Evidence-Based Change: A Protocol to Reduce Ambulance Diversion Using the National Emergency Department Overcrowding Scale Tool

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Abstract

Background: Ambulance diversion (AD) occurs when emergency departments (EDs) experience over-demand of available resources and can no longer accept ambulance patients. Current evidence however, shows that AD delays critical care, negatively impacting quality and cost. The purpose of this project was to reduce AD by creating an evidence-based protocol in the ED setting.

Methods: Underpinned by Kurt Lewin's Change Theory and following a *Plan Do Check Act* model, a healthcare quality improvement team implemented an AD protocol in a busy urban ED. Baseline data was taken from historical hours of AD use and ambulance arrivals over the previous three years. Following a pre-test—post-test design, three year baseline data was compared to data from a 20 week trial using the paired samples *t*-test.

Intervention: An AD protocol was created in the project setting. The protocol used the National Emergency Department Overcrowding Scale tool, with corresponding overcrowding response strategies to make AD decisions.

Results: The mean hours of AD fell from 13.10 hours per week to 2.23 hours per week. The mean number of ambulance patients rose from 156 patients per week to 185 patients per week.

Conclusion: Measuring ED overcrowding and using the AD protocol, the healthcare quality improvement team successfully reduced AD in their project setting. Additionally, an improved understanding between ED overcrowding and AD emerged. This enhanced understanding may present opportunity for similar projects in other EDs seeking to reduce AD as well.

Keywords: ambulance diversion, emergency department, ED, diversion, divert

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At the crossroads of emergency department (ED) overcrowding lies the intersection of ambulance diversion (AD). Where continuing quality care to those already within the department, meets diverting ambulance patients to further away but less busy hospitals. This crossroads represents extremes in ED resource demand and is associated with negative impact to patients, emergency services, and hospitals alike. This scholarly paper describes an evidence-based project to reduce AD. Its origins were derived from a systematic literature review and from a theoretical framework for change in a complex setting. A healthcare quality improvement (HQI) team led by this project lead created an evidence-based protocol to reduce AD and evaluated its effects during a twenty week trial period.

Problem Description

Hospital EDs in the United States provide emergency care to 130,000,000 patients each year, regardless of patient surge or high demand (Centers for Disease Control and Prevention [CDC], 2018). When EDs are busy, hospitals use AD to temporarily close to ambulance patients. This is done to reduce overcrowding by limiting new patient arrivals, but ambulances turned away from their intended facilities experience longer transport times and travel further distances to and from their response areas. This has been shown to delay time to medical screening exam and to burden emergency medical services (EMS) (American College of Emergency Physicians [ACEP], 2013; CDC, 2018; Geiderman, Marco, Moscop, Adams, & Derse, 2015; National Association of Emergency Medical Service Physicians [NAEMSP], 2011; Patel & Vinson, 2012). The CDC (2018) estimates that 500,000 patients each year are still affected by AD. Current evidence reveals AD delays critical care, negatively impacts patient

satisfaction, and represents about $600 per missed ED visit in lost hospital revenues (Consumer Health Ratings, 2018; Salway, Valenzuela, Shoenberger, Mallon, & Viccellio, 2017; Willard, Carlton, Moffart, & Barth, 2017).

In recent years, there has been growing interest in the correlation between AD and ED overcrowding, and how investigation into their relationship may better inform ED clinical practice. In 2011, the NAEMSP issued a policy statement regarding AD use. It indicated that AD is significant to emergency medical services and their patients. It also recommended that reducing ED overcrowding would likely reduce AD (NAEMSP, 2011). Despite these recommendations, EDs continue to activate AD without other attempts to reduce ED overcrowding. Additionally, its use remains common for types of overcrowding unresponsive to AD, such as staffing shortages, bed shortages, or admitted patients occupying ED space while awaiting transfer (Ahalt, Argon, Ziya, Strickler, & Mehrotra, 2018; Burke et al., 2013).

Despite AD's frequency and growing evidence negating it use, no one national system is used to track AD events, and varying state policies affects its use by region (CDC, 2018). As a result, frequency benchmarks have failed to emerge, but hospitals concerned with their use of AD may evaluate their practice by comparing their hours to similar hospitals within their own healthcare systems or settings (Nakajima & Vilke, 2015; NAEMSP, 2011; Operations Policy, Diversion Systems, 2017; Patel & Vinson, 2012).

Legacy Health System (LHS) of Portland, Oregon is comprised of six hospitals in the Greater Portland Metropolitan Area. This evidence-based project took place within the LHS Good Samaritan Medical Center ED. Good Samaritan Medical Center is a 163 bed hospital with a 23 bed ED, which provided care for approximately 47,000 patients last year, 20 percent of whom arrived via ambulance (LHS, 2018b). It was estimated that AD in the Good Samaritan ED

cost as much as $1,685 per hour (from missed ED visits and potential admissions) (LHS, 2018b). Considering ambulance diversion's impact to care, as well as its financial implications, LHS compared the Good Samaritan's AD hours to another ED within their same healthcare system, with similar demographics. The comparison revealed that the Good Samaritan ED used 716 total AD hours in 2015 (547 more hours than the comparison ED), 808 total hours in 2016 (612 more hours than the comparison ED), and 422 total hours in 2017 (210 more hours than the comparison ED) (see Table A for AD hours between Good Samaritan Medical Center ED and comparison hospital ED data Graph). From this evaluation, LHS executive leadership asked this ED manager and project lead, to investigate the use of AD and develop strategies to limit its use in the Good Samaritan ED.

Preliminary investigation into the Good Samaritan ED's AD practice began with an assessment of LHS's existing AD policy. This assessment revealed practical steps to activating AD, but no strategies to limit its use were identified from its review (LHS, 2018a). In addition, the Greater Portland Metropolitan Area had an AD policy which recommended each hospital be responsible for their AD hours and to engage in quality improvement to reduce its use (Operation Policy: Diversion Systems, 2011).

Initial discussions with the Good Samaritan ED charge nurses revealed that most were unaware of the LHS policy. Many of them affirmed though, that AD was activated because of ED overcrowding, but none could describe how overcrowding was measured or a specific threshold for activating AD. Furthermore, none could describe with any certainty, alternative strategies to reduce ED overcrowding besides AD. The charge nurses also described common AD activations for conditions like staffing call offs, lunch coverage, staffing mix, provider requests, or a condition known as *ambulance diversion retaliation*. This occurs when one

hospital activates AD—simply because another hospital did, in fear of getting those patients too (Geiderman et al., 2015).

Although there is no identified *allowable* AD hours threshold for use in the Good Samaritan ED, when compared to another LHS hospital, above acceptable hours were noted. Despite the LHS and Portland area policies describing AD as a 'limited use' tool, the Good Samaritan ED team inquiry as well as AD historical data, revealed AD use as common practice. It appeared that without defined strategies to assess AD need, the ED charge nurses lacked a consistent process to determine activation, and thus, activations due to subjective feelings became normal practice.

Available Knowledge

The primary purpose of this literature search was to discover articles that answered the clinical question: "*Will use of an ED overcrowding measurement tool together with a protocol used by staff reduce AD hours in an urban ED?"* The evidence demonstrated there are accepted evidence-based strategies for reducing AD. The results of the search also emphasized the link between AD and ED overcrowding. The literature search was conducted through the Northern Arizona University (NAU), Cline Library online collection of databases.

Search Process

The search was conducted using the Cumulative Index of Nursing and Allied Health Literature (CINAHL), Cochrane, and PubMed databases. Various combinations of the keywords: *ambulance diversion*, *emergency department*, *ED*, *diversion,* and *divert* were combined with "AND" and entered in each database. Other phrases including *crowding, crowding scale,* and *reduction* were attempted, but produced no new significant results. After abstract review, an appraisal tool was used to review the articles, which provided consistency and optimal article selection (LoBiondo-Wood & Haber, 2014). Results from all searches

were perused and results greater than 10 years old were excluded. Further exclusion resulted from title review, followed by abstract assessment for relevance. From this search a total of 12 articles were retained and synthesized. The evidence is organized in a research table adopted from Melnyck and Fineout-Overholt (2015) (see Table B for Evidence Table).

Articles retained helped define reducing AD from multiple strategies. The Rating System for Hierarchy of Evidence (Petrisor & Bhandari, 2007) describes seven levels of evidence quality with level I highest to level VII, lowest. The articles retained in this search include articles from level I (one article), level II (one article), level III (four articles), level V (three articles), and level VI (three articles). One limitation of this search is that the articles may not represent all contributing factors influencing AD use, such as community disaster events or equipment failure. The search revealed significant evidence to affirm that AD carries negative consequence to patient outcomes, quality of care, and cost to the hospital. Further, the evidence showed convincingly that measuring ED overcrowding is the first step in determining actions that affect AD strategies (Burke et al., 2013; Geiderman et al., 2015; Hoyle, 2011; Hwang, McCarthy, Aronsky, Asplin, & Bernstein, 2011; Salaway et al., 2017; Schrank & Grossman, 2009).

A relative weakness of many of the articles is that they include regional observance of AD deactivation improvement strategies as well. Although these articles provided improved understanding of the AD phenomena, it is difficult to completely ascertain which strategies carried the greatest impact to reducing its frequency. This result may be because strategies to reduce overall AD activation are multifaceted and the development of multiple strategies is often required to meet reduction goals (Burke et al., 2013; Nakajima & Vilke, 2015; Patel & Vinson, 2012).

The retained articles did however hold strength collectively. They described and quantified AD reductions and defined ED overcrowding and its relationship to AD (Hoyle, 2011; Hwang et al., 2011; Willard et al., 2017). Despite AD being deployed as a strategy to improve patient care by reducing ED overcrowding, research is limited regarding its impact to care or crowding. The articles contribute significant qualitative and quantitative analyses of AD reduction (Nakajima & Vilke, 2015, Salway et al., 2017; Schrank & Grossman, 2009). Although the cohort studies are less significant according to the rating system for hierarchy of evidence, their evidence was suitable for reaching conclusions related to the AD phenomena (Ahalt et al., 2018; Burke et al., 2013; Schrank & Grossman, 2009).

Synthesis

Due to the level of evidence discovered and the complexity of the topic, twelve articles were retained for this review. Additionally, a summary review of an article from 2004 that provided inception and validation of the National Emergency Department Overcrowding Scale (NEDOCS) tool was retained, but not included in the evidence table due to age (see Appendix A for Summary Review). The retained studies were separated into four primary categories: (a) articles that elaborate on the negative consequences of AD, (b) articles that describe the relationship between ED overcrowding and AD, (c) articles that address the effectiveness of ED overcrowding measuring tools, and (d) articles that offer strategies to reduce AD. Some articles met multiple criteria and are represented in their appropriate categories respectively.

The negative consequences of ambulance diversion. One well designed randomized control trial (RCT) from major metropolitan areas in California found that patients were five percent less likely to receive cardiac revascularization and ten percent more likely to die if their intended facility experienced 12 hours or more of AD on the day of their admission

(Shen & Hsia, 2015). Two mixed methods studies were identified describing the impact of AD on patient choice and equitable delivery of care (Geiderman, 2015; Salway, 2017). In a four county study surrounding the Los Angeles area, Nakajima and Vilke (2015), reported an 80 percent increase in providing first choice destinations as a result of decreasing AD, which improved patient satisfaction respectively in participating hospitals. Geiderman et al. (2015) evaluated demographics on patients impacted by AD and found its use disproportionate amongst minorities and those of low socioeconomic status. A systematic review evaluating the cost of AD found a correlation between missed ambulance patients and missed hospital admissions, and that increasing the number of admissions from the ED by one per day, could increase a hospital's net profit by $800,000 a year (Salway et al., 2017).

The relationship between ED overcrowding and ambulance diversion. Discovered from EDs examining benchmarks of overcrowding that were also present with AD use, three articles were identified as describing the correlation between the use of AD and its impact on ED overcrowding (Ahalt et al., 2018; Burke et al., 2013; Schrank & Grossman, 2009). Common benchmarks of overcrowding measured with AD were length of stay, available space, number of patients consuming available space, and levels of acuity or other indication of staff workload, including ventilated patients, and boarded versus non-boarded patients (Ahalt et al., 2018; Burke et al., 2013; Schrank & Grossman, 2009). Examination of the articles describing the correlation between ED overcrowding and AD revealed that AD use increased as ED overcrowding increased. This was achieved by describing overcrowding from three primary influences: ED input, throughput, and output. Examples of how these influence overcrowding are: (a) ED input overcrowding is attributed to front door walk in patient arrivals, which have been shown to climb quickly, extending ED wait-to-be-seen times (b) ED

throughput overcrowding occurs when critical patients require one on one care, consuming nurses' time, and decreasing available staff, and (c) ED output overcrowding occurs as surgery, inpatient, or psychiatric patients occupy ED space, while awaiting transfer to other care areas (Ahalt et al., 2018; Burke et al., 2013; Hoyle, 2011; Hwang et al., 2011; Patel & Vinson, 2012; Salway et al., 2017; Schrank & Grossman, 2009).

