ☐ Aerobe Culture   ☐ Anaerobe Culture
  - ☐ Gram Stain
- ☑ Blood Culture x___
  - ☐ Respiratory Culture with Gram Stain
- ☐ Herpes Culture
  - ☐ Stool Culture
- ☐ C Diff Assay
  - ☐ Wet Prep

OTHER LABS
- ☐ Retic Count
  - ☐ Type and Screen
- ☐ Type and Cross – HOLD_____units PRBCs
  - ☐ Rho-Gam work-up
- ☐ Phenytoin level
  - ☐ Carbamezepine level
- ☐ Depakote level

☐ _____

GC and Chlamydia tests

*****DNA PROBES/PCR*****
NOTE: NOT APPROPRIATE IN ASSAULT CASES.
MUST DO CULTURE
- ☐ Chlamydia PCR Probe   ☐ Cervix ☐ Urethra
- ☐ GC PCR Probe   ☐ Cervix ☐ Urethra

*****CULTURES*****
- ☐ Chlamydia Culture *USE M4 RT TRANSPORT TUBE
SOURCE (MARK ONE)
  ☐ CERVIX, ☐ URETHRAL, ☐ EYE
  ☐ NASOPHARYNX, ☐ RECTAL
GC Culture *USE CULTURETTE SWAB

SOURCE (MARK ONE)
☐ CERVIX ☐ URETHRAL ☐ RECTAL ☐ THROAT

*****TREATMENT MUST BE INDICATED*****

TREATMENT: YES_____ NO_____

ANTIBIOTIC_____

DOSE_____

POSITIVES ARE REPORTED TO THE MARION COUNTY HEALTH DEPARTMENT

RADIOLOGY - plain films
- ☑ Chest ☐ Portable
- ☐ KUB/upright abd/chest
- ☐ Pelvis
- ☐ C-Spine
- ☐ T-Spine
- ☐ LS-Spine

	LEFT		RIGHT
Clavicle	☐		☐
Shoulder	☐		☐
Humerus	☐		☐
Elbow	☐		☐
Forearm	☐		☐
Wrist	☐		☐
Hand	☐		☐
Finger___	☐		☐
Hip	☐		☐
Femur	☐		☐
Knee	☐		☐
Tibia-Fibula	☐		☐
Ankle	☐		☐
Foot	☐		☐
Toe___	☐		☐

Other_____

Indication_____

CT
- ☐ Head without IV Contrast
- ☐ C-spine (Trauma)
- ☐ PE (pulmonary emboli)
- ☐ Chest with IV contrast

Abdomen-Pelvis
- ☐ Routine Abdomen-Pelvis
  (with IV contrast AND oral contrast)
- ☐ WITHOUT contrast (no IV OR oral)
- ☐ with IV contrast ONLY
- ☐ with oral contrast ONLY
- ☐ Renal stone study (Spiral non-contrast Abd-pelvis)
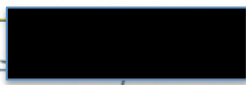
Indication (Mandatory)_____

_____

ULTRASONOGRAPHY
- ☐ Pelvic with Endovaginal
- ☐ Doppler venography of_____
- ☐ Other_____

Indication_____

[signature redacted]
MD SIGNATURE

ESD STAT ORDERS
Page 1 of 1

White Copy - Chart
Canary (both) - Lab
Pink - EMTC RN

T-5

APPENDIX 4 – SAMPLE EPD ED CHART

All information contained in the chart is for a simulated patient

ED Physician Progress Note

Jones, Karen - 42008861

* Final Report *

Result type:	ED Physician Progress Note
Result title:	Abdominal pain
Performed by:	Train, R2C2001 on 21 November 2013 10:45
Encounter info:	000263098295, IUH Methodist Hosp, Emergency, 10/11/2013 -

R2C13001

* Final Report *

Abdominal pain

Patient: **Jones, Karen**   MRN: **42008861**   FIN: **000263098295**
Age: **32 years**   Sex: **Female**   DOB: **04/15/1981**
Associated Diagnoses: **None**
Author: **Train, R2C2001**

Basic Information
   Time seen: Date & time 11/21/2013 10:00:00.
   History source: Patient, friend.

History of Present Illness
   32 y/o presents with abd cramping, vomiting, and diarrhea for one day. Has had a fever and increasing confusion per roommate. Abd pain is diffuse and crampy. No blood in vomit. No neck pain or headache. .

