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Improving arrest electronic medical record Utstein data reporting by emergency services

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Improving Repository Electronic Medical Record Utstein Data Reporting by Emergency Medical Services

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ABSTRACT

Improving emergency medical service (EMS) reporting into large state held databases is becoming more critical as electronic databases are increasingly used. There is little information on methods improving the accuracy of composite data entered, nor on directly improving reporting, into these databases. New Mexico's Department of Health has used an electronic medical record (EMR) for all emergency service pre-hospital documentation since 2009. 2012 database analysis showed poor reporting on Utstein variable, out-of-hospital arrests. Study aims were to develop methods utilizing "Performance Management" to improve emergency service out-of-hospital cardiac arrest reporting on selected Utstein variables into the database, and to sub-analyze reporting changes by emergency service arrest volume (≤ 24 arrests/year vs >24 arrests/year). Join Point Regression was used for analysis with α set at 0.5 and $p < 0.5$. Reporting improved by approximately 40%, with improvement noted only in those emergency services with > 24 arrests reported annually.

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Chapter 1

Introduction

Cardiac arrest is defined as a loss of pulse with either no, agonal or irregular respirations. It excludes obvious signs of death such as rigor mortis and dependent edema, obvious injuries incompatible with life, and respected DNR orders. It is sub-categorized by the location where the arrest occurred, either in-hospital or out-of-hospital (1,2,3). In the United States, national out-of-hospital arrest incidences and survival rates vary regionally and by state. Exact state incidences are largely unknown as there is no national registry and therefore reporting is often emergency service based. Nichol et al published a multi emergency service study showing arrest incidences varying from 40/100,000 in Alabama to 87/100,000 in Milwaukee with mortality ranging from 17% in Seattle to 7% in Dallas. They noted it was difficult to fully ascertain why these regional variations occurred due to documentation and arrest definition variations (3). Several retrospective reviews have shown inconsistent data collection and documentation, making it difficult to identify opportunities aimed at improving out-of-hospital cardiac arrest outcomes. Differing terminology and methods has traditionally made it virtually impossible to combine smaller studies or to compare larger, published studies from different centers (3,7). Recognizing the need to standardize documentation surrounding out-of-hospital cardiac arrests, in 1996, representatives of the

International Liaison Committee on Resuscitation developed the "Utstein Templates" (figure 1). The guidelines were updated in 2004 and again in 2014. The "template" includes patient demographic information such as age, gender and location of arrest. Also included is time of arrest, dispatch times and arrival of emergency personnel, whether the arrest was witnessed, any bystander treatments, all interventions performed by emergency service providers as well as final neurological outcome of survivors (5,6). Despite these recommendations, there still remains inconsistent compliance with these guidelines. Donoghue AJ et al demonstrated when they examined 41 published studies on pediatric out-of-hospital cardiac arrests, only eight papers used the Utstein Templates to describe their data (7). Inconsistent reporting has made it difficult to identify, in all but a select few arrest cases, potential effective interventions aimed at improving outcomes.