The articles also described what impact AD had on input, throughput, and output-related overcrowding, based on quantifiable data. These findings were consistent with the NAEMSP policy statement (2011) and revealed that although AD was *activated* during times of throughput and or output overcrowding, it had no effect on reducing the overcrowding. The authors concluded that throughput and output overcrowding are unresponsive to AD (Ahalt et al., 2018; Burke et al., 2013; Schrank & Grossman, 2009). Input overcrowding however, was responsive to AD, but only for short duration. This would indicate that AD is useful in extreme or disastrous overcrowding events only (Ahalt et al., 2018; Burke et al., 2013; Cameron, Joseph, & McCarthy, 2009; Schrank & Grossman, 2009). Based on the identified relationship between AD and ED overcrowding, a measurement of ED overcrowding would be useful for addressing AD reduction. A standard measurement of ED overcrowding would allow staff to consistently and accurately determine whether AD could help.

ED overcrowding measuring tools. The literature revealed one mixed method study, two well designed RCTs, and one systematic review that examined measurement of ED input, throughput, or output overcrowding (Ahalt et al., 2018; Hoyle, 2011; Hwang et al., 2011; Willard et al., 2017). Use of a measurement tool for overcrowding can help staff tailor strategies within their own setting to decrease overcrowding without AD. By knowing the details of the overcrowding, staff may replace AD with more effective strategies. The Emergency Department

Work Index (EDWIN), the National Emergency Department Overcrowding Scale (NEDOCS), and the Realtime Emergency Analyses of Demand Indicators (READI) tools emerged from the literature as the most commonly assessed ED overcrowding measuring tools (Ahalt et al., 2018; Hwang et al., 2011, Willard et al., 2017). These measuring tools were considered for both their accuracy of ED overcrowding assessment and their consideration of input, throughput, and output variables (Ahalt et al., 2018; Hwang et al., 2011).

The articles described all three measuring tools as comparably accurate in measuring overcrowding (Ahalt et al., 2018; Burke et al., 2013; Schrank & Grossman, 2009). The NEDOCS tool was consistently described as most beneficial for its ease of use by staff, its effectiveness in assessing ED physicians' feelings of being busy, and its usefulness in EDs of various sizes (Ahalt et al., 2018; Burke et al., 2013). Recognizing that physicians' feelings of being busy, may differ from nurses' feelings of being busy, Hwang et al. (2011) compared the EDWIN, the NEDOCS, and the READI tools regarding nurses' ease of use and physicians feeling of being rushed. The NEDOCS tool scored considerably better in these categories. Hwang et al. (2011) also described use of the tools for enhancing communication interactions between the team and again the NEDOCS tool was most desirable. Hoyle (2011) noted the benefit of the NEDOCS for its accuracy in identifying clear indicators of overcrowding conditions, such as wait to be seen times, patients on ventilators' or requiring one on one care, and boarders, which led to optimal AD reduction strategies when these indicators were identified (Ahalt, et al., 2018; Hoyle, 2011; Willard et al, 2017). The NEDOCS measurement tool (see Appendix B for NEDOCS Tool) was validated in a comprehensive study by Weiss et al. (2004). Its continued use in more recent studies further supports its validity.

Strategies to reduce ambulance diversion. Coupled with the overcrowding

measurement tool, an evidence-based and site-specific protocol to address various levels of ED overcrowding will help offer specific strategies available to staff. This protocol will improve communication between staff, charge nurses, providers, department and hospital leadership, as well as other departments by offering guidance for shifting resources, reprioritizing care, and strategies other than ambulance diversion (Nakajima & Vilke, 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017). Specific strategies for various levels of overcrowding were examined from the literature. All the retained studies describing reductions in AD did so by first measuring ED overcrowding with the use of an objective measuring tool (Ahalt et al., 2018; Nakajima & Vilke, 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017). Next, the articles described how EDs could devise a site-specific protocol of AD reduction strategies appropriate in their own settings. Cameron et al. (2009) and Schrank & Grossman (2009) recommend both ED-centric and hospital wide strategies to reduce AD. Salway et al. (2017) describe however, that the best results emerged when EDs and other hospital units, like the inpatient department, intensive care unit, and surgical services department, deployed strategies together to address overcrowding.

Salway et al. (2017) performed a systematic review to discover strategies to reduce AD. Their study examined AD causes by measuring ED overcrowding. In addressing input overcrowding, a provider in triage was successful in reducing delays in care. By deploying strategic patient flow designs to reduce nursing resource demand, throughput overcrowding was reduced (Salway et al., 2017). Lastly, in addressing output overcrowding, it was found that a primary cause of overcrowding was ED patient boarding. Salway et al. (2017) concluded that collaboration with other hospital units would be most effective for decompressing the ED during output overcrowding. These findings were supported by Schrank & Grossman (2009), who

measured ED overcrowding and described output overcrowding to be a significant cause of AD and strategies to address this should arise from whole hospital collaboration. It was noted however, that the ED itself can deploy effective strategies to reduce AD on their own (Schrank & Grossman, 2009). For example, a strategic patient-placement model may be used to maximize space. When appropriate, the ED team could utilize strategies such as using a results waiting area, use of hall beds, reprioritization of lab studies, initiation of nurse standing orders, assistance of physicians in rapid admissions and discharges, and by funneling near complete patients back toward the waiting room (Cameron et al., 2009).

Ahalt et al. (2018) used the NEDOCS tool to create a management alert protocol that extended beyond their ED. Similar to the articles from Cameron et al. (2009) and Salway et al. (2017), Ahalt et al. (2018) formed the assumption that AD could be significantly reduced by measuring ED overcrowding and applying threshold designed interventions to reduce its use. By measuring ED overcrowding first, the team could provide clear communication with hospital units beyond their ED, which illustrated the source of their ED overcrowding and improved awareness with other hospital units. Ahalt et al. (2018) deployed both hospital and ED strategies to reduce AD, which included pre-AD preparations, paging overhead conditions, staff huddles, and use of a systematic response.

Key Issues

Key issues discovered through the literature review were that ED throughput and output overcrowding were unresponsive to AD. Despite its ineffectiveness in reducing ED throughput and output overcrowding, many EDs continue to activate AD during these circumstances (Ahalt et al., 2018, Burke et al., 2013; Geiderman et al., 2015; Hoyle, 2011; Hwang et al., 2011;

Salaway et al., 2017; Shen & Hsia, 2015). Valid tools to measure ED overcrowding gave staff vital information upon which to make the decision about whether to implement AD.

Completing an exhaustive literature search enabled this project lead to discover the most current and best evidence regarding AD reduction. The literature clearly demonstrated that EDs can reduce AD following a protocol that (a) measures ED overcrowding and (b) guides staff strategies for addressing the level and type of overcrowding (Ahalt et al., 2018; ACEP, 2013; Hoyle, 2011; Patel & Vinson, 2012). The literature review supports the use of the NEDOCS tool (see Appendix B for NEDOCS Tool) as superior for its effectiveness in measuring ED overcrowding (Geiderman et al., 2015; Salway et al., 2017; Willard et al., 2017). The most effective evidenced-based strategies to address the overcrowding, were combined into a response protocol. This was created following an organized pathway with hospital and department leadership, providing communication that reached beyond the ED, and reorganizing patients and resources to meet ED patient demand (Ahalt et al., 2018; Cameron et al., 2009; Geiderman et al., 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017).

Rationale

Improving the likelihood of a HQI project's success, Moran, Burson, and Conrad (2014) recommend the use of a theoretical model and conceptual framework while implementing change. Befitting both this evidence-based project and this project lead's philosophical, analytical, and investigatory style, the *Plan Do Check Act* model and Kurt Lewin's Change Theory served as the frameworks for change in the ED setting.

Theoretical Model

The *Plan Do Check Act* model is a four step circular cycle for creating change (Tague, 2004). Similar to a circle having no end, the cycles are intended to be repeated for continuous

improvement. The *Plan Do Check Act* model was used as a process framework during the planning, implementation, and evaluation of the AD protocol in the Good Samaritan ED. Following the model and in planning for the intervention, the *Plan* phase consisted of a literature review, and confirmation of the theoretical model and conceptual framework. The *Do* phase allowed for selection of the NEDOCS tool, and for tailoring the protocol to the project setting. The *Check* phase provided for evaluation of the protocol during a 24 hour *test day*, and the *Act* phase consisted of confirming the trial and evaluation plan with the HQI team. Also following the *Plan Do Check Act* model, implementation and evaluation of the AD protocol occurred. Following the *Plan* phase, the charge nurses set goals for AD hours use during their shifts. The *Do* phase allowed the charge nurses to practice the protocol in the clinical setting. The *Check* phase consisted of weekly meetings that allowed the charge nurses and HQI team to evaluate the effectiveness of the protocol with data, and the *Act* phase consisted of using strategies within the protocol for continued reduction of AD. Additionally, the charge nurses followed a series of *Plan Do Check Act* cycles to address ED overcrowding at preset times during their shifts.

Conceptual Framework

Kurt Lewin's Change Theory follows a three stage model for change by rejecting or expelling old knowledge, and replacing it with new knowledge (Hussein, Talib, Shen, Tayyaba, & Ali, 2018). Its ease of use and familiarity made it ideal for guiding change in the ED setting (Hussein et al., 2018). Following the framework, examination, preparation, and sustainment of organizational change took form using the theory's *unfreeze, change,* and *refreeze* design. During the *unfreeze* phase, examination of the AD status quo, including the teams' current attitudes, existing behaviors, and current policies took place. A literature search was completed to understand the problem of ED overcrowding and its relationship to AD. This review of the

literature revealed best evidence for ED practice regarding AD use. From the literature, the protocol was developed and then tailored to the Good Samaritan ED. Staff, charge nurse, and provider training also occurred. While in the *change* phase, the team created a protocol to address the impact of overcrowding on AD hours. This included implementing an intervention that was successful in reducing AD hours by providing a systematic process to support AD decision making. Lastly, the *refreeze* phase included sustaining the process by sharing the trial outcomes with administration and staff, offering additional as-needed training for staff, and with continued monitoring by the Unit Practice Council Committee (see Appendix C for Change Model) (Current Nursing, 2012; Lewin, 1951; Hussain et al., 2018).

Reasons and Assumptions That Were Used to Develop the Intervention

Kurt Lewin's Change Theory was chosen for its ability to support change in a fast paced environment (Hussein et al., 2017). ED nurses were confronted with change on a regular basis and rapid adaptation to change would be necessary to improve ED practice. This evidence-based project also introduced an AD protocol with a measuring tool and guided response levels. It was created from a systematic literature review as well as the HQI teams' practical knowledge of the ED setting. It included the use of the NEDOCS tool (see Appendix B for NEDOCS Tool) to measure overcrowding and action levels with interventions specific for the Good Samaritan ED (see Appendix D for Protocol). The protocol was assumed to work specifically by result of the systematic review. It was discovered that EDs can reduce AD by measuring ED overcrowding and creating AD protocols (Ahalt et al., 2018; Cameron et al., 2009; Geiderman et al., 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017).

Assumptions drawn from the available knowledge were that high AD hours use in the Good Samaritan Medical Center was likely attributed to a lack of standardized processes to make

AD decisions. This assumption was also supported from the charge nurse inquiry that revealed variation amongst activation steps and reasons for AD use. It was also assumed AD was likely attributed to ED overcrowding, as this was clearly associated in the literature. The literature also led to the assumption that a protocol tailored to the Good Samaritan ED and which measured overcrowding, would be successful in reducing AD use. Lastly, it was assumed that the protocol could be adhered to easily in the project setting, would offer evidence to guide and justify AD decisions, and could create consistency in AD processes (Tague, 2004).

Why the Intervention Was Expected to Work

The literature review revealed that an evidence-based AD protocol could reduce AD. The NEDOCS tool has been shown to be a valid and relevant tool specifically for reducing AD (Ahalt et al., 2018; Hoyle, 2011). The protocol was deemed likely to work because it could aid the ED charge nurses in making critical decisions. Protocols are common in the ED setting, are associated with improved patient outcomes, and facilitate consistency in staff work with organized methods (Tague, 2004). The AD protocol was not intended to override nursing leadership or ED physicians, rather offer guidance in taking safe, evidenced-based action steps to continue providing high quality care in the ED.

Specific Aims

The purpose of this project was to implement an evidence-based protocol to reduce AD use in the Good Samaritan ED. The primary aim was to reduce AD hours by 25 percent. A secondary aim was to increase the number of ambulance patients by 10 percent. Overall, this was to improve understanding between AD use and ambulance patient arrivals as well as to increase potential revenue sources for the hospital. This purpose and aim answers the clinical question:

"*Will use of an ED overcrowding measurement tool together with a protocol used by staff reduce AD hours in an urban ED?"*

Context

Implementation of the AD protocol adhered to the mission of LHS regarding care transformation, "We do what is right—for our employees, our patients, our community, and our world (LHS, 2018a, para. 2). The project specifically aligned with the Good Samaritan ED's community needs assessment by considering a primarily pedestrian patient population, which had a high likelihood to use ambulance transport when seeking emergency services (LHS, 2018b). At the outset of this evidence-based project the Good Samaritan ED and ambulatory urgent care was a recognized stroke and cardiac intervention center. It had a potential patient population of 1.4 million people and saw an average of 125 adult and pediatric patients each day. Ninety percent of ED patients were medical non-trauma patients (LHS, 2018b).