Review of Systems
       Constitutional symptoms: Fever.
       Respiratory symptoms: Shortness of breath.
       Cardiovascular symptoms: No chest pain,
       Gastrointestinal symptoms: Abdominal pain, nausea, vomiting, diarrhea.
       Neurologic symptoms: No headache,
          Additional review of systems information: All other systems reviewed and otherwise negative.

Health Status
   Allergies: .
       Allergic Reactions (All)
          NKA
   Medications: None.

Past Medical/ Family/ Social History

   Medical history
      Negative.
   Surgical history: Negative.
   Family history: Not significant.
   Social history: Alcohol use: Occasionally, Tobacco use: Denies, Drug use: Denies.

Physical Examination

       Vital Signs

Printed by:	Train, R1C2001
Printed on:	11/21/2013 11:18

Page 1 of 2
(Continued)

* Final Report *

Vital Signs Flowsheet.
```
   11/20/2013 14:48        BMI                      25.5
                           Weight for Calculation   72.00 kg
                           BSAM2                    1.73 m2
   11/20/2013 14:47        Height CM                168 cm
                           Weight KG                72 kg
```

Body Measurements.
```
   11/20/2013 14:48        BMI                      25.5
   11/20/2013 14:47        Height CM                168 cm
                           Height method            Actual
                           Weight KG                72 kg
                           Weight method            Actual
```

General: Alert, Oriented to place and person but has repetitive questioning with date..

Skin: Warm.

Head: Normocephalic.

Neck: Supple, no tenderness.

Cardiovascular: Tachycardic, Grade III murmur.

Respiratory: Lungs are clear to auscultation, respirations are non-labored, Symmetrical chest wall expansion.

Gastrointestinal: Diffusely ttp with no guarding or rebound.

Medical Decision Making

Differential Diagnosis: Abdominal pain, Appendicitis, pancreatitis, urinary tract infection, pyelonephritis.

Documents reviewed: Emergency department nurses' notes.

Notes: Pt with elevated temp and HR. Blood cultures and abx started due to concern for infection with murmur. Treated for thyroid storm with metoprolol and PTU. Pt admitted to ICU..

Impression and Plan

Thyroid storm

Plan

Condition: Critical.

Disposition: Admit: to Intensive Care Unit.

Signature Line
```
----------------------------------------------------------------------------
----------------
Electronically Signed By: Train, R2C2001 on 11/21/2013 10:45
----------------------------------------------------------------------------
----------------
```

Completed Action List:
```
* Perform by Train, R2C2001 on 21 November 2013 10:45
* Sign by Train, R2C2001 on 21 November 2013 10:45
* VERIFY by Train, R2C2001 on 21 November 2013 10:45
```

APPENDIX 5 – GOLD STANDARD EXAMPLE

Green Highlights are required elements

Title Case R2- 6: Hypertensive emergency with encephalopathy

History of Present Illness (HPI):
Medics arrive with a patient in restraints with police holding patient down. "This is Bob Jones, we were called for public disturbance and found him in his neighbor's yard urinating on the grill. It took some work but we got him restrained and here he is. We were unable to get vitals enroute."

NOTE PMH/Shx/ROS all unobtainable due to pt's AMS

Hx – 4 + 3(PMH, Sx, ROS – UTO)

Physical Exam:

Vital Signs: HR-96; BP-250/160; RR-24; O2-97%, Temp-97.8
General: confused, dressed in just boxers and shouts out at people
HEENT: pupils 4mm and reactive
Neck: NT, full ROM
Chest: tachypnic, B crackles
Cardiac: III/VI systolic M, RRR
Back: no trauma
 Abdomen: soft, ND, ND, +BS
Genital/Urinary: normal male genitalia
Rectal: no gross blood, good tone
Musculoskeletal: no deformity, no sign of trauma
Vascular: 2+ pulses
 Neurologic: confused, shouts at people, moves all 4 but unable to cooperate with further
    exam
Integument: no rash

PE 17

Diagnostics Indicated:
- o   Repeat BP will be the same. Accucheck 100.
- o   Resident should order EKG, labs, HCT, CXR, urine studies
- o   EKG – LVH
- o   CXR – pulmonary edema
- o   HCT – cerebral edema

Therapy Indicated:
- o   Resident should treat blood pressure with IV meds: (Choices)
  - o   Nicardipine
  - o   Labetalol
  - o   Esmolol
- o   Goal BP: 25% decrease (SBP 200 in this pt)
- o   Neuro exam should improve as BP decreases.

