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Implementing an Electrocardiogram Suite in the Emergency Department to Decrease Door-to-EKG Time

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Abstract

Ineffective emergency department (ED) triage results in preventable medical errors, like untimely electrocardiogram (EKG) completion for patients with chest pain (CP), that increase the risk of patient harm. Obtaining EKGs within 10 minutes of ED arrival is standard of practice because CP is a classic symptom associated with myocardial infarctions (MIs) commonly called heart attacks. Early identification of ST-elevation myocardial infarction on EKG can reduce mortality rates for these patients. The project site's 2025 second quarter mean door-to-EKG (DTE) time was 18.27 minutes. The purpose of this quality improvement project was to implement interventions to partially redesign and improve the triage process to assist ED staff at the project site in meeting the 10-minute practice standard. The direct practice quality improvement project was completed in partial fulfillment of the requirements for the Doctor of Nursing Practice degree. The project had a quantitative quasi-experimental methodology and was guided by Donabedian's Framework and Lewin's Change Theory. Staff participants received pre-intervention education on the Emergency Severity Index (ESI) followed by eight weeks of implementing the ESI and a dedicated EKG suite. The site's daily census fluctuated between 80-115 patients with productivity levels permitting 26 employees scheduled in 24 hours. Pre- and post-intervention mean DTE time was evaluated for the unpaired samples of walk-in patients reporting CP via retrospective chart review. A one-tailed Welch's *t*-test was used for statistical analysis. Post-intervention results ($M = 9.84$, $SD = 4.82$) compared to pre-intervention results ($M = 18.53$, $SD = 17.53$) showed statistical significance with $t(55.23) = 3.35$, $p < 0.001$, and $d = 0.68$. Organizations should mandate training on valid triage tools and the establishment of EKG suites to reduce DTE time. Decreasing DTE time can reduce the cost burden on healthcare systems associated with the length of hospital stay. Hospitals can also expect financial gain through cost-avoidance

by implementing cost-effective practices and process changes.

Keywords

Triage, Critical Clinical Workflow Process, Chest Pain, Electrocardiogram (EKG), Door-to-EKG (DTE) Time

1. Introduction to the Project

It is conceivable for nearly anyone working in healthcare that an emergency department (ED) is one of the most chaotic work environments because of rapidly changing circumstances and the situational unpredictability from one instance to the next. Not every ED is the same, but every facility faces numerous variables that influence the daily operations. These factors may include trauma designator levels, specialty accreditations, constantly fluctuating patient census, and inconsistent patient acuity levels. Unfortunately, EDs around the world face these obstacles that increase the risk of hindering effective clinical workflow that then negatively impacts patient care. This leads to the purpose of the project. The aim of the Doctor of Nursing Practice (DNP) scholarly project was to investigate if interventions aimed at improving the triage clinical workflow process had an impact on a specific preventable medical error identified by the student as the untimeliness of completing electrocardiograms (EKGs) for patients presenting to an ED with a cardiac related complaint of chest pain (CP).

2. Background of the Project

Clinical workflow is described as a process involving the execution of several tasks that culminate in the completion of a predetermined objective; in healthcare, this objective is the delivery of care [1]. The starting point of care delivery in EDs begins with triage. Triage is a critical workflow process for prioritizing patients based on the severity of their presenting symptoms or condition [2], and an effective triage workflow facilitates the reduction of preventable medical errors from occurring [3]. Preventable medical errors, defined as planned tasks that are not performed as intended or an erroneously implemented plan of care, are known to occur because of workflow disruptions [4]. The consequences of triage workflow disruption are the same across all healthcare scenarios; they can potentially result in preventable medical errors that then increase the risk of patient harm and reduce the quality of care delivered [5]. As a result of these risks, efforts over the previous two decades resulted in the standardization of tools like the Emergency Severity Index (ESI) (see **Appendix A**) [2] that are used throughout the world to improve the triage workflow process for patients presenting with a complaint related to any cause.