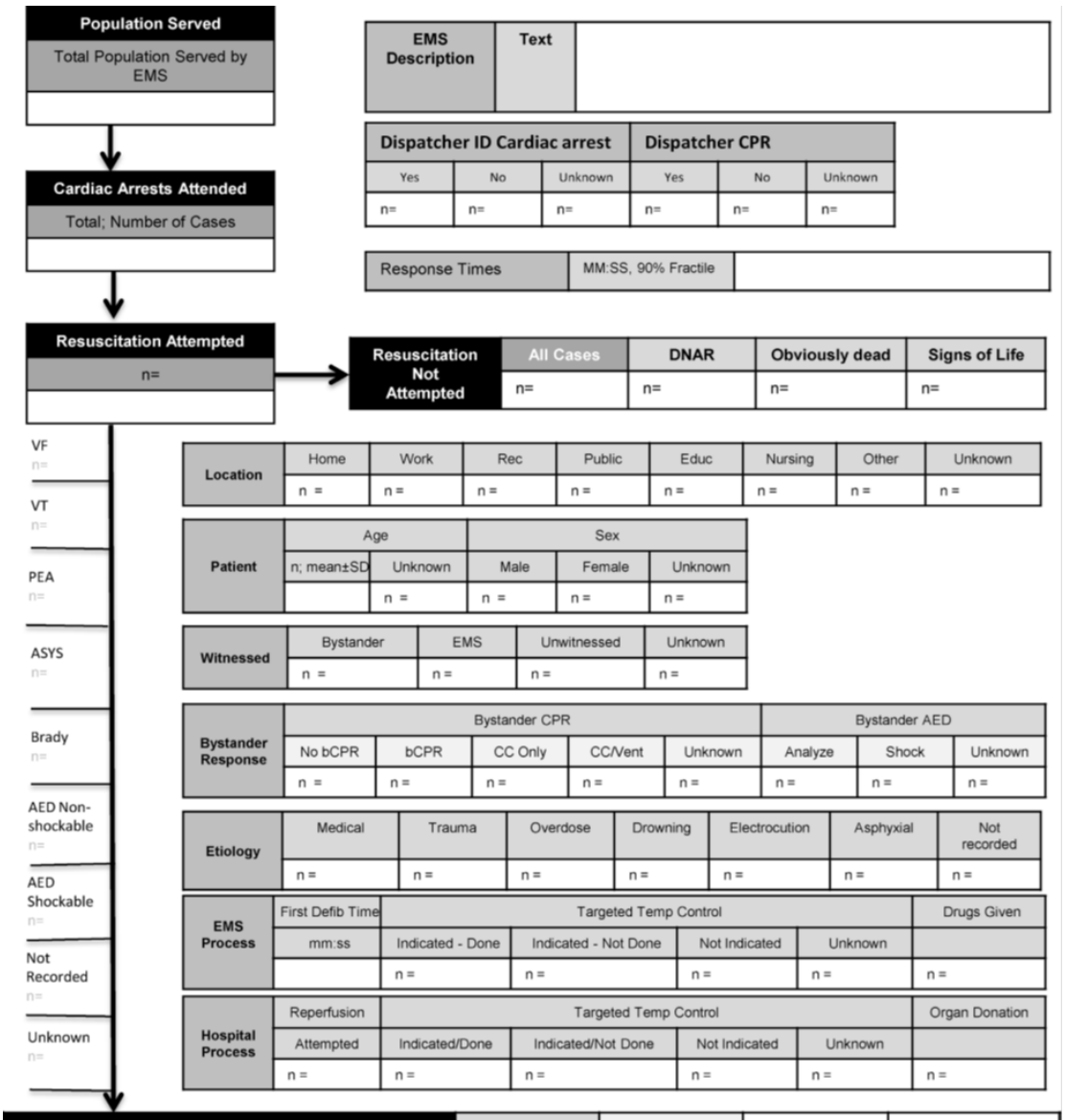


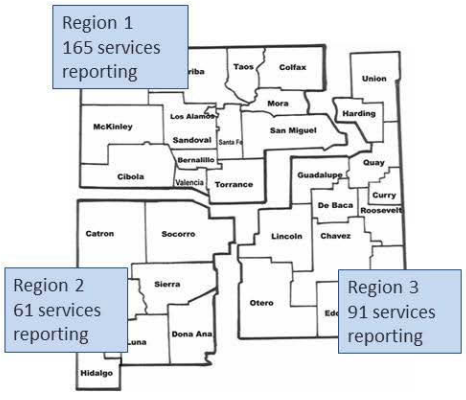
Figure 1
Utstein Data Collection Form

CHAPTER 2

More recently, states have begun adopting large electronic medical records (EMR) for prehospital emergency service documentation. Emergency medical records are vitally important because they are a record of a patient's care. They provide information on a patient's presentation, and an emergency service responder's assessments and evaluation of interventions and the patient's responses to those interventions. They also ensure emergency services provide the "standard of care" and are used to identify responder and system deficiencies, education needs, and skill assessment. When emergency service data is used in aggregate, it drives important system decisions for staffing, peak demand utilization, disaster response, and funding (8). The quality of data held in state-held EMRs is unknown. Prehospital data entered into large, diverse, electronic medical records has the potential for important patient information either entered inaccurately, or not entered at all. Out-of-hospital cardiac arrest Utstein template information may either not be documented at all, or it may be located in the database where it can not be identified or extracted for analysis. In 2009, New Mexico's Department of Health began utilizing a state-held electronic medical record (EMR), "New Mexico's Emergency Service Tracking and Reporting System" or "NMEMSTARS", for all prehospital emergency service encounters. The EMR software was developed by Image Trend specifically for emergency service

documentation. Since 2013, a total of 32 states and multiple emergency services in the United States use this software. Similar to most states in the US, New Mexico state-wide has substantial variation in both size and structure of its emergency services. New Mexico state is unique with unique populations and large rural areas. Some emergency services consist of only a few individuals and are volunteer-based, others utilize local fire departments, and still others are contracted private entities. State emergency services have been reporting all prehospital care information into NMEMSTARS since 2010. There are a total of 344 emergency services in the state of New Mexico with the state divided into three regions (figure 2). Of those 344 services, 334 (97%) enter data into NMEMSTARS consistently with approximately 175-200 emergency services entering data on at least one out-of-hospital cardiac arrest yearly.

New Mexico's Emergency Service Structure



Three Regions

- 344 emergency services
- Substantial variation between services and regions
  - Volunteer, local fire departments, private contractors
- 334 (97%) services report information into NMEMSTARS
  - 175-200 services report at least 1 arrest each year

Figure 2

Since 1997, both the National Highway Traffic Safety Administration (NHTSA) and the Health Resources and Services Administration (HRSA) have included evaluating emergency service documentation as part of emergency service quality assurance (10,12). Both NHTSA and HRSA recommend use of a "Performance Feedback Cycle", also called a "plan-Do-Study-Act (PDSA) Cycle" to improve emergency service system deficiencies (figure 3)(9,11).

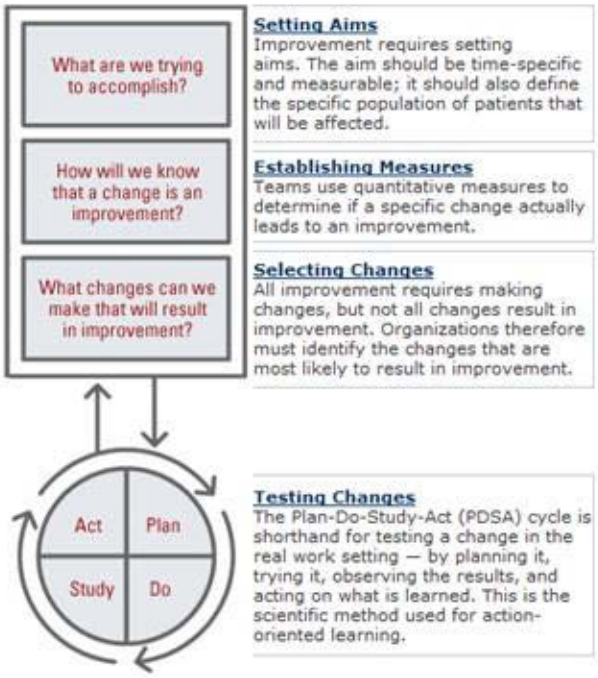


Figure 3
HRSA and NHTSA "PDSA Cycle" for improving emergency service reporting

There are many models for this cycle. One such model, a "Performance Management Cycle", is commonly used in businesses to align performance of personnel with an organization's goals (13). Similar to the PDSA Cycle, Performance

Management Cycle is a process of “continuously identifying, measuring and developing performance of individuals and aligning that performance with the strategic goals of the organization”. The cycle’s structure is similar to both NHTSA and HRSA’s recommended model for performance improvement. A Performance Management Cycle consists of a series of several steps. The cycle begins with establishing the organization’s goals and objectives, then measuring performance relative to those goals, establishing a feedback system on performance results, developing a reward system based on performance outcomes relative to goals, revising the organization’s objectives and activities as needed, and, finally, repeating the cycle again (13). The effective contribution that each aspect of the Performance Management Cycle has on achieving an organization’s goals has been studied extensively both individually and in composite. The four aspects of the cycle analyzed are “performance monitoring”, “performance evaluation”, “performance related compensation” and “employee development”. Kangangi evaluated each of these several components and found that when the components were all combined, there was a composite 60% improvement toward target goals. When they held all other variables at zero, “performance monitoring” yielded a 12% increase toward target goals, “performance evaluation” yielded a 29% increase, “employee development plan” yielded a four percent increase and “performance related compensation” yielded a 14% increase.