Consultants:
- ICU

Meds – 1
Proc – 5
MDM - 4
Transitional Period

Vital Signs / Monitor Readings

BP 248/150 HR 97   RR 22   Temp 97.8   Sp02 97% RA
   Chest: tachypnic, B crackles
   Cardiac: III/VI systolic M, RRR
   Abdomen: soft, ND, ND, +BS
   Neurologic: confused, moves all 4 but unable to cooperate with further exam

PE – 2

Conclusion

Vital Signs / Monitor Readings

  BP 198/90 HR 88   RR 20   Temp 97.9   Sp02 100%
   Chest: tachypnic, B crackles
   Cardiac: III/VI systolic M, RRR
   Abdomen: soft, ND, ND, +BS
   Neurologic: less confused as BP decreases

PE – 2

Gold Total
Hx – 7
PE – 21
Proc – 5
Med – 1
MDM - 4

REFERENCES

1 To err is human: Building a safer health system. Washington, DC: Committee on Quality of Health Care in America, Institute of Medicine; 2000. Report No.: 0-309-51563-7.

2 42 CFR parts 412, 413, 422 Medicare and Medicaid programs; electronic health record incentive program; final rule. In: Services HaH, editor. Washington DC: Federal Register; 2010.

3 Blumenthal D, Tavernner M. The "Meaningful Use" regulation for electronic health records. New England Journal of Medicine. 2010;363(6):4.

4 Menachemi N, Collum TH. Benefits and drawbacks of electronic health record systems. Risk Management and Healthcare Policy. 2011;4:9.

5 Adler-Milstein J, Daniel G, Grossmann G, et al. Return on information: A standar model for assessing institutional return on electronic health records. In: Medicine Io, editor.: National Academy of Sciences; 2014.

6 Hillestad R, Bigelow J, Bower A, et al. Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. Health Affairs. 2005;24(5):16.

7 Handel DA, Wears RL, Nathanson LA, Pines JM. Using information technology to improve the quality and safety of emergency care. Acad Emerg Med. 2011 Jun;18(6):e45-51.

8 Wolfe R. Electronic charting in the ED: making it work for all. Attention to speed, safety, efficiency, and--above all--early involvement with the emergency department staff is crucial to real-world adoption of EMR's. Healthc Inform. 2010 Oct;27(10):43-4.

9 Chua RV, Cordell WH, Ernsting KL, Bock HC, Nyhuis AW. Accuracy of bar codes versus handwriting for recording trauma resuscitation events. Annals of Emergency Medicine. 1993;22(10):6.

10 Dawdy MR, Munter DW, Gilmore RA. Correlation of patient entry rates and physician documentation errors in dictated and handwritten emergency treatment records. American Journal of Emergency Medicine. 1997;15(2):6.

11 Eden KB, Messina R, Li H, Osterweil P, Henderson CR, Guise JM. Examining the value of electronic health records on labor and delivery. American journal of obstetrics and gynecology. 2008 Sep;199(3):307 e1-9.

12 Daniel GW, Ewen E, Willey VJ, Reese CL, Shirazi F, Malone DC. Efficiency and economic benefits of a payer-based electronic health record in an emergency department. Academic Emergency Medicine. 2010 Aug;17(8):824-33.

13 Zlabek JA, Wickus JW, Mathiason MA. Early cost and safety benefits of an inpatient electronic health record. J Am Med Inform Assoc. 2011 Mar-Apr;18(2):169-72.

14 Holden RJ. Cognitive performance-altering effects of electronic medical records: An application of the human factors paradigm for patient safety. Cogn Technol Work. 2011 Mar;13(1):11-29.

15 Chan P, Thyparampil PJ, Chiang MF. Accuracy and speed of electronic health record versus paper-based ophthalmic documentation strategies. American journal of ophthalmology. 2013 Jul;156(1):165-72 e2.

16 Perry JJ, Sutherland J, Symington C, Dorland K, Mansour M, Stiell IG. Assessment of the impact on time to complete medical record using an electronic medical record versus a paper record on emergency department patients: a study. Emergency medicine journal : EMJ. 2013 Aug 23.