Cardiovascular diseases (CVDs) are the number one causes of death throughout the world [6] and are expected to result in approximately 23 million deaths by

the year 2030 [7]. Myocardial infarctions (MIs), a type of CVD commonly referred to as a heart attack, are the most prevalent cause [8]. Chest pain (CP) is the second leading cause of patient visits to EDs in the United States (U.S.) with over 6.5 million cases annually [9] [10], and it is the most common symptom of a MI [7]. Due to the association of CP with MIs, it is imperative that CP be evaluated as quickly as possible. An EKG is a simple test used in the triage process to evaluate CP and should be completed within 10 minutes of patient arrival time to improve patient outcomes [9] [11] [12]. While it is not a specific order to obtain an EKG within a certain time frame, accredited CP centers are required to follow evidence-based guidelines which includes the 10-minute benchmark standard as presented in the CP guideline jointly produced by the American Heart Association (AHA) and the American College of Cardiology (ACC) [9]. Therefore, it is considered a preventable medical error when an EKG is not obtained within 10 minutes from time of arrival to the ED for patients experiencing CP.

Staff at the practice site consistently used the ESI tool, which is permitted by copyright notice (see **Appendix B**) [13], in their routine triage process but with inconsistent accuracy which prompted the need to include educational retraining on the ESI. There were also barriers that continued to disrupt the triage workflow. The clinical problem identified for the project regarded the inconsistent attainment of an EKG within the benchmark standard time of arrival to the ED for patients presenting with complaints of CP. At the project site, an average of 10 walk-in patients a day arrived with a complaint of CP related to CVDs. The average door-to-EKG (DTE) completion time at the project site was 18.27 minutes during the second quarter of 2025. This extended time had the potential to create a local concern in the community regarding the facility's credibility as an accredited CP center. Meeting the standard is imperative for CP patients because studies show prompt identification of ST-elevation myocardial infarction (STEMI) improves patient outcomes [9]. One study reported that obtaining an EKG within 10 minutes could reduce mortality rates by 50% in ED STEMI patients [12]. It quickly became evident that improving triage clinical workflow benefits patients presenting to EDs with CP by reducing the risk of a specific preventable medical error, a DTE time exceeding 10 minutes, and thus improving the quality of care delivered.

3. Organizational Needs Assessment

A needs assessment is defined as the process of gathering and evaluating data related to the needs of an identified population, and it assists in determining any gaps between established standards of care and current practice; a SWOT (strengths, weaknesses, opportunities, and threats) analysis is commonly used for organizational needs assessments [14]. The site for the scholarly project is a tertiary hospital and accredited CP center in a metropolitan area of Texas in the U.S. A SWOT analysis (see **Appendix C**) at the project site assisted in identifying noticeable gaps between current practice preventing attainment of the desired practice outcome of obtaining a DTE time under 10 minutes. These gaps included

poor triage training for nurses and lack of dedicated space for completing EKGs. The quantitative quasi-experimental quality improvement project focused on evaluating training nurses on using the ESI tool and modifications to the triage workflow process in the ED for patients presenting with CP over eight weeks.

4. SWOT Analysis

Interest initially developed in EKG completion times as data on CP patients was reported to the ED leadership from the organization's CP coordinator on a monthly basis. The student noted that the ED was not meeting the established benchmark standard for this specific population. The objectives of the SWOT analysis were to identify barriers impacting desired practice outcomes and provide insight on feasible changes for a quality improvement initiative. Observations are suitable when completing a needs assessment [14]. This was the method used for the SWOT analysis. Significant barriers identified from the SWOT analysis included inadequate triage training for staff, no space strictly for completing an EKG, and lack of a designated EKG machine for the triage area in the ED.

Well established triage workflows promote patient safety, efficiency, and quality of care delivered [3]. One triage tool proven valid and reliable is the ESI Scale [15] [16]. The ESI has been shown to have a significant inter-rater reliability rating as demonstrated by Cohen's Kappa score of 0.75, yielded an average sensitivity of 74.3%, and indicated specificity of 94.4% [15]. Training on the use of the ESI scale for the triage process has shown to improve nurses' performance in triage accuracy [17]. ED nursing staff received training during shift huddle over the span of a week that included a review of the ESI triage scale and modification to the workflow process with implementation of an EKG suite. The project methodology was quantitative quasi-experimental which was useful in determining it there was a causal relationship between the intervention and outcome [18]. The project had a pre/post intervention design. Descriptive statistics and inferential statistical analysis was used to compare pre-intervention and post-intervention data and provided quantitative evidence of project success.