Providing further impetus to reduce AD in the Good Samaritan ED was the ED's role in the community distribution of ambulance patients across receiving hospitals. The Good Samaritan Medical Center was a community hospital within the Greater Portland Metropolitan Area's *Central* ambulance transport zone. The remaining EDs were two Level I trauma centers and two specialty EDs. By avoiding AD, the Good Samaritan ED would have an improved ability to accept ambulance patients when either of the Level I trauma centers became inundated with trauma patients. A majority of the zone's ambulance patients were transported to the Good Samaritan ED or to either of the Levels I trauma centers. The specialty EDs received fewer ambulance patients due to their patient acceptance requirements. The Veterans Affairs ED only accepted active or retired military members, and the Psychiatric Emergency Services Department only accepted preexisting behavioral health patients exhibiting a behavioral health crisis (Oregon

Health Authority, 2018). By avoiding AD the Good Samaritan ED would be able to improve availability of ED resources to ambulance patients throughout the community.

Staff in the Good Samaritan ED consisted of two hospital unit clerks, eight scribes, 13 ED technicians, 47 registered nurses, 12 advanced practice registered nurses, 16 medical doctors, and seven pharmacists. The HQI team was comprised of six charge nurses, the assistant nurse manager, the medical director, and the nurse manager. The six charge nurses and assistant nurse manager were all bachelors-degree prepared registered nurses. The medical director was a certified emergency physician and masters-degree prepared in business. The project lead was the ED nurse manager, a doctoral nursing student. All nursing members of the HQI team held specialty certifications in emergency nursing.

Involving the charge nurses as change champions was paramount to project success. After collaboration with the providers, the charge nurses retained operational authority for making AD decisions in real time. The charge nurses were chosen specifically for the HQI team because of the responsibilities inherent to their roles within the department. Their participation was also essential for their ability to influence change. The project would be achieved in part by ensuring the staff nurse understood the intent and purpose of the protocol. Ensuring understanding of intent and purpose would require constructive staff and charge nurse interactions to overcome previously developed habits by the ED staff. Historically, the staff were able to persuade the charge nurses to use AD when the staff felt busy. The medical director played an invaluable part in protocol development and the assistant nurse manager provided clinical expertise. The ED nurse manager maintained responsibility for the project. From assessment of team member needs, and role delineation, progress toward the intervention was able to begin.

Intervention

Using the framework of Kurt Lewin's Change Theory, the HQI team initiated implementation of an AD protocol in the project setting (see Table C for Project Timeline). The AD protocol followed a systematic approach to making critical AD decisions. Charge nurses would use the protocol to measure ED overcrowding with the NEDOCS tool. Using the protocol would then allow the charge nurses to make evidence-based data driven decisions (see Appendix B for a description of the NEDOCS tool). The protocol was developed with evidence-based strategies intended to reduce AD and would be specifically tailored to the Good Samaritan ED (see Appendix D for Protocol).

Preparation for the Intervention

Applying the *unfreeze* phase of Change Theory, this project lead identified the local problem and conducted an exhaustive literature review. Following the literature review, confirmation and selection of the conceptual and theoretical frameworks occurred. Kurt Lewin's Change Theory and the *Plan Do Check Act* model were selected in recognition of both the Good Samaritan ED environment as well as the project itself. This section describes in detail each step of the preparatory work for the practice change. The first step included protocol creation, development of an implementation plan, and project proposals to the academic and project settings. The second step included site and staff preparations. Lastly, the third step included user (charge nurse and provider) training.

First step. Abiding by the Portland area and hospital AD policies, an HQI team created an evidence-based AD protocol for use in the Good Samaritan ED. This was done originally in draft form during a two hour protocol development session. The protocol development session was attended by the HQI team and provider staff. During the session, the project lead gave a

project presentation that provided AD background, AD use between the Good Samaritan ED and the comparison hospital, and an evidence-based recommendation to implement change. This recommendation was to introduce a protocol to reduce AD in the Good Samaritan ED. A protocol would be more effective however, if the protocol was created with input from the users themselves and from multiple view-points.

To include multiple perspectives, the project lead provided a tri-fold poster board with a large copy of the NEDOCS tool on one side, and a blank copy of a five leveled protocol that matched the NEDOCS tool on the other (see Appendix D for Protocol). There were also blank copies of the protocol that each member could write notes on. The project lead then led the group in a discussion illustrating how the NEDOCS tool would be calculated to direct users with a protocol that aided in reduction strategies to avoid AD. The charge nurse and providers decided on the frequency to which to calculate the NEDOCS score and the reduction strategies for use within the protocol. The charge nurses and providers also selected the evidence-based strategies identified from the literature and considered how they could be applied in our ED setting. Finally, the charge nurses and providers decided which strategies would be feasible in the Good Samaritan ED and matched the strategies to the NEDOCS scores that best warranted their use.

After the protocol was created (see Appendix D for Protocol), the project lead created a project proposal to implement a practice change in the Good Samaritan ED. A 30 minute project proposal was presented to the NAU School of Nursing faculty and approval to proceed with the project was granted. The project lead also presented a 30 minute project proposal to the Good Samaritan Medical Center's President, Chief Nursing Officer, and Medical Staff President. The proposal included background information on AD, local use in the Good Samaritan ED, and details about the project goals. Following proposal approvals, Institutional Review Board (IRB)

applications were submitted and approval to proceed with the HQI project was granted from both NAU as well as LHS.

Second step. Accessing the NEDOCS score quickly and effortlessly would be vital to project success. The NEDOCS tool was already embedded within the Good Samaritan ED's Electronic Health Record (EHR) ED dashboard, but its preset auto population times were insufficient to meet protocol need. The assistant nurse manager made an EHR enhancement request to the EHR super user group, requesting that the NEDOCS tool function as an on-demand feature (see Table C for Project Timeline). While awaiting this enhancement to the ED dashboard, a service request was made to the information services department to add the NEDOCS tool online link to the charge nurses' computers. The link was successfully added to all of the charge nurses' desktop login screens and the link was labeled *NEDOCS* for easy identification.

Unfreezing the current state also took form as a one month campaign to ready the staff for change. The project lead conducted two-one hour staff meetings one month prior to implementation. The staff meetings were at 0730 for day shift and 1930 for night shift (see Table C for Timeline). The staff meetings occurred during one of the department's regularly scheduled monthly staff meetings. During these meetings, the project lead explained the background of AD, described local use in the Good Samaritan ED, presented the protocol, and answered any staff questions.

Following the meetings, all ED staff received daily verbal reminders on the protocol and the upcoming change within the department. Daily staff huddles provided the verbal reminders and occurred in the ED conference room. Huddles took place for day shift at 0700 and night shift at 1900. Additionally, tri-fold presentation boards with the NEDOCS tool and protocol were

displayed in the ED conference room and lounge and were observable when the staff huddles occurred.

Third step. In a separate charge nurse training session, the project lead gave one-two hour training session to the charge nurses to provide AD background, tool introduction, and simulation training with the NEDOCS and protocol. First, the charge nurses demonstrated accessing the NEDOCS tool and became familiar with the tool. Once they were familiar, each charge nurse practiced calculating simulated overcrowding events. Then, as a group they identified strategies from within the protocol to limit AD use, and discussed how they might have proceeded and why. The ED medical director provided similar training to the provider staff (see Table C for Project Timeline). No charge nurses were hired during the intervention therefore, no additional training was required.

After the charge nurses were trained, a *test day* was conducted to allow practical training with the protocol in the project setting (see Table C for Project Timeline). The test day was held for two consecutive 12 hour shifts, one week prior to implementation of the trial. The 24 hour test day was intended to improve understanding about the protocol. The test day included attendance by the off duty charge nurses from 1400 to 2200 hours, and helped ensure that the protocol was tailored effectively to the local context. The test day also allowed the HQI team to build change momentum and assess for potential barriers. The protocol was found to be practical for use in the project setting and an evaluation plan was ready to be developed.

Lastly, the HQI team established a twenty week trial period for assessment of the protocol. Trial period assessment consisted of a comprehensive evaluation plan that followed the *Plan Do Check Act* model. The evaluation plan included the project lead to collect data on AD hours and the number of ambulance patients, organizing it into data tables, creating graphs for

visual representation of use, and facilitating team development of protocol practice as the trial progressed (see Table C for Project Timeline). After the evaluation plan was agreed upon, the trial was ready for implementation. The trial began on August 13, 2018.

Ambulance Diversion Protocol

ED overcrowding is both complex and dynamic. ED overcrowding may increase progressively, or, conditions within the ED can change rapidly. These types of conditions may require escalation to any action level within the protocol (see Appendix D for Protocol). Although the protocol could be followed sequentially, escalation out of sequence was not considered deviation from the protocol. Rather, when this occurred, this was considered flexibility within it. The first step of the protocol required the charge nurses to assess the NEDOCS score. After the score was calculated, the charge nurse identified the level of overcrowding and used the protocol' action levels to assist in deciding steps to avoid AD.

The National Emergency Department Overcrowding Scale Tool

The NEDOCS tool was used by the charge nurses to determine an overcrowding score by accessing the link on their desktop computers and filling in the seven objective measures of ED overcrowding (see Appendix B for NEDOCS Tool). The score started at zero and had no upper limit. A score of zero to 60 was green and considered normal. A score of 61 to 100 was yellow and considered busy. A score of 101 to 140 was amber and considered overcrowded. A score 141 to 180 was orange and considered severe, and a score greater than 181 was red and considered dangerous (Weiss et al., 2004). The NEDOCS tool followed a color coded score to allow its users to translate the results into an easily communicated format (Weiss et al., 2004). The NEDOCS tool was available for public access at (https://emed.unm.edu/clinical/nedocs.html) (University of New Mexico [UNM], 2018).

Response Strategies

Created to offer organized reduction strategies from five action levels, the AD protocol was created from evidence discovered during the literature review. Based on the NEDOCS score given, the charge nurses used the protocol to follow approved steps to avoid AD. The NEDOCS tool and protocol were similarly color coded for ease of use and for consistency with others. It was recognized that not all strategies within each action level would be applicable in all overcrowding conditions, but the protocol was created to offer multiple strategies that the charge nurses could choose from (see Appendix D for Protocol).

Implementation of the Ambulance Diversion Protocol into Use

Applying the concepts of the *change* phase, practical use of the AD protocol was deployed. Charge nurses followed the protocol and calculated the NEDOCS score every two hours, or every hour in severe or dangerous overcrowding conditions. Calculation of the NEDOCS score at two or one hour intervals prompted the charge nurses to conduct a series of *Plan Do Check Act* cycles to avoid AD throughout their shifts. Observance of the score and its variables led to action steps within the protocol. The charge nurses selected the action steps they felt would reduce AD and deployed them as appropriate.

The *refreeze* phase occurred after and as a result of the *change* phase. Because AD hours were reduced, the *refreeze* phase included unanimous agreement by the HQI team for permanent sustainment of and ongoing use of the protocol in the Good Samaritan ED. From this agreement, establishment of an annual monitoring plan took place. The monitoring plan was to be maintained by the Good Samaritan ED's shared governance-Unit Practice Council, which was comprised of frontline ED staff. The maintenance plan included a quarterly AD report to the ED manager and an annual review of the protocol strategies for continued relevance.

Cost

Implementation of the AD protocol occurred as part of day to day operating costs in the Good Samaritan ED. The project manager incurred an insignificant out of pocket expense on lamination of the protocol. There were no costs associated with software use or purchase. Continued use of the protocol has no ongoing costs.

Study of the Intervention

Assessment of the intervention continued following the conceptual framework of Kurt Lewin's Change Theory and the *Plan Do Check Act* model. Incorporating the concepts of the *change* phase, the HQI team studied the intervention as the trial progressed. Each week of the trial included meetings to assess the protocol' *Plan Do Check Act* cycles. The meetings allowed the team to evaluate AD hours and the number of ambulance patients, discuss protocol use, and establish new *Plan Do Check Act* cycle goals for upcoming trial weeks. To successfully complete these cycles, the HQI team set a recurring meeting every Thursday, from 0730 to 0930. During Thanksgiving week, the meeting occurred on Wednesday.

Representing weeks 33 through 52 of the calendar year, the project trial consisted of a sample of a twenty week interval. It occurred between the dates of August 13 through December 30, 2018 (see Table C for Project Timeline). AD hours and the number of ambulance patients were collected for each week of the trial. AD baseline data was compiled for the same weeks of the previous three years (weeks 33 through 52 of 2015, 2016, and 2017) (see Table D for AD History, Baseline, Trial Data, and Percent of Change Table). The baseline number of ambulance patients was also compiled for the same weeks of the previous three years (weeks 33 through 52 of 2015, 2016, and 2017) (see Table E for Number of Ambulance Patients History, Baseline, Trial Data, and Percent of Change Table).

Measures

Without AD benchmarking, the HQI team established improvement goals designed to evaluate the protocol trial use against their own historical trends. This design was applied so that the team could focus on their own success and avoid competition between the LHS hospitals. The rationale for selecting AD hours and number of ambulance patients was derived from their ability to assess the AD phenomena. Use of AD hours were negatively correlated to patient outcomes and equitable delivery of care (Geiderman et al., 2015; Shen & Hsia, 2015). AD hours were the outcome measure and were chosen to show a direct measure of AD use. The number of ambulance patients was chosen for its relationship to AD and for its cost opportunity for hospitals (Salway et al., 2017). The number of ambulance patients served as a balancing measure.