17 Ammenwerth E, Spotl HP. The time needed for clinical documentation versus direct patient care. Methods Inf Med. 2009;48:8.

18 Hripcsak G, Vawdrey DK, Fred MR, Bostwick SB. Use of electronic clinical documentation: time spent and team interactions. J Am Med Inform Assoc. 2011 Mar-Apr;18(2):112-7.

19 Persell SD, Kaiser D, Dolan NC, et al. Changes in performance after implementation of a multifaceted electronic-health-record-based quality improvement system. Medical Care. 2011;49(2):9.

20 Hahn KA, Ohman-Strickland PA, Cohen DJ, et al. Electronic medical records are not associated with improved documentation in community primary care practices. Am J Med Qual. 2011 Jul-Aug;26(4):272-7.

21 Soto CM, Kleinman KP, Simon SR. Quality and correlates of medical record documentation in the ambulatory care setting. BMC Health Services Research. 2002;2(22).

22 Schiff GD, Bates DW. Can electronic clinical documentation help prevent diagnostic errors? New England Journal of Medicine. 2010;362(12):4.

23 Weir CR, Nebeker JR. Critical issues in an electronic documentation system. AMIA; 2007; 2007. p. 5.

24 Pourasghar F, Malekafzali H, Koch S, Fors U. Factors influencing the quality of medical documentation when a paper-based medical records system is replaced with an electronic medical records system: an Iranian case study. Int J Technol Assess Health Care. 2008 Fall;24(4):445-51.

25 Van Vleck TT, Stein D, Stetson PD, Johnson SB. Assessing data relevance for automated generation of a clinical summary. AMIA Annual Symposium; 2007; Chicago; 2007. p. 761-5.

26 Dimick C. HHS warns hospital groups on EHR fraudulent billing. 2012 [cited 2013 12 August]; Available from: http://journal.ahima.org/2012/10/17/hhs-warns-hospital-groups-on-ehr-fraudulent-billing/

27 Hagland M. Balancing act: Can CMIOs and CIOs make physician documentation work for everyone? Healthc Inform. 2011(May 2011):5.

28 NIghtengale F. Notes on Hospitals. 3rd ed. London: Longman, Green, Longman, Roberts and Green; 1863.

29 MITRE C. Electronic health records overview. Virginia; 2006.

30 Gillum RF. From papyrus to the electronic tablet: a brief history of the clinical medical record with lessons for the digital age. The American journal of medicine. 2013 Oct;126(10):853-7.

31 Dunbar B. Maintaining accuracy and compliance in the medical record. 2011 [cited 2012 7 May]; Available from: http://www.billdunbar.com/urgent-care/maintaining-accuracy-and-compliance-in-the-medical-record/

32 Davidson SJ, Zwemer FL, Nathanson LA, Sable KN, Khan ANGA. Where's the beef? The promise and the reality of clinical documentation. Academic Emergency Medicine. 2004;11(11):8.

33 Laudermilch DJ, Schiff MA, Nathens AB, Rosengart MR. Lack of emergency medical services documentation is associated with poor patient outcomes: a validation of audit filters for prehospital trauma care. J Am Coll Surg. 2010 Feb;210(2):220-7.

34 Yu KT, Green RA. Critical aspects of emergency department documentation and communication. Emerg Med Clin North Am. 2009 Nov;27(4):641-54, ix.

35 France DJ, Levin S, Hemphill R, et al. Emergency physicians' behaviors and workload in the presence of an electronic whiteboard. International Journal of Medical Informatics. 2005 Oct;74(10):827-37.

36 Buller-Close K, Schriger DL, Baraff LJ. Heterogeneous effect of an Emergency Department Expert Charting System. Annals of Emergency Medicine. 2003 May;41(5):644-52.

37 Marill K, Gauharou ES, Nelson BK, Peterso MA, Curtis RL, Gonzalez MR. Prospective, randomized trial of template-assisted versus undirected written recording of physician records in the emergency department. Annals of Emergency Medicine. 1999;33(5):12.

38 Meyer H. The doctor (and his scribe) will see you now. Hosp Health Netw. 2010 Dec;84(12):41-2, 4.

39 DeHart K, Holbrook J. Emergency department applications of digital dictation and natural language processing. Journal of Ambulatory Care Management. 1992;15(4):6.

40 Hoyt R, Yoshihashi A. Lessons learned from implementation of voice recognition for documentation in the military electronic health record system. Perspectives in Health Information Management. 2010;Winter.