"Performance evaluation" and "monitoring" combined resulted in approximately 40% overall improvement toward target goals (17). Optimal time in each domain of the cycle as well as the entire cycle duration is flexible. Cycle timing is most frequently repeated over six months to one year. Success of Performance Management is complex and is dependent on different motivational theories for change to occur. One important aspect for motivating change for Performance Management's success is how well the goal is structured. Successful goal setting criteria has been well established. The most studied is "Goal-Setting Theory" (14,15). This theory is exceptionally reliable, valid, and is useful across diverse work situations. When the principles are followed, improvement occurs greater than 95% of the time. Goal Setting Theory has five "Goal Setting Principles". The goal must be clear, it must be challenging enough to spark interest, it must have commitment from the entire team that understands and agrees to the goal, feedback must align the goals and performance, and task complexity must allow the goal to be attainable. Goal Setting Theory's success is based on the concept that "working toward a goal is a major source of motivation, which, in turn, improves performance" (14).

We hypothesized that by utilizing a Performance Management Cycle following Locke's Goal Setting Theory with New Mexico's Department of Health's electronic medical record, NMEMSTARS,

we could improve emergency service Utstein variable reporting on out-hospital cardiac arrests. We began our intervention with three Utstein variables and followed a fourth variable to determine if our intervention improved reporting on other variables not included in our study. Additionally, we hypothesized that services with less than two arrests per month (≤ 24 arrests per year) would be more difficult to change reporting practices than those with greater arrest volumes. To further understand the study's difficulties and successes, at study closure we evaluated the study cycle timing as well as the feasibility of our objectives and goals.

CHAPTER 3

Methods

Study was designed as prospective, intervention-based and quasi-experimental. Approval was obtained from the University of New Mexico School of Medicine's Internal Review Board and New Mexico Department of Health's Medical Director and Emergency Services Bureau. All data on out-of-hospital cardiac arrests obtained from the NMEMSTARS database was de-identified. Data was collected from January of 2012 through December of 2014. Data from 2012 served to establish baseline seasonal variation reporting.

Working Group

New Mexico's Department of Health has three regional NMEMSTARS "field trainers", responsible for communications between the state's emergency service administrators and The Department of Health's Emergency Service Bureau. They assist with educating services, state-wide, on data entry into NMEMSTARS. To establish goals, objectives and methods for the study, a NMEMTARS "Working Group" was formed. The Working Group consisted of two emergency service administrators (Albuquerque Ambulance Services and Bernalillo Fire Department), two regional NMEMSTARS field trainers, the NMEMSTARS Database Administrator, and the study's Principle Investigator. The Working Group was formed in late July into early August of 2013.

The first meeting established the study's objectives and methods for dispersing information to the state's emergency service database administrators. Consensus agreement was to disseminate study goals through Working Group meetings and emails sent state-wide to emergency service administrators. Email communication from the Department of Health's Emergency Service Bureau to emergency services is a common method of communication for information updates. The first Working Group meeting resulted in agreement to utilize a Performance Management Cycle on three Utstein Variables. The three variables chosen were "was CPR initiated by the emergency service responder", "what was the patient's first cardiac rhythm", and "was there a return of spontaneous circulation". Additionally, a fourth Utstein Variable, "what medications did the emergency service first responder administer", was followed to determine if the intervention effected reporting of other Utstein Variables. The first intervention was followed by a reminder email with the cycle completed over 17 months. The study began in late August, early September of 2013 shortly after the Working Group was formed and consisted of informing services of study goals and objectives through Working Group meetings and emails. Seven months later, a reminder email regarding the study's goals and objectives was sent to all emergency service administrators. Eight months later reporting pre and post the two interventions was analyzed and one month later

feedback was given to the state's emergency service administrators (figure 4).

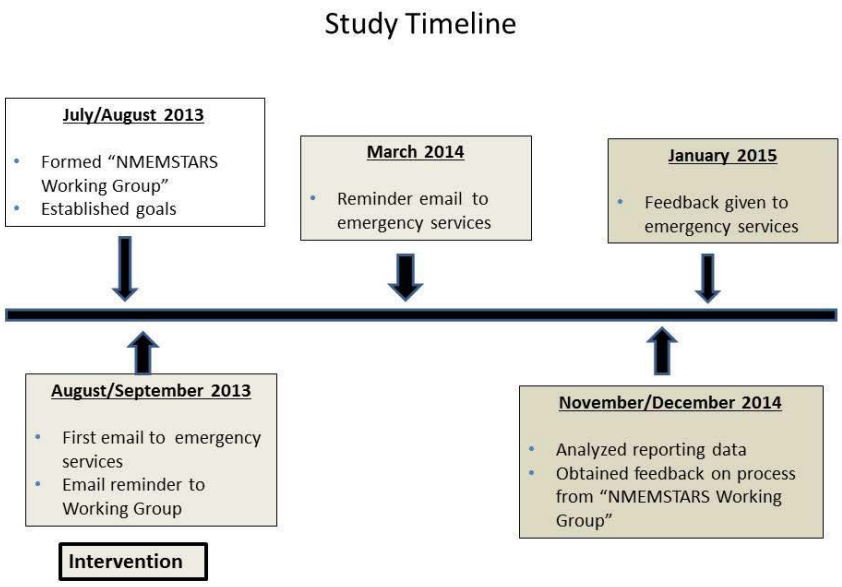


Figure 4

In December of 2014, just after completion of the study, the Working Group met to analyze the study's objectives and goals and to evaluate the study results. The follow-up meeting's first objective was to explore if the study's goals were realistic, relevant and attainable. The secondary objectives were to determine if the cycle timing was appropriate and how the overall process of the study might be improved. Email communications within the Working Group consisted of study reminders in October 2013 and March 2014, other focus meetings occurred in June and December 2014, in February 2015 (after data analysis), and in May 2015. The follow-up questions evaluated by the working group included, "What were the objectives of the study?" "What were the study

goals and were they realistic, relevant and attainable?" "Was the cycle timing adequate?" "Any potential ideas to improve the study's processes and results?"