The Oregon Health Authority (OHA) stipulated that each hospital participating in AD actively review AD data for quality purposes (Operations Policy, 2017). Granted through provision of the Oregon Health Authority as well as the Multnomah County Diversion Operations Guideline, historical, baseline, and trial data was accessed from the Hospital Capacity Network (HOSCAP) (OHA, 2018; Operations Policy: Diversion Systems, 2017). The HOSCAP was an emergency management software program which tracked AD use and assisted in the direction of emergency resources in the state. AD events were input into the HOSCAP in real time during the trial as the charge nurses activated and removed the Good Samaritan ED from AD status. Data management occurred weekly from a password-secured—web-based portal. AD data was accessible for scholarly development by affiliation agreement between NAU and LHS.

Mitigated by frequent data collection intervals, customizable search criteria, and use of analytical software, data analysis barriers were minimal (Operations Policy: Diversion System,

2018). The project lead was responsible for collecting, aggregating, and reporting all project data. The project lead accessed historical, baseline, and trial data under secure login to the HOSCAP. Logins occurred on password protected work and personal computers. Data was input into data tables for ease of use (see Tables D and E for Historical, Baseline, Trial Data, and Percent of Change Tables). No data bore patient identifying information. Coding was not required.

Analysis

For the comparison of historical AD hours to the current AD hour trial data, analysis was observed using a two series bar graph that included a trend line of trial data (see Tables F for AD Hours Graph with Linear Trend Line). For comparison of historical number of ambulance patients to trial number of ambulance patients, analysis was again observed using two series bar graphs that included a linear trend line of trial data (see Table G Ambulance Patients Graph with Linear Trend Line). The graphs were intended specifically to show the effectiveness of the protocol by providing a visual representation between baseline and trial data. Inclusion of the trend line allowed for a week to week representation of progress throughout the trial. The graphs with linear trend lines allowed the HQI team to recognize overcrowding timeframes within the department when AD was used. This prompted further discussions of strategies specific to those instances and facilitated an improved understanding of contributing factors.

Following a pre-test—post-test design, the HQI team compared mean AD hours from the trial period against the mean AD hours from the same weeks of the previous three years. This comparison was intended to represent considerations such as higher or lower prevalence of flu, communicable disease, or inclement weather. In recognition of patient volume variation related

to time of year, the HQI team compared the mean number of ambulance patients between the trial period and the same weeks of the previous three years.

More accurately representing extremes in AD use, retention of data outliers was relevant for data analysis. For this reason the paired samples *t*-test was used to assess data means between the baseline and trial period. Statistical Package for Social Sciences (SPSS) (Version 21, 2016) was used to calculate data for its accuracy of use and ability to retain data outliers (Kim & Mallory, 2016). No exclusion events occurred during the trial. Exclusion of data would have resulted from computerized tomography scan' equipment failure or downtime, or due to community-wide disaster management situations.

To determine the difference between baseline and trial data for both AD hours as well as the number of ambulance patients, the paired samples *t*-test was performed (Kim & Mallory, 2016). Baseline and trial data was measured at interval level and evenly distributed. The first step was performed by calculating the mean difference between the measurements for each week of the trial. Based on this comparison, once this statistic was computed, the associated *p*-value was compared with the alpha, and a decision could be made regarding its results (Kim & Mallory, 2016). Lastly, a percentage of baseline and trial data change was calculated for consistent conveyance of evidence.

Ethical Considerations

No patients were intentionally exposed to AD as a result of this project. NAU and LHS deemed the project as *Non Research* status and *Quality Improvement* (see Appendices E and F for IRB Not Research Determination). Project letters of support were provided by the Good Samaritan ED Medical Director as well as the Vice President and Chief Nursing Officer (see Appendices G and H for Letters of Support). No conflicts of interest were identified for any

member of the HQI team. At no time did the project manager have financial or employment interests or concerns that could have influenced the conduct or the outcome of this project.

Results

Current evidence shows that use of an AD protocol can have a direct impact on the reduction of AD hours (Geiderman et al., 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017; White & Dudley-Brown, 2016). This project was intended to reduce AD hours while focusing on benefit to patients, the community, and the hospital. These anticipated benefits included improved patient access to emergency care, ambulance stewardship, and financial opportunity for the hospital.

An AD protocol that incorporated the use of the NEDOCS tool was introduced for use within the Good Samaritan ED. The impact of the intervention was measured during a twenty week trial period, weeks 33 through 52 of 2018. The results revealed that using the protocol reduced AD hours and increased the number of ambulance patients. Achieving an 82.97 percent reduction, mean AD hours fell from 13.10 hours per week to 2.23 hours per week during the trial period (see Table D for AD History, Baseline, Trial Data, and Percent of Change Table). Achieving over a 15.67 percent increase during the trial period, the mean number of ambulance patients increased from 156 patients per week to 185 patients per week (see Table E for Number of Ambulance Patients History, Baseline, Trial Data, and Percent of Change Table).

Initial Steps of the Intervention

During the 24 hour test day and while following a *Plan Do Check Act* cycle, a charge nurse recommended evaluation of the NEDOCS score hourly if the previous regularly scheduled measurement revealed a severer or dangerous, overcrowding score, greater than 140. This recommendation was unanimously agreed upon by the HQI team and was included into the protocol. During week three of the trial, an additional *Plan Do Check Act* cycle resulted in

another recommendation to the protocol. After recognition of boarding patients (output flow) as a hindrance to avoiding AD, a charge nurse recommended calling report for admitted patients awaiting transfer. If the receiving nurse would not be available, report would be given to the receiving unit's charge nurse or patient flow nurse. This recommendation was also unanimously agreed upon by the HQI team and the protocol was updated to include this recommendation as well (see Appendix D for Protocol). No further modifications were made to the protocol.

Comparison between baseline and trial data revealed that AD hours in the first week fell from 13.10 hours per week to 6.21 hours per week. By week 20 of the trial, AD hours had fallen to 1.62 hours per week and an accompanying trend line showed a steady decline in hours throughout the trial (see Table F for AD Graph with Trend Line). Additionally, the trend line that illustrated the number of ambulance patients steadily increased throughout the trial (see Table G for Number of Ambulance Patients Graph with Trend Line).

Details of the Process Measures and Outcomes

To determine if the difference between baseline AD hours and trial AD hours was statistically significiant, a comparison of means was performed. The null hypothesis was that the comparison would be equal. The alternative hypothesis was that the trial AD hours would be statiscally significantly lower. Where *M* is mean and *SD* is standard deviation, to test the null hypothosis that the baseline AD hours ($M = 13.10$, $SD = 4.03$) and trial hours ($M = 2.23$, $SD = 2.44$) were equal, the paired samples *t*-test was performed. The null hypothesis was rejected however when the test revealed significance at $t(19) = 10.57$, p .001. Therefore, the alternative hypothesis was accepted. The difference between the trial period AD hours were proven to be statistically significantly lower than the baseline AD hours (see Table G for AD Paired Samples *T*-Test).

To determine if the difference between the baseline number of ambulance patients and the trial number of ambulance patients was statistically significant, a comparison of means was again performed. The null hypothesis was that the comparison would be equal. The alternative hypothesis was that the trial number of ambulance patients would be statisically significantly higher. To test the null hypothosis that the baseline number of ambulance patients (M = 167.96, SD = 5.06) and the trial number (M = 185.10, SD = 5.06) were equal, the paired samples t-test was again performed. The null hypothesis was rejected when the test revealed significance at $t(19) = 7.96$, p .001. The alternative hypothesis was then accepted. The trial period number of ambulance patients were proven to be statistically significantly higher than the baseline number of ambulance patients (see Table H for Number of Ambulance Patients Paired Samples T-Test).

Contextual Elements that Interacted With the Intervention

Kurt Lewin's Change Theory provided a useful backdrop for exploring how contextual factors influenced the improvement process, and how they interacted to facilitate change. Application of the AD protocol in the Good Samaritan ED revealed systematic and staff level contextual elements that interacted with the intervention. The ED's systematic contextual elements that facilitated AD change were its preexisting structure for quality improvement, division of leadership, and span of control. The Good Samaritan ED participated regularly in quality improvement and was supported by systems level organizational development. Division of leadership between the nursing manager and the provider medical director supported interdisciplinary change. The six primary charge nurses in the ED were also members of the HQI team. This dynamic created a broad span of control that fostered communication to and from the ED staff and maintained consistency of department frontline leadership during the trial.

The charge nurses and providers drew on their experiences, training, and expertise in emergency nursing or medicine to create the protocol. The HQI team was instrumental in creating practical, solution-based strategies for the protocol in the project setting. Inclusion of staff level contextual elements improved the successful development of the protocol by providing an improved consideration of the protocol's potential interactions with other hospital departments. These staff level contextual elements were instrumental in facilitating change with the imaging and laboratory diagnostics departments and inpatient units.

Following Kurt Lewin's Change Theory, key steps of the change process were examined and studied more thoroughly. The HQI team developed an enhanced understanding between the steps in the change process by consistently following a framework for each phase of the investigation, intervention, and study of the intervention process. Also following the framework, correlation between each of the change phases and an improved connection between the current, previous, or upcoming phase as the trial progressed was assessed (Grant & Osanloo, 2014). Lastly, following a framework built on cumulative knowledge development with the HQI team, which fostered an enhanced understanding of AD as well as the change process itself (Hussain et al., 2018).

Using the protocol provided a new measurement of ED overcrowding and enhanced the charge nurses own understanding of the AD phenomena, and how ED overcrowding contributed to, or resolved AD use. This was beneficial not only for recognizing considerations that impacted AD, but also for discerning the degree of impact various types of overcrowding had. For example, the staff's first-hand experience describing how an increase of one or two inpatient boarders was far more impactful than one or two new patient arrivals, or, that wait to be seen times may be influenced by delays in diagnostic studies. This allowed for improved severity

recognition of the overcrowding source and led to enhanced solutions to address overcrowding based on assessment of its impact.

Observed Associations between Outcomes, Interventions, and Relevant Contextual Elements

Relevant contextual elements that had an observed association with the intervention can be described through evaluation of staff level contextual elements (Moran et al., 2014). Individuals influenced the intervention by contributing to protocol development. The group of charge nurses played a significant role in the intervention by providing application of the functional change. The leaders within and around the department supported the change by conferring and working together for effective interdepartmental collaboration. Lastly the organizational context influenced change by supporting comprehensive, evidence-based, healthcare reform. These elements combined improved cohesion and purpose of the HQI team and maintained focus on ED overcrowding resolution. These staff level contextual behaviors enhanced problem solving strategies for remaining open to ambulance patients.

Unintended Consequences Such as Unexpected Benefits, Problems, Failures, or Cost

No unexpected problems, failures, or cost were observed as a result of the intervention in the Good Samaritan ED. There were multiple benefits that arose as a result of an improved understanding of ED overcrowding. The greatest benefit was the ability to recognize the source of ED overcrowding. This became especially relevant while actively addressing ED overcrowding and while also attempting to describe overcrowding with others. Following the protocol allowed its users to accurately describe overcrowding using objective, detailed descriptions. The process was quantified and provided data for the charge nurses to express how

busy the ED was and why. This improved understanding of ED overcrowding and was evidenced by charge nurses applying strategies to reduce overcrowding before AD became necessary.

Details about Missing Data

All data required to study the intervention were obtained. No data was missing from the study of the intervention.

Summary

Kurt Lewin's Change Theory and the *Plan Do Check Act* model were a foundation for the activities of a HQI team to reduce AD. Particular strengths discovered during the HQI project were that following the AD protocol allowed its users to communicate conditions of ED overcrowding more quickly and efficiently. This improved communication and enhanced collaboration between disciplines and departments, and maintained focus on solution-based outcomes. Additional discoveries from the 20 week project revealed an improved understanding between the relationship of AD and ambulance patient arrivals, and how reducing ED overcrowding reduced AD hours and increased the number of patients brought in by ambulance. A key finding discovered during the project was that AD plays an important but limited role in managing high ED demand. ADs use alone though is insufficient in reducing most types of ED overcrowding. When EDs are full, they should use AD as part of an organized approach inclusive of multiple strategies to reduce overcrowding (Ahalt et al., 2018; Cameron et al., 2009; Geiderman et al., 2015; Patel & Vinson, 2012; Salway et al., 2017; Willard et al., 2017).

Using the protocol that incorporated the NEDOCS tool was successful in identifying sources of overcrowding and provided strategies that reduced AD increased the number of ambulance patient arrivals in the Good Samaritan ED. The NEDOCS tool provided an evidence-based objective measure of ED overcrowding and allowed its users to identify

potential sources of patient flow constraint. The tool's clearly defined color coded rankings were effective in conveying critical messages of overcrowding across departments.

The protocol provided a systematic approach to respond to overcrowding and reduce AD. The systematic approach allowed the charge nurses to respond to overcrowding with improved consistency and communication with staff, providers, and other department employees. Additionally, the systematic approach reduced the steps between becoming overcrowded and taking action with other key team members to avoid AD, like the house supervisors and providers. The protocol's systematic approach with other key team members provided a common language for AD discussions, increased the frequency in which AD discussions occurred, improved predictive analysis, and decreased redundancy of work.