41 Saleem JJ, Russ AL, Sanderson P, Johnson TR, Zhang J, Sittig DF. Current challenges and opportunities for better integration of human factors research with development of clinical information systems. IMIA Yearbook of Medical Inforamtics. 2009:11.

42 Middleton B, Bloomrosen M, Dente MA, et al. Enhancing patient safety and quality of care by improving the usability of electronic health record systems: recommendations from AMIA. Journal of the American Medical Informatics Association. 2013;20:7.

43 Bergrath S, Skorning M, Rortgen D, et al. Is paper-based documentation in an emergency medical service adequate for retrospective scientific analysis? An evaluation of a physician-run service. Emergency Medicine Journal. 2010;28(4):320-4.

44 Rogers ML, Patterson E, Chapman R, et al. Usability testing and the relation of clinical information systems to patient safety. Advances in Patient Safety. 2008;2(Usability Testing and Software Systems):365-78.

45 Landman AB, Redden L, Neri P, et al. Using a medical simulation center as an electronic health record usability laboratory. Journal of the American Medical Informatics Association. 2013 November 18, 2013.

46 Kushniruk AW, Patel VL. Cognitive and usability engineering methods for the evaluation of clinical information systems. Journal of Biomedical Informatics. 2004;37:20.

47 Flanagan M, Arbuckle N, Saleem JJ, Militello LG, Haggstrom DA, Doebbeling BN. Development of a workflow integration survey (wis) for implementing computerized clinical decision support. AMIA Annual Symposium; 2011; Washington DC; 2011. p. 8.

48 Campbell EM, Sittig DF, Ash JF, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. Journal of the American Medical Informatics Association. 2006 Sep-Oct;13(5).

49 Taylor. Electronic interface for emergency department management of asthma: a RCT of clinician performance. 2008.

50 Weizberg M, Cambria B, Farooqui Y, et al. Pilot study on documentation skills: is there adequate training in emergency medicine residency? The Journal of Emergency Medicine. 2011 Jun;40(6):682-6.

51 Friedman E, Sainte M, Fallar R. Taking note of the perceived value and impact of medical student chart documentation on education and patient care. Academic medicine : journal of the Association of American Medical Colleges. 2010 Sep;85(9):1440-4.

52 Isoardi J, Spencer L, Sinnott M, Nicholls K, O'Connor A, Jones F. Exploration of the perceptions of emergency physicians and interns regarding the medical documentation practices of interns. Emergency Medicine Australasia. 2013;25:6.

53 Feied CF, Handler JA, Smith MS, et al. Clinical information systems: Instant ubiquitous clinical data for error reduction and improved clinical outcomes. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine. 2004 Nov;11(11):1162-9.

54 Bennett KJ SC. Electronic Medical Record Customization and the Impact Upon Chart Completion Rates. Family Medicine. 2010;42(5):5.

55 Howell J, Chisholm C, Clark A, Spillane L. Emergency medicine resident documentation: results of the 1999 american board of emergency medicine in-training examination survey. Academic Emergency Medicine. 2000 Oct;7(10):1135-8.

56 Michael V. Bloom P, Mark K. Huntington M, PhD. Faculty, Resident, and Clinic Staff's Evaluation of the Effects of EHR Implementation. Family Medicine. 2010;42(8).

57 Eastes LE, Johnson J, Harrahill M. Using the electronic medical record for trauma resuscitations: is it possible? J Emerg Nurs. 2010 Jul;36(4):381-4.

58 Chisholm RL, Sarangarm D, Goyal N, Chisholm CD. Are Emergency Medicine PGY-1's Ready for EMR Use in teh Emergency Department? Submitted to Academic Medicine; 2014.

59 Elstein AS, Schwarz A. Clinical problem solving and diagnostic decision making: selective review of the cognitive literature. British Medical Journal. 2002;324.

60 Jeanmonod R, Loewenthal M, Triner W. The nature of emergency department interruptions on patient satisfaction. Emergency medicine journal : EMJ. 2010;27:4.

61 Dekker SWA. Doctors are more dangerous than gun owners: A rejoinder to error counting. Human Factors. 2007;49(2):9.

62 Carayon P, Wood KE. Patient safety- the role of human factors and systems engineering. Stud Health Technol Inform. 2010;153:23.