NMEMTARS Database

The NMEMSTARS database contains over one million emergency service encounters with 334 emergency services entering data from throughout the state of New Mexico. Prior to study initiation, methods were developed to identify all out-of-hospital cardiac arrest encounters in the database, to remove duplicate reporting of encounters by emergency services, and to review each Utstein variable's variables reporting parameters to define "acceptable" versus "poor reporting". Arrest encounters were identified using Image Trend's "primary" and "secondary impression", "cardiac arrest" field, and searching under the diagnosis of "cardiac arrest". Arrest encounters were manually reviewed to ensure accurate capture of all arrests. After manual review, encounters which either met death criteria or respected DNR orders (approximately 40% of annual reported arrest encounters) were removed. Data from 2012 served to establish baseline NMEMSTARS reporting. There were 2,418 encounters identified with 175 state services reporting at least one arrest annually. Using the 2012 census estimated population for New Mexico at approximately 2,085,000 this yielded an out-of-hospital cardiac arrest incidence of 116/100,000. Several methods were utilized to locate Utstein variables in NMEMSTARS.

To identify all database sites where services might document Utstein variables in NMEMSTARS, we reviewed Image Trend's documentation manual and met with emergency service database administrators. There were multiple locations where Utstein variable information could be entered by a service. For example, the Utstein variable "first cardiac rhythm" might be entered under the encounter "vitals" or "first cardiac rhythm" or "EKG rhythm". To further ensure that Utstein information was collected from the arrest scene by first responders, 12 responders from two different emergency services were interviewed with consensus agreement that all Utstein variable information was consistently collected and documented on from the arrest scene. Finally, to establish and define clinically meaningful emergency service documentation on the Utstein variables, all possible entry options for each variable were reviewed in NMEMTARS. "Poor documentation" occurred when emergency services either left the Utstein variable "blank" and/or "not applicable" or "not known". The Utstein variable "first documented cardiac rhythm" was considered "poorly documented" when left "blank" or "not applicable", the variable "was CPR administered by emergency responders" was considered "poorly documented" if left "blank", "not known" or "not applicable". The variable "return of spontaneous circulation" or "ROSC" was considered "poorly documented" if "blank" or "not known", and the variable "medication administered" was considered "poorly documented" if "blank", "not known" or "not applicable". Other

variable entries were considered potentially clinically feasible in an arrest situation and were therefore considered acceptable documentation.

Accurate Utstein documentation (greater than 90%) was noted on patient demographics (such as gender and zip codes) and vehicle arrival/departure times, but poor reporting, ranging from zero to 55%, was found on most events occurring before and after a first responder's arrival. Several of the Utstein variables such as "bystander CPR" and "was the event witnessed" had no documentation. The variable "first cardiac rhythm" had approximately 14% documentation, and the Utstein variable "medications emergency responder administered" had the best documentation at approximately 55% documentation. Baseline reporting for the Utstein study variable "first cardiac rhythm" was approximately 20%, "did responder administer CPR" had approximately 25% reporting, and "did the patient have return of spontaneous circulation" had approximately 23% reporting. Similar to other large databases, New Mexico's Department of Health has no methods to evaluate, nor improve, reporting into NMEMSTARS. Additionally, there is no methodology for evaluating the potential effects of any interventions. We are unaware of any studies designed to improve multiple, diverse emergency service out-of-hospital cardiac arrest reporting into a large state-held emergency medical record database.

Performance Management Cycle and Locke's Goal Setting Theory

The study's "Performance Management Cycle" timing and implementation structure was developed by the principle investigator and the NMEMSTARS Working Group. Two specific aspects of the Performance Management Cycle were utilized, "performance evaluation" and "performance monitoring". Based on prior studies, anticipated results of these two dimensions of the cycle, if successful, should lead to approximately 40% overall improvement toward the study's target goals. The three Utstein Variables that were selected for the study represent minimal basic information obtained, and reported on, during any out-of-hospital arrest encountered. The three variables were "was CPR administered by the emergency responder", "what was the first cardiac rhythm of the patient", and "was there a return of spontaneous circulation (ROSC)". The fourth variable, "what medications were administered by emergency responders" was followed to determine if our interventions changed reporting of other Utstein Variables. Goals of the study followed Locke's Goal Setting Theory; the goals were clear, challenging enough to spark interest, full commitment was obtained from the team, all parties understood and agreed to the goals, feedback was scheduled to align with the goals and performance, and goal complexity still allowed the goals to be obtainable. The study's primary targeted goal was to improve reporting to greater than 90% on each of the three chosen

Utstein variables. We anticipated, if the cycle was successful, a 40% improvement in reporting on each variable. Study cycle began with goal development in late July, early August of 2013, emails to services occurred in September 2013 with a reminder email to all emergency services in March 2014. The study targeted state-wide emergency service administrators as they are responsible for reporting data into NMEMSTARS. Study emails came from the Department of Health's NMEMSTARS Database Administrator with emergency service administrators informed about the study objectives (to improve reporting in preparation for developing a New Mexico Out-of-Hospital Cardiac Arrest Registry) and goals (to obtain greater than 90% reporting) on three Utstein variables with baseline reporting results from 2012 included. Individual services were not informed of their own reporting results as information was aggregated from all services state-wide.