Interpretation

After implementing the HQI intervention, AD hours at the Good Samaritan ED were significantly reduced by 82.97 percent, exceeding the HQI team's goal of a 25 percent reduction in AD hours. The percentage of ambulance patient arrivals also increased by 15.67 percent, above the HQI team's goal of a 10 percent reduction. Further interpretation of these results in the Good Samaritan ED considered association between the intervention and outcome, comparison of results with other works, impact of the project on people and systems, differences between observed and anticipated outcome, and opportunity costs.

Nature and Association Between the Intervention and the Outcomes

This evidence-based project was founded in the most current literature and derived from a theoretical framework for change in a complex setting. The HQI project demonstrated that implementation of an AD protocol in an urban ED can assist in reducing AD hours. Utilization of the AD protocol also revealed a connection between decreased AD hours and an increased

number of ambulance patients. These results were consistent with results found in other current nursing and healthcare literature. This project's findings were also consistent with the relevant literature supporting AD reduction through an improved understanding of its relationship to ED overcrowding.

Comparison of Results with Findings from Other Publications

This project added to the body of knowledge surrounding evidence-based change in the healthcare setting, and further demonstrated the benefits of a quality improvement approach to systematic change. The results of this project concurred with Schrank and Grossman (2009) as well as Ahalt et al. (2018), in finding that AD alone is unsuccessful in resolving ED overcrowding. This correlation supports evidence that a protocol inclusive of multiple strategies is necessary to reduce AD. Additionally, this project produced results similar to Salway et al. (2017), and found that whole hospital solutions were instrumental in reducing AD by managing ED overcrowding.

Impact of the Project on People and Systems

The impact of the AD protocol on systems was minimal. Kurt Lewin's Change Theory and the *Plan Do Check Act* model fit well into the Good Samaritan ED's improvement structure and context (Grant & Osanloo, 2014). The protocol was created by those responsible for its use and with a focus on patient centered outcomes. It was intended to offer ED charge nurses specific and guided strategies to avoid AD. The impact of the protocol on people was best demonstrated by nurses who improved their understanding of ED overcrowding, and then successfully guided response strategies to avoid AD.

Reasons for any Differences Between Observed and Anticipated Outcomes, Including the Influence of Context

The protocol's standardized approach for making AD decisions contributed to significantly reduced AD hours in the Good Samaritan ED (Tague, 2004). Slight variation may have arisen from differing experiential knowledge possessed by the charge nurses, but these were considered minimal as all charge nurses quickly became successful in using the protocol. Various charge nurses' experiences with ED overcrowding may have contributed to assessment of continued AD potential, such as time of day, time of year, or community evaluation.

Costs and Strategic Trade-offs, Including Opportunity Cost

Specifically measured to demonstrate opportunity cost, the increase in the number of ambulance patients illustrated the strategic benefit of reducing AD hours. Reduced AD hours in the project setting improved sources of financial opportunity that were otherwise lost during AD use. Ambulance patients are also a valuable revenue source for the hospital because ED patients arriving by ambulance have higher rates of inpatient admissions to the hospital than walk-in patients (Salway, et al., 2017). Additionally, ambulance patients tend to be more critically ill, adding to the hospitals benefit when receiving these patients for treatment and reimbursement (Hoyle, 2011; Salaway et al., 2017).

Increasing ambulance patient arrivals by 15.67 percent during the trial increased potential revenue sources for the hospital from ED visits. The increased revenue sources represented approximately $18,000 per week in hospital revenue and were consistent with the findings from Salway et al. (2017). The intervention incurred no additional operating cost and required no new additional staff or space. Hospital and community stakeholders further benefitted from reduced AD through increased referral from ED providers for ambulance patients. Additionally, the reputation of Good Samaritan ED by ambulance crews improved as AD was avoided. The Good Samaritan ED developed a reputation as being ready and able to

accept critical ambulance patients, which has further potential to generate increased ED volume and revenue sources.

Limitations

Despite being founded in current evidence, specific tailoring of the AD protocol to the Good Samaritan ED may impede generalizability of the work. Yet because the protocol was created from a systematic literature review, generalizability of this project may be able to extend beyond the Good Samaritan ED. The intervention may be found relevant to other settings seeking to reduce AD through a systematic approach. Generalizability of the protocol can be found from a comprehensive literature review that led to the use of the NEDOCS tool. The NEDOCS tool was also found reliable by the results of this study. The protocol included current evidence-based strategies that addressed ED overcrowding and it could be easily tailored to other ED settings as well.

Although the number of ambulance patients increased during the trial period in 2018, total walk-in visits decreased in the Good Samaritan ED, and across the other LHS EDs as well. This may have been attributed to milder winter weather, or a less severe winter flu season. Yet these findings demonstrate the effects of the protocol in improving availability of emergency resources to the community. An increase in ambulance patients further shows the protocol's impact on balancing critical patients amongst area hospitals by demonstrating an increase in patient arrivals that were otherwise missed during AD.

User judgment in selecting the overcrowding strategies was seen as flexibility of the protocol. The protocol was designed to offer various strategies to accommodate the differing types of overcrowding. It was also designed to accommodate various users, staff mix, or resource availability based on time of day. Application of user judgment demonstrated the users' nursing

and ED insight, and further demonstrated the protocols usefulness in the project setting. These considerations also demonstrated that the protocol was tailored effectively to the Good Samaritan ED. User judgment may affect generalizability as other users may not reach conclusions for selecting reduction strategies.

Conclusions

EDs across the country face potentially high rates of AD use, and emergency nurses themselves have an ethical obligation to ensure their patients receive the best quality access to critical care. From this perspective, the HQI team recognized that understanding ADs impact to patient care was a necessary responsibility of AD use. Critical consideration for impact to patient care remained a priority when activating AD, and patient focus endured at the forefront of this HQI project throughout.

Sustaining the project into regular practice after trial completion was facilitated by the framework of Kurt Lewin's Change Theory and the refreeze phase. The most important factor that contributed to sustainability of the project was that the NEDOCS tool continued to be available in the EHR ED dashboard. The tool remained easy to access and continually used by the charge nurses. ED staff interacted to sustain the project as the protocol became habituated into the charge nurse's regular daily activities. The perception within the department regarding AD changed, and the culture surrounding AD had shifted to measuring ED overcrowding using the NEDOCS tool. This allowed the charge nurses and ED team to understand and resolve ED overcrowding before AD became necessary. The charge nurses no longer simply activate AD when staff feel it is necessary.

The NEDOCS tool provided an accurate measure of ED conditions. Overtime, these measures may provide valuable information regarding trends in ED volume, flow, or demand.

These evaluations have potential to spread to other departments that may benefit from an improved understanding of ED overcrowding. The information identifying the time of day when ED boarding occurred may prove useful for inpatient units creating staffing plans or surgery schedules in anticipation of ED admissions. This would also carry an added benefit to the ED by reducing output overcrowding.

High AD use and lack of alternative strategies to address ED overcrowding was shown to have a significant impact on an ED's ability to deliver quality care. In contrast, evidence clearly showed managing the operational impact of AD leads to potential and actual improvements in care (Ahalt et al., 2018, Burke et al., 2013; Geiderman et al., 2015; Hoyle, 2011; Hwang et al., 2011; Salaway et al., 2017; Shen & Hsia, 2015). Although achieving AD reduction during the trial period in the Good Samaritan ED, further study may be required to identify best practices regarding preset time limitations for AD use. Future literature review may be required to determine best practice regarding AD time limitations.

In order for newly discovered evidence to influence the healthcare community, dissemination is a critical next step in the next HQI process. Factors influencing the dissemination process may include what was discovered, whom the discovery will effect, and future considerations of the discovery (Moran et al., 2014). Based on these factors, a local, regional, and then national approach to project dissemination was developed by the HQI team.

Local dissemination strategies shed light on the usefulness of the tool and further support its validity as an effective strategy to reduce AD. Local dissemination of this project's outcomes could convey additional evidence to nearby facilities and that could easily comply with adoption. The results will be presented to the LHS Nurse Executive Committee. With their support, the results will be shared with the other LHS ED managers in the healthcare system, with potential

to implement similar protocols in their settings as well. Regionally, project presentation to the Greater Portland Metropolitan Area ED/EMS Leadership Collaborative could convey the results of this evidence-based project to regional stakeholders. The ED/EMS Leadership Collaborative meets monthly and its membership consists of a collection of ED nursing managers and ambulance officers spanning four counties in the region.

To add to the body of evidence surrounding AD nationally, publication in the *Journal of Emergency Nursing* may be an appropriate opportunity for national dissemination. It is imperative that outcomes of process improvements be disseminated widely to nurses and other healthcare workers in order to achieve its fullest effect.

Funding

This project received no outside funding. It was conducted as an HQI project internal to the Good Samaritan Hospital and considered intrinsic to the work of the ED manager. Motivation for the project was derived from within the Good Samaritan ED, without financial or other influence.

References

Ahalt, S., Argon, W., Ziya, T., Strickler, S., & Mehrotra, J. (2018). Comparison of emergency department crowding scores: A discrete-event simulation approach. *Health Care Management Science*, *21*(1), 144-155. https://doi.org/10.1007/s10729-016-9385-z

American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice.* Washington, DC: Author. Retrieved from https://www.aacnnursing.org/DNP/DNP-Essentials

American College of Emergency Physicians (ACEP). (2013). Policy statement: Crowding. Retrieved from https://www.acep.org/globalassets/new-pdfs/policy-statements/crowding.pdf

American Psychological Association. (2010). *Publication manual of the American Psychological Association*. (6th ed.). Washington, DC: American Psychological Association.

Burke, C., Joyce, N., Baker, W., Biddinger, P., Dyer, K., Friedman, F., &Epstein, S. (2013). The effect of an ambulance diversion ban on emergency department length of stay and ambulance turnaround time. *Annals of Emergency Medicine*, *61*(3), 303-311.e1. http://dx.doi.org/10.1016/j.annemergmed.2012.09.009

Cameron, O., Joseph A., & McCarthy J. (2009). Access block can be managed. *Medical Journal of Australia 190* (7), 364-368. doi: 10.5694/j.1326-5377.2009.tb02449.x

Centers for Disease Control and Prevention (CDC). (2018). *Emergency department visits*. Retrieved from https://www.cdc.gov/nchs/fastats/emergency-department.html

Consumer Health Ratings. (2018). *Average cost for people with hospital ER visit*. Retrieved from https://consumerhealthratings.com/healthcare_category/emergency-room-typical-average-cost-of-hospital-ed-visit/

Current Nursing. (2012). Kurt Lewin's change theory. Retrieved from http://currentnursing.com/nursing_theory/Lewin's_change_theory.html

Geiderman, T., Marco, W., Moskop, T., Adams, J., & Derse, P. (2015). Ethics of ambulance diversion. *American Journal of Emergency Medicine*, *33*(6), 822-827. doi: 10.1016/j.ajem.2014.12.002

Grant, C., & Osanloo, A. (2014). Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your "house". *Administrative Issues Journal*, *4*(2), 12-26. Retrieved from https://eric.ed.gov/?id=EJ1058505

Hoyle, L. (2011). Condition yellow: A hospital-wide approach to ED overcrowding. *Journal of Emergency Nursing*, *39*(1), 40-45. doi: 10.1016/j.jen.2011.07.020.

Hussain, S., Talib, L., Shen, A., Tayyaba, H., & Ali, M. (2018). Kurt Lewin's change model: A critical review of the role of leadership and employee involvement in organizational change. *Journal of Innovation & Knowledge, 3*(3), 123-127. doi: org/10.1016/j.jik.2016.07.002

Hwang, S., McCarthy, C., Aronsky, O., Asplin, T., & Bernstein, A. (2011). Measures of crowding in the emergency department: A systematic review. *Academic Emergency Medicine, 18*(5), 527-38. doi: 10.1111/j.1553-2712.2011.01054.x

Kim, M., & Mallory C. (2016). *Statistics for evidence-based practice in nursing*, (2nd ed.). Burlington, MA: Jones & Bartlett.

Legacy Health System. (2018a). Legacy Good Samaritan Medical Center: Community health needs assessment. Retrieved from file:///C:/Users/kitty000/AppData/Local/Microsoft

/Windows /INetCache/IE/DOWI0G43/2018LegacyGoodSamaritan CHNACHIPReportFINAL.pdf

Legacy Health System. (2018b). Legacy Good Samaritan Medical Center: Our strategic plan. Retrieved from https://www.legacyhealth.org/our-legacy/strategic-plan.aspx

Lewin, K. (1951) *Field theory in social science: Philosophy of science in social science.* New York: Harper & Row.

LoBiondo-Wood, G., & Haber, J. (2014). *Nursing research: Methods and critical appraisal for evidence-based practice* (8th ed.), 68. St. Louis, MO: Elsevier

Melnyk, B. M., & Fineout-Overholt, E. (2015). *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.). Philadelphia: Wolters Kluwer.

Moran, K., Burson, R., & Conrad, D. (2014). *The doctor of nursing practice scholarly project*. Burlington, MA: Jones & Bartlett.