63 Hickman DH, Severance S, Feldstein A, et al. The effect of health care working conditions on patient safety: Agency For Healthcare Research and Quality; 2003.

64 Ahmed A, Chandra S, Herasevich V, Gajic O, Pickering BW. The effect of two different electronic health record user interfaces on intensive care provider task load, errors of cognition, and performance. Critical Care Medicine. 2011;39(7):9.

65 Hart SG. NASA-task load index (NASA-TLX); 20 years later: NASA - Ames Research Center.

66 Rubio S, Diaz E, Martin J, Puente J. Evaluation of subjective mental workload- a comparison of swat, nasa-tlx, and workload profile method. Applied Psychology: An International Review. 2004;53(1):26.

67 Silfen E. Documentation and coding of ED patient encounters: an evaluation of the accuracy of an electronic medical record. American Journal of Emergency Medicine. 2006 Oct;24(6):664-78.

68 Bloom MV, Huntington MK. Faculty, resident, and clinic staff's evaluation of the effects of EHR implementation. Family Medicine. 2010;42(8).

69 Bergrath S, Rortgen D, Skorning M, et al. [Emergency mission documentation in simulated care. Video-based error analysis]. Anaesthesist. 2011 Mar;60(3):221-9.

70 Posner G, Bonin B, Nakajmia A. Evaluation of residents' documentation skills after a simulated operative vaginal delivery. JOGC. 2009(November):4.

71 Carroll AE, Tarczy-Hornoch P, O'Reilly E, Christakis DA. Resident documentation discrepancies in a neonatal intensive care unit. Pediatrics. 2003;111(5):5.

72 Kaji AH, Bair A, Okuda Y, Kobayashi L, Khare R, Vozenilek J. Defining systems expertise: effective simulation at the organizational level--implications for patient safety, disaster surge capacity, and facilitating the systems interface. Acad Emerg Med. 2008 Nov;15(11):1098-103.

73 Gordon JA, Shaffer DW, Raemer DB, Pawlowski J, Hurford WE, Cooper JB. A randomized controlled trial of simulation-based teaching versus traditional instruction in medicine: a pilot study among clinical medical students. 2006 Feb.

74 Roy MJ, Sticha DL, Kraus PL, Olsen DE. Simulation and virtual reality in medical education and therapy: a protocol. 2006 Apr.

75 McLaughlin S, Fitch MT, Goyal DG, et al. Simulation in graduate medical education 2008: a review for emergency medicine. Acad Emerg Med. 2008 Nov;15(11):1117-29.

76 Langhan TS. Simulation training for emergency medicine residents: time to move forward. 2008 Sep.

77 Wittels KA, Takayesu JK, Nadel ES. A two-year experience of an integrated simulation residency curriculum. 2012 Jul.

78 Hamman WR, Beaudin-Seiler BM, Beaubien JM, et al. Using simulation to identify and resolve threats to patient safety. Am J Manag Care. 2010;16(6):6.

79 Okuda Y, Bryson EO, DeMaria S, Jacobson L, Quinones J. The utility of simulation in medical education: What is the evidence? Mount Sinai Journal of Medicine. 2009;76:14.

80 Carayon P, Schoofs Hundt A, Karsh BT, et al. Work system design for patient safety: the SEIPS model. Qual Saf Health Care. 2006 Dec;15 Suppl 1:i50-8.

81 Russ AL, Saleem JJ, Justice CF, Woodward-Hagg H, Woodbridge PA, Doebbeling BN. Electronic health information in use: Characteristics that support employee workflow and patient care. Health Informatics Journal. 2010 Dec;16(4):287-305.

82 Eng J. Sample Size Estimation. 2012 [cited 2012 January 25, 2012]; Available from: http://www.rad.jhmi.edu/jeng/javarad/samplesize/

83 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42(2):5.

84 Makoul G, Curry RH, Tang PC. The use of electronic medical records: Communication patterns in outpatient encounters. JAMIA. 2001;8:6.

85 El-Kareh R, Gandhi T, Poon E, et al. Trends in primary care clinician perceptions of a new electronic health record. Journal of General Internal Medicine. 2009;24(4):5.

86 Fernandopulle R, Patel N. How the electronic health record did not neasure up to the demands of our medical home practice. Health Affairs. 2010;29(4):7.

87 Rahman M. Residents skip lectures to catch up on EHR charting. American Academy of Family Practice Scientific Assembly; 2013 September 24-29; San Diego, CA; 2013.