Statistical Analysis

Utstein reporting variables were entered directly from NMEMSTARS into Microsoft EXCEL, 2010 version, spreadsheets. Descriptive statistical analysis was performed using SAS version 9.3. All Utstein variable responses were made dichotomous (yes or no if the variable was documented) with the proportions that were answered appropriately aggregated monthly for analysis. Join Point Regression Program, version 4.1.1.3 was used to evaluate reporting changes over time. The dependent variable was the

proportion of accurate data reported and the independent variable was time. Regression models were selected by testing “null hypothesis number of join points” against “alternative hypothesis number of join points”. Each hypothesis was tested, adding and/or removing join points, to obtain “best fit models” which were statistically significant with the least number “join points”. Join Point limits testing to five models ranging from zero to four changes, evaluating each curve’s join points and associated slopes. The best model is selected from these five by comparing Goodness of Fit (GOF) statistics between each of these five models beginning with the null hypothesis of zero join points and the alternative hypothesis of five join points and the better of these two models is compared with the four join point model and so forth. The GOF statistic is similar to the standard F-statistic but the P-value is the number of times the alternative model GOF is greater than or equal to the null model GOF over five thousand permutation data set trials. The test statistic α is Bonferroni corrected to prevent type I errors from occurring with multiple comparisons: α/(K alternative – K null) where K is the number of join points in the respective hypothesis with α equal to 0.05. All final models selected had $p < 0.05$ unless specified otherwise. Utstein variable reporting was analyzed from 2012-2014. Reporting from 2012 established seasonal baseline reporting variations. Data reporting was additionally sub-analyzed by emergency service arrest volume. Those emergency services with less than 24 arrests encountered

per year were compared with those services with greater than 24 arrests per year.

CHAPTER 4

Results

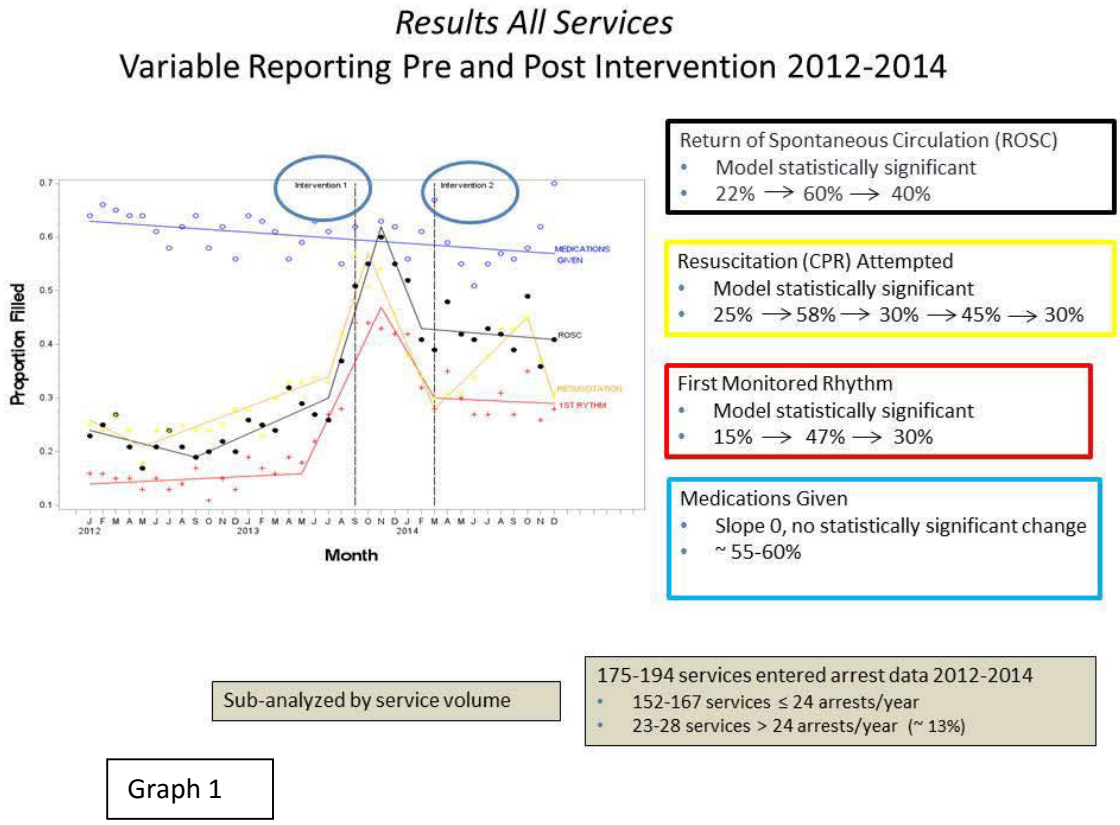
Out-of-hospital cardiac arrest encounters in NMEMSTARS from 2012-2014 ranged from 1,975 to 2,418. Annual arrest incidences over 2012-2014 ranged from 95-116/100,000, with 175-194 of the state's services reporting on arrests. 2012 baseline analysis identified 2,418 arrests with 175 emergency services entering data. Of the 175 services entering arrest data, 152 (87%) entered data on ≤ 24 arrests and 23 services entered data on greater than 25 arrests. The 23 services entering data on more than 25 arrests entered 79% of the arrest encounters. In 2013, there were 2,010 arrests entered in the database with 194 services reporting. 167 (86%) of services entered data on ≤ 24 arrests with 27 services entering data on > 24 arrests per year. 75% of all arrests for 2013 were entered by services with greater than 24 annual arrests. In 2014, there were 1,975 arrests entered with 188 services reporting encounters. 160 (85%) services entered data on ≤ 24 arrests and 28 services entered data on greater than 25 arrests. 73% of all arrests for 2014 were entered by services with greater than 24 arrests annually (table 1).