Nakajima, Y., & Vilke, G.M. (2015). Editorial: Ambulance diversion: The Con perspective. *American Journal of Emergency Medicine 33*(6), 818-819. doi:10.1016/j.ajem.2015.03.005

National Association of Emergency Medical Services Physicians (NAEMSP). (2011) Policy statement: Ambulance diversion and patient offload delay. Retrieved from https://naemsp.org/resources/position-statements/principles-of-medical-direction/

Operations Policy: Diversion Systems, 50.030, § 3, (2017). Retrieved from https://multco.us/sites/default/files/health/documents/2013-50_operations_ems.pdf

Oregon Health Authority (OHA). (2018). *Oregon health alert network and HOSCAP*. Retrieved from

https://www.oregon.gov/oha/PH/PREPAREDNESS/PARTNERS/HEALTHALERTNETWORK/Pages/weblinks.aspx

Patel, P. B., & Vinson, D. R. (2012). Ambulance diversion reduction and elimination: The 3-2-1 plan. *Journal of Emergency Medicine, 43*(5), E363-E371. doi: org/10.1016/j.jemermed.2012.01.031

Petrisor, B., & Bhandari, M. (2007). The hierarchy of evidence: Levels and grades of recommendation. *Indian Journal of Orthopaedics, 41*(1), 11-15. doi: 10.4103/0019-5413.30519

Salway, S., Valenzuela, W., Shoenberger, C., Mallon, A., & Viccellio, L. (2017). Emergency department (ED) overcrowding: Evidence-based answers to frequently asked questions. *Revista Médica Clínica Las Condes, 28*(2), 213-219. doi: 10.1016/j.rmclc.2017.04.008

Schrank, K., & Grossman, M. (2009) On diversion: Dealing with ED overcrowding and requests for EMS to transport elsewhere. *Journal of Emergency Medical Services*. Retrieved from http://www.jems.com/articles/2009/05/diversion.html

Shen, Y., & Hsia, R. (2015). Association between ambulance diversion and survival among patients with acute myocardial infarction. *Health Affairs*. Retrieved from https://www.ncbi.nim.nih.go/pmc/articles/PMC4109302/

Statistical Package for Social Sciences [Computer Software]. (2016). Retrieved from https://www.ibm.com/analytics/spss-statistics-software

Tague, N. R. (2004). *Quality toolbox* (2nd ed). Milwaukee, WI: ASQ Quality Press.

University of New Mexico (UNM). (2018). *Department of emergency medicine: National emergency department overcrowding scores*. Retrieved from https://emed.unm.edu/clinical/nedocs.html

Weiss, M., Derlet, A., Arndahl, S., Ernst, W., Richards, T., Fernández-Frankelton, J., . . . Nick, S. (2004). Estimating the degree of emergency department overcrowding in academic medical centers: Results of the National ED Overcrowding study (NEDOCS). *Academic Emergency Medicine*, 11(1), 38-50. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/14709427

Willard, S., Carlton, C., Moffat, T., & Barth, T. (2017). A full-capacity protocol allows for increased emergency patient volume and hospital admissions. *Journal of Emergency Nursing*, *43*(5), 413-418. doi: 10.1016/j.jen.2017.01.007.

White, M.K., & Dudley-Brown, S. (2016). *Translation of evidence into nursing and health care practice*, 2nd ed. New York, NY: Jones & Bartlett.

Table A

Good Samaritan and Comparison Hospital Ambulance Diversion Hours

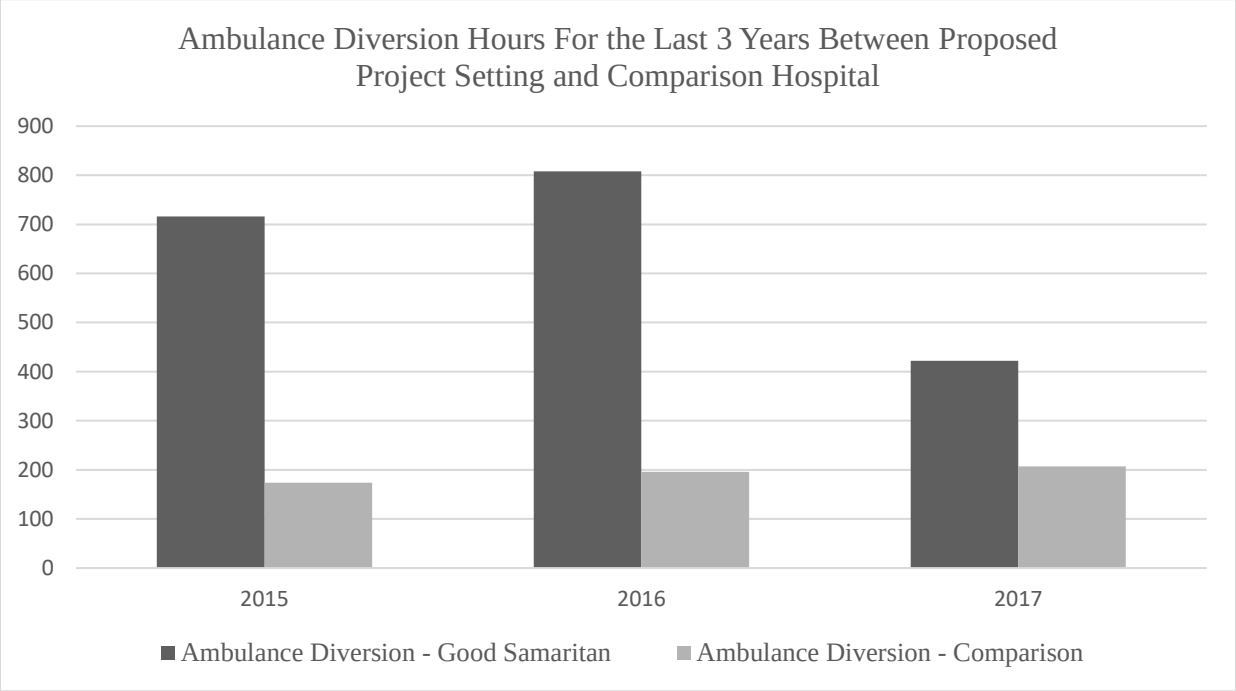


Table B

Evidence Table

Study Reference	Design	Intervention Style	Sample & Setting	Findings: positive/ Negative	Evidence Level
Ahalt, S., Argon, W., Ziya, T., Strickler, S., & Mehrotra, J., 2018	Well-designed control trial	Simulation models to evaluate the effectiveness of ED crowdedness, predictive ability, and usability in disease outbreak considerations	**Sample:** Simulation models of 68,000 patients a year. **Setting:** Level I Trauma Center. The hospital system has an active residency program and approximately 800 inpatient beds. The ED saw 68,000 patients in calendar year 2013	They compare the National Emergency Department Overcrowding Scale (NEDOCS), Real Emergency Analyses of Demand Indicators (READI), and Emergency Department Work Index (EDWIN) to each other under consistent conditions. EDWIN and NEDOCS appear to be helpful measures of current ED crowdedness. NEDOCS best depicts the crowdedness compared to the average length of stay in the ED. The authors of the study suggest the use of NEDOCS for assisting healthcare professionals at detecting crowding situations and deciding prudent actions to take as a result, in their hospital.	II
Burke, C., et al., 2013	Well-designed control trials	Retrospective, pre-post observational analysis of 9 Boston-area hospital EDs before and after the ban. We used ED length of stay as a proxy for ED crowding. We compared hospitals individually and in aggregate to determine any changes in ED length of stay for admitted and discharged	**Sample:** 9 Boston area EDs **Setting:** population of approximately 725,000 potential patients from Boston and Cambridge MA	The authors found that despite an overall increase in ED volume, there was no evidence of an increase in length of stay for admitted or discharged patients. They also found a decrease in ambulance turnaround time, suggesting an increased availability of ambulances to respond to 911 calls. The concept of AD reduction was initially met with concern. It was feared that ED crowding and EMS TAT would worsen. Their study suggests that neither of these occurred. They attribute this success to ED throughput improvement strategies that facilitate patient flow, such as:	III

		patients, ED volume, and turnaround time.		Change the culture of divert use by requiring activators to obtain management divert permission. Implementing a provider in triage Eliminate boarding	
Cameron, O., Joseph, A., & McCarthy, J., 2009	Evidence from qualitative studies	Qualitative view points on AD and ED crowding	**Sample:** N/A **Setting:** Melbourne Australia	Ambulance diversion should only be seen as a tool for managing disasters, not routine demand management strategies.	VI
Geiderman, T., Marco, W., Moskop, T., Adams, J., & Derse, P., 2015	Qualitative studies	Review of literature to find qualitative studies about the ethics and effectiveness of ambulance diversion.	**Sample:** 17 articles **Setting:** Articles from hospitals in America, Europe, and Australia	The team is able to describe qualitative rationale for limiting AD use, ranging from: Lack of patient choice Its negative impact on minority serving hospitals, and Its likelihood of success as a tool to alleviate busy ED's. They conclude, decisions regarding AD should be made with careful consideration of patient choice and need.	V
Hoyle, L., 2011	Qualitative study and literature review	Project was undertaken to develop processes that would address ED overcrowding.	**Sample:** 16 articles **Setting:** not given	The project scoring tool chosen is NEDOCS, which specifically measures the state of overcrowding. Ambulance diversion reduced by 50% over the first year. Patient satisfaction improved to the 90th percentile ED visits increased by 600 visits Inpatient admissions increased by 10% Left without being seen decreased by 50 per month within The average length of stay was reduced by 1 hour	V

Hwang, S., McCarthy, C., Aronsky, O., Asplin, T., & Bernstein, A., 2011	Evidence from qualitative studies	Systematic review and well-designed study	**Sample:** 46 unique studies **Setting:** global review	The team's systematic review revealed that NEDOCS, EDWIN, and READI are most commonly discussed. They add however, that during their own validation trials of these three tools, they found that no significant difference was observed between the tool determination of crowding and numerical counts. The tools were found to be consistent however in validating physicians' feelings of being rushed and concern of error.	I
Nakajima, Y., & Vilke, G.M., 2015	Qualitative study	Editorial, of follow up articles updating their data regarding AD success. Most notably the inclusion data from San Diego that evaluates patients whom are actually transported to their facility of choice.	**Sample:** 17 articles **Setting:** Various articles from the US, Europe, and Australia	In San Diego, a voluntary, community-led effort, reducing ambulance diversion, had already been successful. The main facet of their reduction was that diversion in a hospital could not last more than one hour. In their follow up, San Diego defines this impact to patient choice, noting that the number of patients whom weren't transported to their requested facility, fell from 1,320 a month-down to 322 a month.	VI
Patel, P.B., & Vinson, D. R., 2012	Well-designed control trails	Using tight diversion criteria, AD at each ED was limited by protocol to 3 h at a stretch, after which incoming ambulances had to be accepted at that ED for at least 1 h. After 6 months, AD was limited to 2 h per diversion event; after another 6 months, AD was limited to 1 hour.	**Sample:** 3 year study **Setting:** 17 EDs in a region in northern CA	As the team sequentially decreased the specified time period to 3 hours down to 2 hours and then down to 1 hour, they noted a significant reduction in overall AD hours. This occurred despite increased ambulance arrivals, ED census, admissions, ICU admissions, and overall population census.	III

Salway, S., Valenzuela, W., Shoenberger, C., Mallon, A., & Viccellio, L., 2017	Evidence from systematic review	Review of qualitative and quantitative research	**Sample:** N/A	Increasing the number of admissions from the ED by one a day would net around $800,000 to the institution at the end of the year. Without considering the potential of admission revenue, each missed patient, by walkout or diversion, represents roughly $600 to $800 in lost revenue	VI
Schrank K., & Grossman, M., 2009	Qualitative study	Qualitative studies, of EMS and hospital articles	**Sample:** 7 articles **Setting:** Articles from around the nation. EMS insight from Miami FL.	ED overcrowding has a major impact on EMS providers and its occurrence is likely to increase. Hospitals should develop internal plans to eliminate ED crowding, diversion alone does not work. They go on to affirm that hospital systems should take their own part in reducing ED crowding, such as letting admissions go upstairs, to be boarded in their hallways. They also attest that steps progressing to divert use should be considered while including managers and administrators in the decision process as well.	III
Shen, Y., & Hsia, R., 2015	Well-designed control trial	Analyze whether temporary ED closure on the day a patient suffers from acute myocardial infarction (AMI), as measured by AD hours of the nearest ED, is associated with increased mortality rates among AMI patients	**Sample:** 13860 Medicare AMI patients **Setting:** 4 counties in CA	This study determined the relation of Acute Myocardial Infarction (AMI) to 12 hours or more of ambulance diversion-or-12 hours or less of ambulance diversion. Less than 12 hours of AD did not result in increased AMI deaths. However, greater than 12 hours of diversion in neighboring hospitals, resulted in statistically significant correlations between AD and AMI mortality.	III
Willard, S., Carlton, C., Moffat, T., & Barth, T., 2017	Evidence from systematic reviews	Qualitative studies of ED overcrowding causes and potential interventions to mitigate. Followed	**Setting:** Singular hospital setting in a metropolitan area	The team conducted a complex quality improvement study with pre and post implementation results. A limitation of the study is that AD is not addressed on its own. Other results are included in the study. That being said however, this study may more accurately provide the	V

	by pre and post review.	rationale for why measuring ED crowding is an effective tool for reducing ambulance diversion.