88 Friedberg MW, Chen PG, Busum KRV, et al. Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy; 2013.

89 Pitts SR. Higher-Complexity ED Billing Codes — Sicker Patients, More Intensive Practice, or Improper Payments? New England Journal of Medicine. 2012;367:3.

90 Vainiomaki S, Kuusela M, Vainiomaki P, Rautava P. The quality of electronic patient records in Finnish primary healthcare needs to be improved. Scandinavian journal of primary health care. 2008;26(2):117-22.

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AWARDS

Graduate Assistantship Research and Development Scientist	**2004**
Department of Physics Graduate Student Fellowship	**2000**
University Physics Award	**1999**
Outstanding Undergraduate Physics Award	**1998**

MEMBERSHIPS

Association of Clinical Research Professionals (ACRP)
American Medical Informatics Association (AMIA)
Health Information Management Systems Society (HIMSS)

RESEARCH EXPERIENCE

Indiana University – Indianapolis
Clinical Research Coordinator   **2006 - 2013**

- Regulatory documents (IRB, Radiation Safety, FDA, ICRC, DSMB, Clinicaltrials.gov)
- Study Sponsors (Budgeting, Study Feasibility, Monitoring)
- Study Conduct (recruiting, consenting, study procedures, documentation, follow-up)
- Study Design (feasibility, chart review, statistical methods, power calculations, procedures, budgeting, database design)
- Literature Review (PubMed, Ovid, ISI Web, etc.)
- Development of study tools (questionnaires, data collection forms, visual aids for subjects or staff)
- Grant Writing and submission
- Data Analysis (Biostatistics, SPSS, SAS)
- Teaching (research associates, lab technicians, nurses, patients, families)
- Supervision and training (summer research associates, laboratory technicians, research nurses)
- Grant Account management (supply ordering)
- Laboratory Samples (handling, storage, cataloging, measuring)

Informatics Research   **2010 - 2014**

- Designed, coordinated, collected data and analyzed data for a multifactorial study to determine the impact of computerized order entry and physician documentation in the emergency department of a large urban teaching hospital. This study included direct observation, chart reviews and surveys over a 2-year period finishing March 2014.

- Developed surveys for emergency medicine researchers to study morbidity and mortality conferences; journal club evaluations; palliative care use; email etiquette, weapons and metal detector use in the emergency department; perceived safety in and around the ED; and mass casualty response. Computed statistics as needed for these projects.
- Internet log file analysis for emergency physician web search strategies.
- Served on Council of Residency Directors Task Force developing, distributing and analyzing a survey to study the impact of electronic medical records on education, workflow and job satisfaction in emergency medicine physicians and residents nationwide.

TEACHING EXPERIENCE

Indiana University – Indianapolis
Adjunct Faculty – Health Informatics　　　　　　**2014 – present**
Teach graduate HIPAA Privacy and Security

IVY Tech Community College – Indianapolis
Adjunct Faculty – Liberal Arts & Sciences　　　　**2013 – present**
Teach physical science and mathematics both in-person and on-line

International School of Indiana – Indianapolis
Teacher　　　　　　　　　　　　　　　　　　**2002 – 2006**
Taught International Baccalaureate higher-level physics and mathematics, grade 6, 9, & 10 math, and grade 10 physics.

IUPUI – Indianapolis
Teaching Assistant　　　　　　　　　　　　　**2000 – 2002**
Undergraduate Electricity and Magnetism

IUPUI – Indianapolis
Undergraduate Student Mentor and Physics Tutor　**1997 - 1999**
Physics Department

Brownsburg School Corporation – Brownsburg, Indiana
Substitute Teacher　　　　　　　　　　　　　**2001 – 2002**
High school and middle school

City Colleges of Chicago – Nuremberg, Germany
Adjunct Faculty　　　　　　　　　　　　　　　**1983 - 1985**
EMT, EMT-I, and IV Therapy Instructor

NURSING EXPERIENCE

Mary Bridge Children's Hospital – Tacoma, WA
Emergency Department Charge Nurse   **1982 - 1983**
Medical Center Hospital – San Antonio, Texas
Pediatric Emergency Department Staff RN   **1985 - 1987**
Neonatal Intensive Care Staff RN
Professional Nurses Bureau – San Antonio, Texas
Float Pool RN BAMC Emergency Department   **1987 - 1989**