Reporting Year	Number of Arrest Reports*	Annual Arrest Incidences**	Total Number of Services Reporting Arrests	Number of Services Reporting ≤ 24 Arrests Annually	Number of Services Reporting > 24 Arrests Annually
2012	2,418	116/100,000	175	152	23 (79% arrests)
2013	2,010	97/100,000	194	167	27 (75% arrests)
2014	1,975	95/100,000	188	160	28 (73% arrests)

Table 1, Yearly Arrest Reports 2012-2014
*All duplicated, false arrests, DNR and death criteria reports removed
**Incidences calculated using New Mexico 2012 population estimate of 2,085,000

When all service reporting from 2012-2014 was combined and analyzed pre and post interventions we found the following. The first Utstein study variable “did the patient have return of spontaneous circulation (ROSC)” had baseline reporting in 2012 of approximately 22%. Just prior to the study’s first intervention reporting began to improve, just after the first intervention reporting peaked at approximately 60%, declined three months later, and with second intervention the decline stabilized at approximately 40% reporting. The second study Utstein variable, “was CPR initiated by first responders” had 2012 baseline reporting of approximately 25%. Just prior to the first intervention reporting began improving and just after the first intervention reporting peaked at 58% then rapidly declined with the decline stabilizing with the second intervention at approximately 30%. Reporting again improved rapidly after the second intervention, declined rapidly again at which time the study ended. The third Utstein variable, “what was the patient’s first monitored rhythm”, had baseline reporting in 2012 of approximately 12%. Shortly before our first intervention reporting began to improve, peaking shortly after our first intervention at approximately 47%, rapidly declining over three months with the reporting decline stabilizing around the time of the second intervention at approximately 30%. When we analyzed reporting on the fourth Utstein Variable “did the emergency responder document medications administered to the

patient", there was no statistically significant change in reporting either before or after our intervention from 2012-2014 with reporting remaining at approximately 55% over all three years (graph 1).

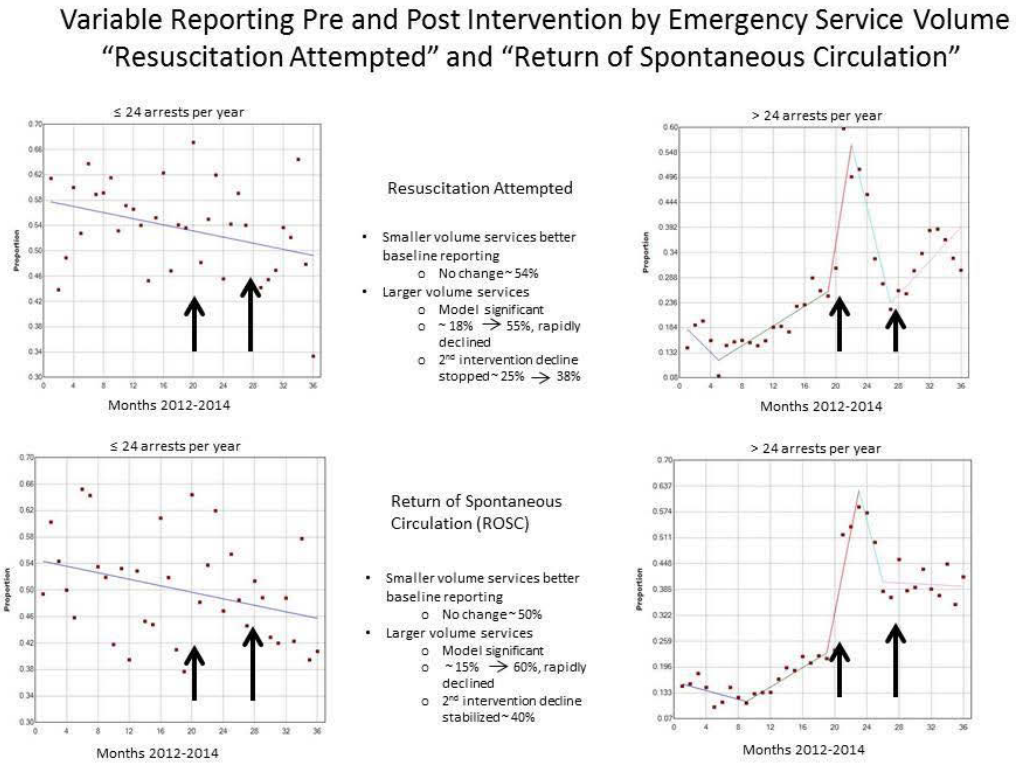


Graph 1

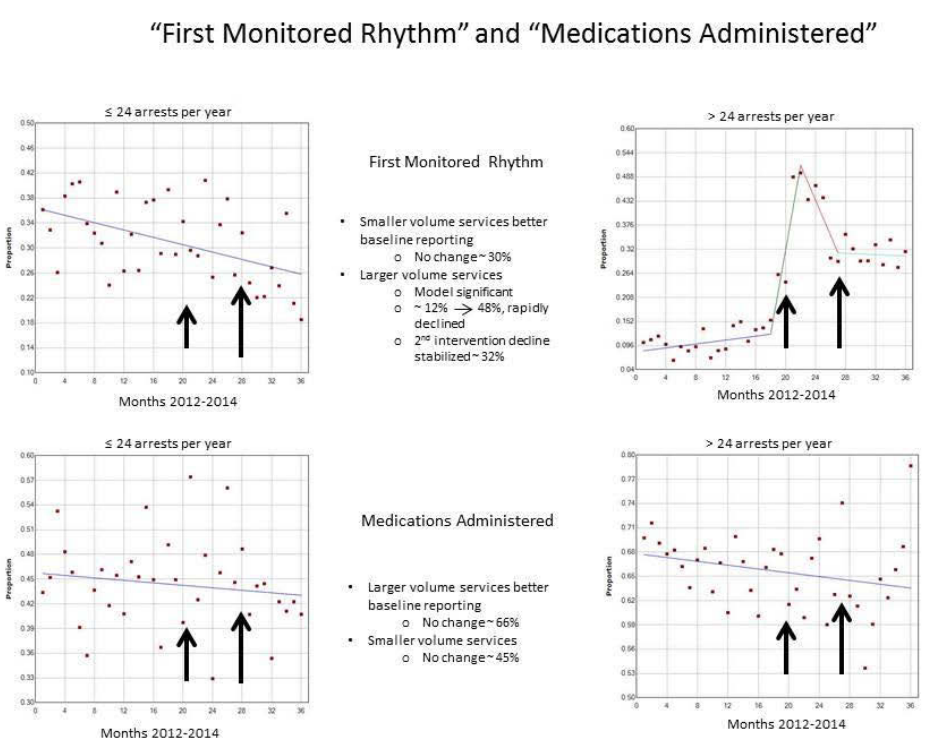
When reporting changes were sub-analyzed based on emergency service arrest volume, those with ≤ 24 arrests versus those with greater than 24 arrests, we found the following. Services with smaller volume arrests (≤ 24) annually had better baseline reporting on both of the Utstein variables "did the patient have return of spontaneous circulation" and "resuscitation attempted" at approximately 50%, but there was no statistically significant change in reporting from 2012-2014. Similarly, when evaluating the third Utstein variable "what was the patient's first monitored rhythm",