Table C

Project Timeline

Timeline

Project Phase	Milestone	Timeline												
		Spring 18			Summer 18		Fall 18				Spring 19			
		Mar	Apr	May	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	Project proposal at academic center.		4/26											
	Project proposal at LHS			5/11										
Unfreeze	**Registered nurse champion to super user group for EHR request for NEDOCS tool**				7/10									
	Information systems department to add link to charge nurse & ED physician's desktops				7/10									
	Charge nurse & relief charge nurse protocol training				7/11									
	Provider training													

	Began campaign to facilitate change	**7/12**				
	Staff meetings	**7/12 & 7/13**				
	Huddle discussion	**7/12**				
	Protocol upload to SharePoint	**7/12**				
	Laminated copy of protocol dispersed in ED	**7/12**				
	Test day	**7/29**				
	IRB completion		**7/29 & 8/13**			
Change	**Evaluation start**		**8/13**			
	Week 1		**8/13-8/19**			
	Week 2		**8/20-8/26**			
	Week 3		**8/27-9/2**			
	Week 4			**9/3-9/9**		
	Week 5			**9/10-9/16**		
	Week 6			**9/17-9/23**		
	Week 7			**9/24-9/30**		
	Week 8				**10/01-10/07**	
	Week 9				**10/8-10/14**	
	Week 10				**10/15-10/21**	
	Week 11				**10/22-10/28**	
	Week 12					**10/29-11/4**
	Week 13					**11/5-**

	Week 14	**11/11**				
	Week 15	**11/12-11/18**				
	Week 16	**11/19-11/25**				
	Week 17	**11/26-12/2**				
	Week 18		**12/3-12/9**			
	Week 19		**12/10-12/16**			
	Week 20		**12/17-12/23**			
	Trial end		**12/24-12/30**			
Refreeze	**Data collection & review**		**12/30**	**1/7**		
	Consider balancing measures & accuracy of results				**2-8**	
	Summary of findings & next steps					2/10

Table D

Historical, Baseline, Trial, and Percent of Change Table for Ambulance Diversion Hours in the Good Samaritan ED

Sample	**AD Hours 2015**	**AD Hours 2016**	**AD Hours 2018**	**Mean AD Hours from 2015, 2016, 2017 (Baseline)**	**Trial AD Hours (Trial)**	**Difference (%)**
Week 1	5.61	17.45	19.93	13.16	6.21	-51.82%
Week 2	9.32	20.32	18.14	19.36	4.32	-76.69%
Week 3	11.56	17.81	33.62	20.99	5.27	-74.90%
Week 4	13.48	7.46	20.76	13.91	3.19	-75.82%
Week 5	9.71	9.38	17.82	12.30	0.27	-97.81%
Week 6	15.32	14.65	6.46	12.14	1.56	-87.35%
Week 7	12.56	10.66	14.30	12.50	0.00	-100%
Week 8	7.24	9.21	11.28	9.24	0.00	-100%
Week 9	9.14	8.93	9.13	8.86	1.10	-86.59%
Week 10	10.76	9.42	6.98	8.64	4.00	-5.36%
Week 11	6.16	7.37	14.81	9.45	0.00	-100%
Week 12	2.36	12.42	7.48	7.42	8.95	+7.39%
Week 13	2.49	28.71	11.56	14.25	2.00	-84.75%
Week 14	1.85	32.18	15.18	13.42	2.00	-84.10%
Week 15	2.91	23.66	3.72	9.27	0.00	-100%
Week 16	8.46	12.41	5.57	8.81	1.88	-77.66%
Week 17	23.32	16.83	8.62	15.92	0.00	-100%
Week 18	16.71	19.54	10.41	15.55	0.29	-97.32%
Week 19	20.27	17.21	15.35	17.61	2.00	-87.64%
Week 20	28.39	16.66	12.97	19.34	1.62	-91.63%
Mean Total	10.80	15.10	13.40	13.10	2.23	-82.97%

Table E

Historical, Baseline, Trial and Percent of Change Table for Number of Ambulance Patients in the Good Samaritan ED

Sample	**Ambulance patients per week in 2015**	**Ambulance patients per week in 2016**	**Ambulance patients per week in 2017**	**Mean Ambulance patients per week: 2015, 2016, & 2017 (Baseline)**	**Ambulance patients per week in 2018 (Trial)**	**Difference (%)**
Week 1	148	155	168	157	183	+14.21%
Week 2	149	153	167	156	175	+11.86%
Week 3	151	152	169	156	177	+11.87%
Week 4	147	155	166	156	187	+14.58%
Week 5	139	157	168	154	162	+4.94%
Week 6	142	158	165	155	182	+14.74%
Week 7	144	161	172	159	186	+14.52%
Week 8	139	163	168	156	189	+17.47%
Week 9	138	158	172	156	184	+15.22%
Week 10	144	142	155	147	191	+14.04%
Week 11	141	155	168	154	185	+16.76%
Week 12	150	157	177	161	183	+12.03%
Week 13	138	138	173	149	191	+11.99%
Week 14	142	150	166	152	188	+12.15%
Week 15	129	149	169	149	188	+20.75%
Week 16	137	161	166	154	193	+20.31%
Week 17	144	158	177	159	187	+14.98%
Week 18	139	162	161	154	194	+20.62%
Week 19	144	155	163	154	189	+18.52%
Week 20	146	158	169	157	188	+16.49%
Mean Total	142	158	161	156	185	+15.67%

Table F

Comparison of Baseline and Trial Ambulance Diversion Hours in the Good Samaritan ED with Linear Trend Line for 2018

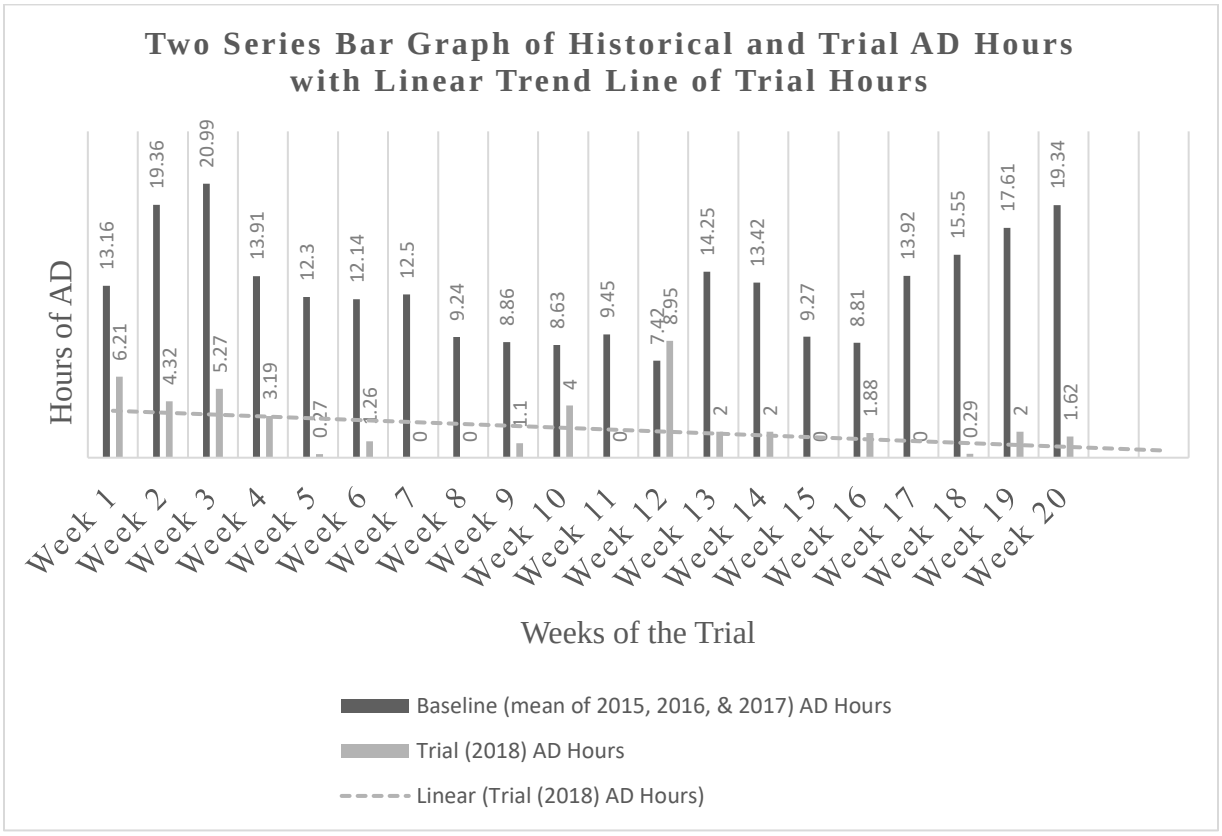


Table G

Comparison of Baseline and Trial Number of Ambulance Patient Arrivals in the Good Samaritan ED with Linear Trend Line of 2018

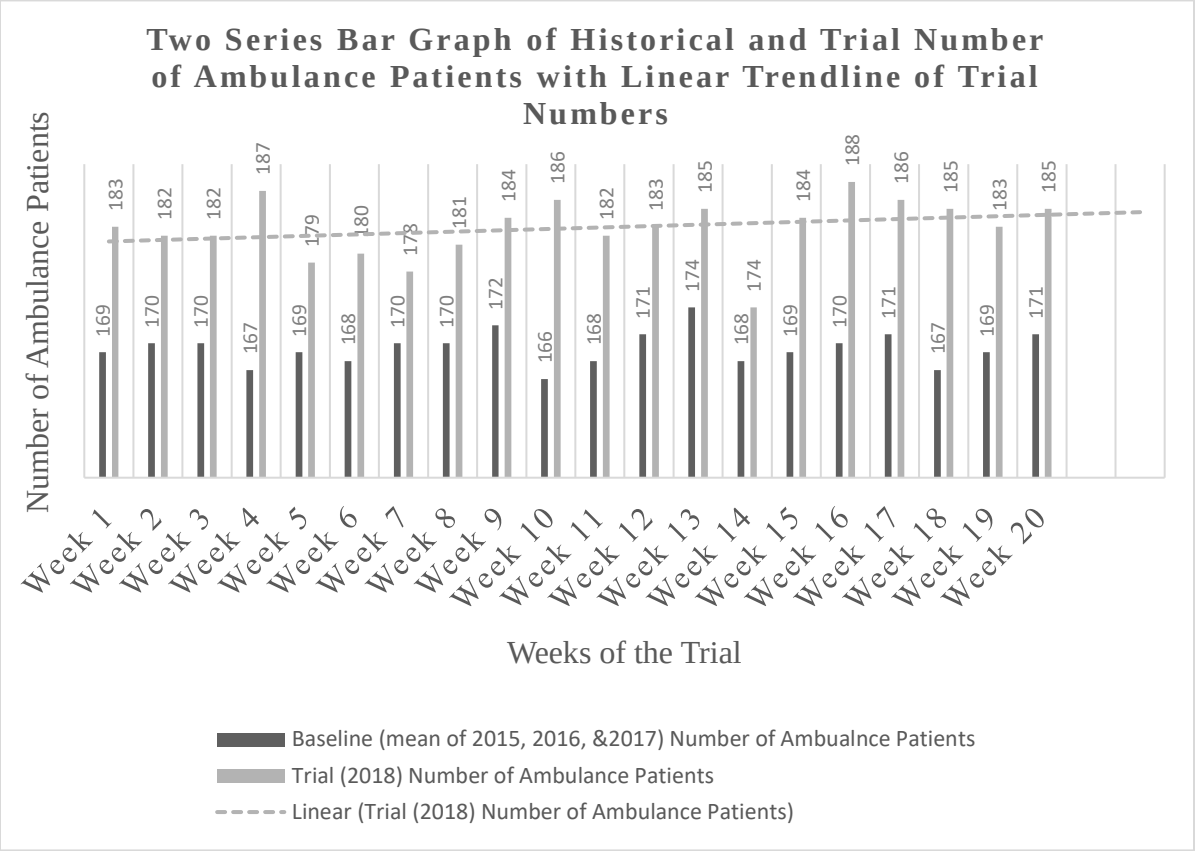


Table H

Comparison of Baseline and Trial Ambulance Diversion Hours in the Good Samaritan ED using Paired Samples *T*-Test

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	2015, 2016, and 2017	13.1070	20	4.03996	.90336
	AD_hours_2018	2.2330	20	2.44424	.54655

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	2015, 2016, and 2017 & AD_hours_2018	20	.058	.807

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	2015, 2016, and 2017 - AD_hours_2018	10.87400	4.59840	1.02823	8.72188	13.02612	10.575	19	.000

Table I

Comparison Baseline and Trial Number of Ambulance Patients in the Good Samaritan ED using Paired Samples *T*-Test

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	The number of patients BIBA in 2017	156.25	20	6.240	1.395
	The number of patients BIBA in 2018	185.10	20	7.240	1.619

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	The number of patients BIBA in 2017 & The number of patients BIBA in 2018	20	.067	.779

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	The number of patients BIBA in 2017 - The number of patients BIBA in 2018	-28.850	9.235	2.065	-33.172	-24.528	-13.970	19	.000

Appendix A

Summary of NEDOCS Inception

In 2004, a team of healthcare professionals from the University of New Mexico hypothesized that an ED complexity site sampling score could be used to measure ED overcrowding and then also validated in other healthcare settings as well. Weiss et al. (2004) described their validation process for the NEDOCS tool by comparing sampling topics and objective scores of ED overcrowding. The sampling topics ranged from very slow to severely overcrowded. The sampling topics were then compared to objective data: 1) number of beds in the ED, 2) number of patients in the ED, 3) number of admitted patients boarding in the ED, 4) number of beds in the hospital, 5) longest duration of an admitted patient boarding in the ED, 6) number of patients on respirators requiring one on one care, and 7) longest waiting room time (Weiss et al., 2004). Objective and subjective data was compared using linear regression, which proved accuracy between the data eighty eight percent of the time, thus validating the degree of overcrowding against objective measures (Weiss et al., 2004).