VOLUNTEER LECTURES

Navigating the IRB – EM Journal Club
Designing and Conduction Survey Research – EM Research Committee
Grant Writing – EM Academic Track
Procedure Lab: IV Skills – 3rd year medical students
iPad setup and apps for EM – EM PGY-1 orientation

PUBLICATIONS
1. Malik, ST, **Chisholm RL**, Doehring M, Chisholm CD. Weapons Retrieved After the Implementation of Emergency Department Metal Detection. Poster presentation at SAEM May 2014.
2. Hussain M, Jangorbhani M, Schuette S, Considine RV, **Chisholm RL**, Mather, KJ. [$_{13}$C] Glucose Breath Testing Provides a Noninvasive Measure of Insulin Resistance: Calibration Analyses Against Clamp Studies. Diabetes Technology and Therapeutics. 2014,16(2).
3. Moberly SP, Mather KJ, Berwick ZC, Owen MK, Goodwill AG, Casalini ED, Hutchins GD, Green MA, Ng Y, Considine RV, Perry KM, **Chisholm RL**, Tune JD. Impaired Cardiometabolic Responses to Glucagon-Like Peptide 1 in Obesity and Type 2 Diabetes Mellitus. Basic Res Cardiol. 2013 Jul;108(4):365. doi: 10.1007/s00395-013-0365-x. Epub 2013 Jun 14
4. Snipes C, Miramonti C, Chisholm C, **Chisholm R**. Reporting for Duty During Mass Casualty Events: A Survey of Factors Influencing Emergency Medicine Physicians. J of Graduate Medical Education. 2013 Sep; 417-426.
5. Kharrazi H, **Chisholm R**, VanNasdale D, Thompson B. Mobile personal health records: An evaluation of features and functionality. Int J Med Inform. 2012Jul 16 epub ahead of print PMID: 22809779
6. **Chisholm RL**, Finnell JT. Emergency department physician Internet use during clinical encounters. Presented at AMIA 2012.
7. Lteif AA, **Chisholm RL**, Gilbert K, Considine RV, Mather KJ. Effects of losartan on whole body, skeletal muscle and vascular insulin responses in obesity/insulin resistance without hypertension. Diabetes Obes Metab. 2012 Mar;14(3):254-61 PMID: 22051059
8. Han KA, Patel Y, Lteif AA, **Chisholm R**, Mather KJ. Contributions of dysglycaemia, obesity, and insulin resistance to impaired endothelium-dependent vasodilation in humans. Diabetes Metab Res Rev. 2011 May;27(4):354-61. doi: 10.1002/dmrr.1183.PMID: 21309061
9. Singal P, Janghorbani M, Schuette SA, **Chisholm R**, Mather KJ. Intra-individual variability of CO2 breath isotope enrichment compared to blood glucose in the oral glucose tolerance test. Diabetes Metab Res Rev. 2011 May;27(4):354-61. doi: 10.1002/dmrr.1183 PMID: 21309061

10. Singal P, Muniyappa R, **Chisholm R**, Hall G, Chen H, Quon MJ, Mather KJ. Simple Modeling Allows Prediction of Steady-State Glucose Disposal Rate from Early Data in Hyperinsulinemic Glucose Clamps. Am J Physiol Endocrinol Metab. 2010 Feb;298(2):E229-36. Epub 2009 Nov 17. PMID: 19920219

PUBLICATIONS IN PROGRESS:
1. **Chisholm RL**, CORD EMR Task Force. Are Emergency Medicine Interns Ready for EMR in the Emergency Department? Submitted to Academic Medicine April 2014.
2. Malik, ST, **Chisholm RL**, Doehring M, Chisholm CD. Weapons Retrieved After the Implementation of Emergency Department Metal Detection. Submitted to JAMA 7-2014.
3. **Chisholm RL**, Cooper DD. Perfect Practice Makes Perfect: Observations from EM Simulation Lab. Submitted to Graduate Medical Education July 2014.
4. **Chisholm RL**, Chisholm CD, et al. Electronic Physician Documentation and Computerized Physician Order Entry Decreases Faculty Feedback to Residents in the Emergency Department
5. **Chisholm RL**, Chisholm CD, et al. Observation of Workflow Change in the Emergency Department After EMR.
6. **Chisholm RL**, Cooper DD. EMR – More Time but not Better Quality in the Emergency Department