services with ≤ 24 arrests annually showed better baseline reporting at approximately 30%, also with no change in reporting from 2012-2014. For those services with greater than 24 arrests reported annually, the first Utstein variable “did the patient have return of spontaneous circulation or ROSC” showed baseline reporting from of approximately 15% with reporting improving shortly after the first intervention to approximately 60%, rapidly declining after five months, and with the second intervention, the decline stabilizing at approximately 40%. In services with larger volume arrests, the second Utstein variable “did the responder attempt resuscitation” had baseline reporting of approximately 18%. Immediately before the first intervention, reporting began to improve and continued after the intervention to approximately 55%, rapidly declined, and after the second intervention reporting improved again to approximately 38% at which time the study ended. The third Utstein variable, “what was the patient’s first monitored rhythm” showed baseline reporting at approximately 12%. Reporting began to improve just prior to our first intervention, peaked shortly after at approximately 48% over four months after which reporting declined rapidly with the decline stabilizing after the second intervention at approximately 32%. All three Utstein variable models were statistically significant with α of 0.05 and p values < 0.05. The fourth Utstein variable “what were the medications that the emergency responder administered” showed better baseline reporting in services with greater than 24 arrests at

approximately 66% versus 45% in smaller volume services, but there was no statistically significant changes in reporting pre or post the study's interventions from 2012-2014 (graphs 2,3).



Graph 2



Graph 3

Utilizing open-ended questioned, the Working Group evaluated the study parameters and results in February 2015. Evaluation focused on the study objectives (recall and clarity of the objectives and were emergency services aware of them), goal parameters (were they realistic, relevant, and attainable), Performance Management Cycle design and timing (was cycle and timing appropriate), and any ideas for improving the study process overall. There was consensus among the group that all members were aware of the study objectives to improve reporting on three Utstein Variables. The emergency services involved with the Working Group were larger volume services, and were heavily invested in the study objectives as they were interested in developing and

capturing the information obtained in a state-wide cardiac arrest registry. The NMEMSTARS field workers (whom were the only individuals communicating in person with the state's smaller emergency services regionally) did not inform many of the state's smaller volume services of the study. The field workers stated that "many services did not really have any questions and therefore the study, and those services reporting practices, were never addressed". When the study goals were evaluated, all Working Group members felt the goals were realistic, relevant, and attainable. When evaluating the study cycle timing, there was consensus agreement that the timing between study reminders made it difficult to maintain the study's improved reporting results. The ideal cycle timing was thought to be three months, consistent with the study results on timing noted when reporting improvement declined. To address the smaller volume services reporting, the Working Group agreed that providing individual feedback to each service on their reporting parameters, rather than providing generalized feedback to all services, would improve communication and knowledge regarding the study.

CHAPTER 5

Discussion

Several studies have evaluated the many challenges associated with the implementation of electronic medical records (EMRs). Terry et al looked at the experiences of several primary care practices with implementing and adopting EMRs. They found the following issues associated with adoption of an EMR: expectations of the system (what is needed for using the software and the level of commitment), availability of someone to take a leadership or champion role, and how much knowledge of computers the potential EMR users have (21). Boonstra et al performed an extensive systematic literature review looking at the implementation of electronic medical records in hospital based systems. They concluded that electronic health record systems (EHR) “have particular complexities and should be implemented with great care and with attention given to context and process issues and to interactions between these issues” (22). Both studies looked at implementation of EMRs in medical systems but neither reviewed accuracy, nor content, of the electronic medical record.

Evaluating a different issue with EMRs, Heisey-Grove et al evaluated, at the national level, difficulties associated with “meaningful use” of electronic medical record data in practice settings. They identified issues present at different stages of EMR implementation and potential solutions for rectifying these problems. They suggested that once an electronic medical record

is implemented, one of the top challenges might be the “proper recording of various patient parameters (such documenting a patient’s “smoking status”) within the EMR”. They felt that this issue could potentially be resolved through the training of practice staff. For example, “knowing where in the vendor product the capturing of smoking status is as structured data”. They also identified potential challenges in modifying workflow to ensure that relevant data is captured on patients, and that to address this issue, a practice “might require more in-depth practice coaching support” and “redesigning to facilitate capturing of appropriate information and the exchange of patient data” (23). Similar to other studies, they did not evaluate accuracy of EMR data entry, nor did they establish successful, definitive methods for improving data reporting.