Appendix B

National Emergency Department Overcrowding Scale Tool

NEDOCS

NEDOCS CALCULATOR

INSTITUTIONAL CONSTANTS	Number of ED Beds	Number of Hospital Beds	
COMMON ELEMENTS	Total Patients in the ED	Number of Respirators in the ED	Longest admit time (in hours)
MODEL SPECIFIC	Total Admits in the ED	Waiting room wait time for last patient called (In hours)	
NEDOCS SCORE-		Compute	

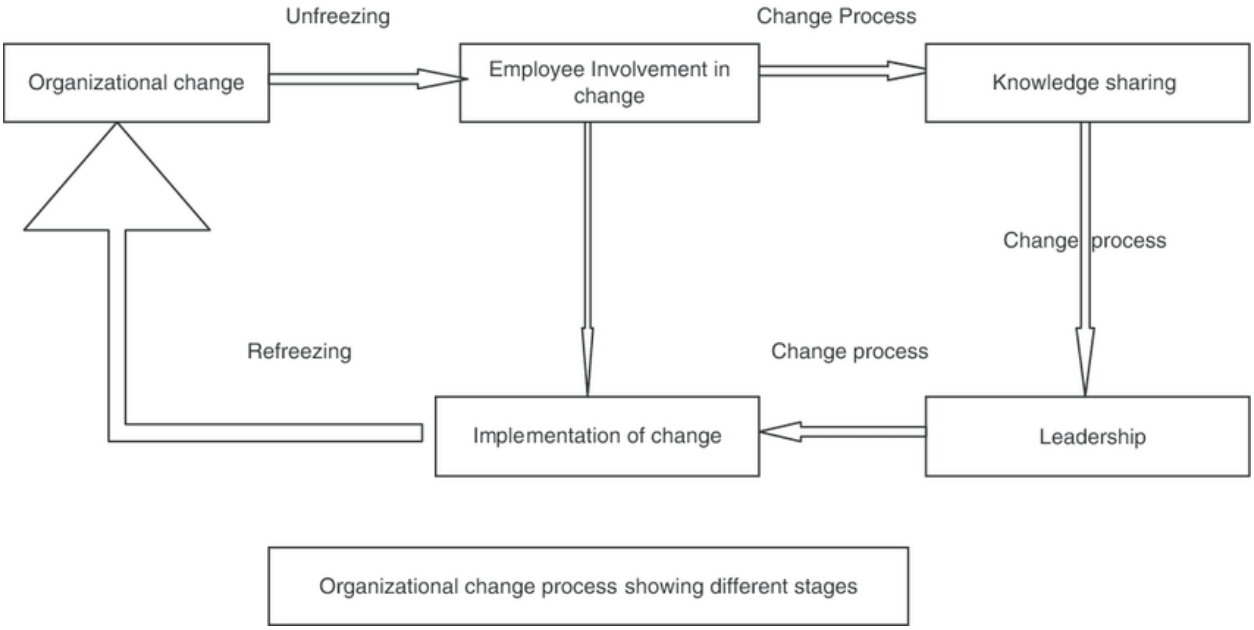
Clear Fields

Interpretation of results

00 to 20 Not busy	21 to 60 Busy	61 to 100 Extremely busy but not overcrowded	101 to 140 Over-crowded	141 to 180 Severely over-crowded	181 to 200- Dangerously over-crowded

Appendix C

Kurt Lewin's Change Model



Appendix D

Ambulance Diversion Protocol

NEDOCS Score	0-60 Normal: AL Green	61-100 Busy: AL Yellow	101-140 Crowded: AL Amber	141-180 Severe: AL Orange	Above 180 Dangerous: AL Red
Abbreviations AI: Action Indicators AL: Action Level APPs: Advanced Practice Providers CMRN: Case Manager Registered Nurse CRN: Charge Nurse ED: Emergency Department EDP: Emergency Dept. Physician EVS: Environmental Services HICS: Hospital Incident Command Systems House Sup: House Supervisor NIOS: Nurse Initiated Order Set NEDOCS: National Emergency Department Overcrowding Scale PIT: Provider in Triage Pt: Patient RN: Registered Nurse	Assess NEDOCS every 2 hours or as need arises	CRN, EDP, & House Sup. huddle CRN & team RN huddle EVS to ED to expedite room cleaning Stretchers & wheelchairs returned to ED Reassess NEDOCS every 2 hours	ED page overhead *pre-divert* CRN, EDP, & House Sup. huddle CRN & team RN huddle EVS to ED to expedite room cleaning Stretchers & wheelchairs returned to ED Initiate NIOS in triage EDP & RN to expedite admissions EDP & RN to expedite discharges CMRN arrange transport for discharges Open hall beds pod Deploy APPs to triage Consider opening PIT pod Reassess NEDOCS every 2 hours	ED page overhead *divert* CRN, EDP, & House Sup. huddle CRN & team RN huddle EVS to ED to expedite room cleaning Stretchers & wheelchairs returned to ED Initiate NIOS in triage EDP & RN to expedite admissions EDP & RN to expedite discharges CMRN arrange transport for discharges Open hall beds pod Deploy APPs to triage Consider opening PIT pod EDP & CRN reprioritize lab and imaging studies For all admitted patients with a bed assignment report will be called immediately For all admitted patients without a bed assignment report will be called immediately to the admit floor CRN or Patient Flow Nurse Initiate pull vs. push method for all ED patient transports Consider double rooming ED, 3rd & 4th floor patients if status permits Keep upright Pts upright; use of loungers Activate staffing response team Activate staffing response plan to recruit qualified ED RNs Notify ED Manager Reassess NEDOCS every 1 hour	ED page overhead *divert* CRN, EDP, & House Sup. huddle CRN & team RN huddle EVS to ED to expedite room cleaning Stretchers & wheelchairs returned to ED Initiate NIOS in triage EDP & RN to expedite admissions EDP & RN to expedite discharges CMRN arrange transport for discharges Open hall beds pod Deploy APPs to triage Consider opening PIT pod EDP & CRN reprioritize lab and imaging studies For all admitted patients with a bed assignment report will be called immediately For all admitted patients without a bed assignment report will be called immediately to the admit floor CRN or Patient Flow Nurse Initiate pull vs. push method for all ED patient transports Consider double rooming ED, 3rd & 4th floor patients if status permits Keep upright Pts upright; use of loungers Activate staffing response team Activate staffing response plan to recruit qualified ED RNs Notify ED Manager ED manager to notify ED medical director Notify hospital executive leadership Activate HICS Reassess NEDOCS every 1 hour

Appendix E

Institutional Review Board Approval from Northern Arizona University

To:	Kathryn Rogers
From:	NAU IRB Office
Date:	August 15, 2018
Project:	Implementation of National Emergency Department Overcrowding Scale to Establish an Emergency Department Overcrowding and Ambulance Diversion Clinical Practice Guideline
Project Number:	1297017-1
Submission:	New Project
Review Level:	Administrative Review
Action:	NOT RESEARCH
Project Status:	Not Research

The project listed above does not require oversight by the Northern Arizona University Institutional Review Board because the project does not meet the definition of 'research' and/or 'human subject'.

- **Not Research as defined by 45 CFR 46.102(d):** As presented, the activities described above do not meet the definition of research as cited in the regulations issued by the U.S. Department of Health and Human Services which state that "research means a systematic investigation, including research development, testing and evaluation, designed to contribute to generalizable knowledge".
- **Not Human Subjects Research as defined by 45 CFR 46.102(f):** As presented, the activities described above do not meet the definition of research involving human subjects as cited in the regulations issued by the U.S. Department of Health and Human Services which state that "human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains data through intervention or interaction with the individual, or identifiable private information".

Note: Modifications to projects not requiring human subjects review that change the nature of the project should be submitted to the Human Research Protection Program (HRPP) for a new determination (e.g. addition of research with children, specimen collection, participant observation, prospective collection of data when the study was previously retrospective in nature, and broadening the scope or nature of the research question). Please contact the HRPP to consult on whether the proposed changes need further review.

Northern Arizona University maintains a Federalwide Assurance with the Office for Human Research Protections (FWA #00000357).

Appendix F

Institutional Review Board Approval from Legacy Health System

LEGACY HEALTH

Legacy Research Institute
1225 N.E. Second Ave.
Portland, OR 97232
503.413.2491 phone
503.413.4942 fax

July 31, 2018

Kathryn S. Rogers MSN, RN, NEA-BC, CEN, CPEN, TCRN, CPHQ
Emergency Services Nurse Manager
Legacy Good Samaritan Medical Center
1015 NW 22nd Ave
Portland, OR 97210

Dear Ms. Rogers:

SUBJECT: IRB EXEMPTION—REGULATORY OPINION: QUALITY IMPROVEMENT
Protocol Title: ***Implementation of National Emergency Department Overcrowding Scale to Establish an Emergency Department Overcrowding and Ambulance Diversion Clinical Practice Guideline***
Investigator: Kathryn S. Rogers MSN, RN, NEA-BC, CEN, CPEN, TCRN, CPHQ

This letter is in response to your request for an opinion as to whether the above-mentioned project would constitute human subject research requiring IRB review. Legacy IRB staff has reviewed the project proposal and find that the project is not intended to generate generalizable knowledge for research purposes but is a quality improvement project only not subject to Legacy IRB oversight. The protocol provides that:

> "This project is intended to reduce Ambulance Diversion (AD) by identifying and then reducing causes of ED overcrowding that lead to its use. This may be accomplished with the use of a tool that provides an objective measure of ED overcrowding, and algorithm that gives guided response strategies based on the objective measures. And should AD become necessary, despite overcrowding reduction attempts, the algorithm should provide guidance for divert activation as well."

The protocol also notes that "(t)he purpose of this project is to implement a clinical practice change, the introduction of a clinical practice guideline, the Emergency Department Divert Operations Guideline (EDDOG)."

The project has the support of Ms. Denise Fall, DNP, RN, CENP, Legacy VP Chief Nursing Officer, who has confirmed that the "aim of the project is to improve the process/delivery of care with established/accepted standards to implement evidence-based change. There is no intention of using the data for research purposes."

The Legacy IRB is governed by an assurance granted by the Office of Human Research Protections (Federal Wide Assurance #00001280). In addition to that assurance, the Legacy IRB is governed by FDA regulations (21CFR50) and Legacy institutional policy (LHS 100.18).

If you have any questions, or if we can be of further assistance, please contact Research Regulatory Specialist Sr, Paul Newton, JD, CIP, at 503-413-5355, or e-mail at pwnewton@lhs.org.

Sincerely,

Signature Redacted

Paul Newton, JD, CIP
Research Regulatory Specialist Sr.
Legacy Research Institute
1225 NE 2nd Ave
Portland, OR 97232
Phone (503) 413-5355
pwnewton@lhs.org

Cc: Denise Fall, DNP, RN, CENP

Appendix G

Letter of Support from ED Medical Director

LEGACY
HEALTH

In support of: Kathryn S. Rogers DNP(c)

From: Jenny Aponte, Medical Director, Legacy Good Samaritan-Emergency Department

As a doctoral student in nursing practice, it falls before Kathryn Rogers to demonstrate competency in knowledge and skill development through completion and comprehension of a healthcare quality improvement project. In doing so, I offer full support in her implementing a clinical practice change to reduce ambulance diversion, a topic befitting both a worthy educational endeavor as well as her clinical scope and experience. I also acknowledge that I am apprised of its process and origins, agree on its anticipated outcomes, and will observe results as a member of the quality improvement team.

I remain readily available for further discussions regarding Kathryn's scholarly pursuit at japonte@lhs.org.

Signature Redacted

Jenny Aponte MD, FACEP
ED Medical Director
Medical Staff President

Appendix H

Letter of Support from Vice President and Chief Nursing Officer

LEGACY HEALTH

Legacy Good Samaritan Hospital
& Medical Center
1015 N.W. 22nd Ave.
Portland, OR 97210
503.413.7711 phone

Thursday December 27th, 2018

Northern Arizona University School of Nursing:

Kitty Rogers has received support from Legacy Good Samaritan Medical Center to pursue "Implementation of National Emergency Department Overcrowding Scale to Establish an Emergency Department Overcrowding and Ambulance Diversion Clinical Practice Guideline" at our facility for the academic and scholarly requirements related to her DNP. As the VP and Chief Nursing Officer I have requested an opportunity to review any manuscripts submitted for publication prior to submission for final approval.

Sincerely,

Denise D. Fall

Signature Redacted

Denise Fall, DNP, RN, CENP
VP Chief Nursing Officer| Legacy Good Samaritan Medical Center
1015 NW 22nd Ave|Portland, OR 97210|p (503) 413-7318|f (503) 413 6347
dfall@lhs.org