Few studies have evaluated the quality of information entered by care providers into electronic medical records, nor how to improve that information, and none have evaluated emergency medical service system reporting. Laudermilch et al showed, when they reviewed electronic medical records on trauma patients from the Central Region Trauma registry and emergency medical services patient logs, 28% of emergency service records were missing patient scene physiologic data. Using multivariate analysis, they found that patients missing one or more measures of patient physiology data from the scene had an increased risk of death

(adjusted OR 2.15; 95% CI 1.13-4.10). They concluded that the failure of EMS services to document basic measures of scene physiology was associated with increased mortality and that this may serve as a sensitive audit filter for performing performance improvement (19). Landman et al examined challenges associated with adopting EMRs in 14 emergency service agencies. They found that the primary reason for adopting emergency service electronic medical records was to support quality assurance. They identified the need for emergency service EMR funding, difficulties associated with integrating medical health information, and the building of internal informational technology capacity. They did not evaluate quality of information contained in emergency service EMRs (18). One of the few studies that have assessed the quality of electronic medical record data was conducted by Kern et al. They looked at accuracy of electronic medical records used for quality assessment at one health center. They compared EMR documentation to manual chart review on several different “EMR meaningful use” quality care measures. They found the sensitivity of electronic medical record data reporting ranged from 46% to 98%, with specificity ranging from 62% to 97% (20). They did not evaluate methods, nor feasibly, of improving data information on patient care elements.

In general, EMR databases have the potential to contain critical information which is vitally important. In emergency medical

service systems, medical records document information on a patient's presentation, the emergency service responder's assessments, what interventions were used, and the patient's response to those interventions. Additionally, review of emergency records ensures that emergency services provide the "standard of care" by identifying deficiencies in training, education, and in responder skills. When emergency service data is aggregated, it can drive important system decisions regarding staffing, peak demand utilization, disaster response, and funding distributions. More recently large, aggregated EMRs are being used for documenting prehospital care delivered by emergency responders. Our study findings are similar to Kern et al in that we found discrepancies in reporting accuracy but we found significantly poorer reporting in New Mexico's much larger, diverse emergency service database than their study demonstrated. By utilizing a Performance Management Cycle we were able to improve reporting in emergency services with greater than 24 arrests reported annually by approximately 40 percent on three selected Utstein variables with baseline reporting between 15 to 20 percent. After reviewing the study findings with the NMEMSTARS Working group, it was thought this may be due to poorer communication with the smaller volume services regarding the study objectives. This would not necessarily explain the lack of change in reporting when the email reminder was sent to all services in March of 2014. It may actually be a combination of factors, including smaller arrest

volumes and thus less frequency and familiarity with reporting goals, and/or poor information delivery regarding the study's objectives and goals. Future studies may benefit from individual emergency service feedback on reporting results with feedback on reporting changes over time.

The 40 percent improvement noted immediately after our first Working Group meeting when we implemented the Performance Management Cycle, indicated we were successful at combining two of the cycle's elements, "performance evaluation" and performance monitoring". The Performance Management Cycle was developed with a goal of improving reporting at ≥ 90% to meet Locke's Goal Setting Theory's parameters. When all service reporting was analyzed on the three study Utstein variables, reporting began improving a just prior to our intervention. This improvement was correlated much closer to the timing of the intervention when we sub-analyzed services by reporting volumes separately. This early improvement most likely was a reflection of the NMEMSTARS Working Group discussing the study a month prior to the first planned official meeting for the project.

Optimal timing of the Performance Management Cycle varies considerably and is dependent on an organization's structure and needs. Many recommend reassessment intervals of six months to one year. The rapid improvement then decline in reporting after

the study's intervention was discussed by the Working Group with agreement that this indicated that the cycle reminders needed to be shortened to three month intervals.

When reporting on the fourth Utstein variable, "did the emergency responder document medications administered to the patient", was analyzed, there was no change in reporting from 2012-2014. It was initially hypothesized that by informing services of the study goals and objectives that we would improve reporting on all of the Utstein out-of-hospital cardiac arrest variables. However, discussion at the study closure with the Working Group's emergency services indicated that services were unaware of the other Utstein variables. The Working Group meetings, as well as email reminders, never offered information regarding the other Utstein variables, only the three that were followed for the study. This indicates that notification of all Utstein variables to emergency service might improve reporting on other variables if they are clearly specified, and that future studies might benefit from providing individual feedback on reporting performance to each agency, provide information on all of the Utstein variables, and cycle reporting reminders and reporting progress every three months. This is the first study evaluating, and developing methods, for improving emergency service documentation in a large, diverse and multiple services, state-held electronic medical record. With EMRs increasingly used to combine data from larger, diverse healthcare systems, there is a critical need to extract data from these EMRs

that is meaningful and accurate. This study demonstrates the need to evaluate the quality of data entered in these large databases and the methodology for improving that information.

Conclusion

There is a need to establish the quality of data entered into large electronic medical record databases. Improving large, diverse, multiple emergency service database reporting on Utstein variable out-of-hospital cardiac arrests is feasible in those services with arrest volumes greater than 24 per year. Performance Management is an effective method to improve reporting in these databases but may require shorter time cycles than six months to one year.

Limitation

There are several limitations with this study. First, the study's design is quasi-experimental making it difficult to establish a definitive causal relationship associated with the study's interventions. Despite this limitation, our findings demonstrate a statistically significant, clear association in reporting improvements post our interventions. Although we followed only one additional study-separate Utstein variable, "medications administered by EMS responders", our findings of unchanged reporting pre/post our interventions is consistent with the observation that we were successful with the variables selected for the study. Future studies

might benefit from either including all variables in the study or following all of the clinical elements of interest to definitively evaluate this effect. Additionally, we included feedback to all emergency services combined, overlooking that smaller services might not have been updated with respect to the study or arrest volumes were too infrequent to affect their reporting. It is unclear if this contributed to our findings. This would need to be studied further as this was an exploratory study. Additionally, in New Mexico, there are multiple methods used by emergency services for reporting encounter data into the NMEMSTARS database. Some services utilize their own staff and others use hired vendors. This study did not address the effects these differences had on reporting accurate data into NMEMSTARS. This study approach was used because each emergency service administrators specifies which information is reported. Finally, New Mexico Department of Health's EMR and the state's emergency service structure may vary from other states which would potentially lead to differing results from the Performance Management Cycle. However, several studies have shown these methods to be effective across diverse situations and would be effective regardless of the particular system they are used in.

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