4.1. Strengths

Radio/walkie use is regularly utilized to enhance speed of communication between the triage nurse and other staff members. The rapid response of others responding to radio communication demonstrates effective teamwork within the department. The organization also uses a language translation service that is readily available at all times; this assists in expediting identification of patients experiencing CP symptoms.

4.2. Weaknesses

The organization has a substantial number of contract employees that are not considered core staff due to high turnover rates; these employees struggle with learning every process in detail due to their short tenures. There are more novice staff

members in the department who are inexperienced in utilizing the ESI tool and unfamiliar with the triage workflow process. Patient boarding, a common occurrence in EDs, is also a regular obstacle that often leaves no available space to complete timely EKGs for other patients.

4.3. Opportunities

Providing staff with structured training and education on the ESI triage tool could assist with patient throughput by improving triage accuracy. A partially modified triage workflow process for patients presenting with CP by establishing an EKG suite could reduce delays and improve patient outcomes if they are experiencing a major cardiac adverse event; the modification would include completing registration after obtaining an EKG rather than at time of arrival. A modified triage workflow process could improve patient experience ratings, a measurable quality metric used by the Centers for Medicare and Medicaid Services (CMS) for hospital reimbursement [19].

4.4. Threats

A threat to the implementation of the project is the use of agency personnel to fill as needed staffing gaps. These individuals are external to the facility and only work one or two shifts in the department every four to eight weeks or longer. The effort to mitigate this threat is recommending the agency personnel not work in the triage role. If this is unavoidable, then it is recommended that these individuals receive frequent reminders of the modified triage workflow process. Another threat is the variability of patient flow; during times of high patient arrival, staff tend to move the EKG machines around the department. This then causes waste of time as staff members must look for an EKG machine. The mitigation effort for this threat is to clearly label the EKG machine dedicated for the triage suite and educate staff that it should never be removed from the space. A third threat is variations in patient descriptions of symptoms. Effort to mitigate missing cardiac related complaints is to include commonly used terms and phrases for CP such as "chest pressure" and "chest tightness" to name a few.

5. Problem Statement

Obtaining an EKG within 10 minutes is not an actual order, however, it is a practice standard promoted in the evidence-based CP guideline jointly produced by the AHA and the ACC [9]. Ideally, every ED across the world would have an effective and efficient triage clinical workflow that reduced the likelihood of preventable medical errors from occurring like untimely completion of an EKG for CP patients. However, the reality is that common dilemmas like overcrowding and boarding in EDs create workflow obstacles by decreasing available resources necessary to care for newly arriving patients which then increases the risk of medical errors occurring [20]. The Emergency Medical Treatment and Active Labor Act is a federal healthcare law that guarantees stabilizing treatment for patients

regardless of their ability to pay, and it is often considered a reason for ED overcrowding in the U.S. [21]. A study in Pakistan highlights the issue from a global level as it is not a problem specific to the U.S.; the study reported fewer than sixty percent (60%) of patients with CP received an EKG under 10 minutes and expressed bed unavailability as the primary (49.3%) barrier [20]. This is alarming given patients with CP require an EKG within a specific time to optimize their prognosis. Considering the reverse is true per the authors, then the consequences of failing to meet the benchmark standard could increase mortality rates by 50% for ED STEMI patients [12].

Not every complaint of CP is due to a CVD, but when it is, it can potentially be fatal [10]. This is concerning because CP is the most common symptom of MI [7] which is the most prevalent CVD cause of death globally [8]. Barriers to obtaining a timely EKG at the project site revolve around an inefficient triage workflow process that includes inadequate training on the ESI tool, no consistently available space, and lack of a dedicated EKG machine. The goal of implementing the project is to assist the organization's ED staff consistently meet this benchmark standard by closing the training gap and removing the barriers related to available space and equipment. The specific question the scholarly project aims to address is: For newly arriving walk-in patients with chest pain in the emergency department, will use of the Emergency Severity Index and implementation of an electrocardiogram triage suite compared to current practice reduce door-to-EKG time within 8 weeks?

6. Definition of Terms

The ED is a setting within the healthcare industry where certain actions, processes, and tasks may be identified by a single word or phrase. The specific terminology used within the ED is not always considered common knowledge to other hospital employees or the general public. While some overlap in knowledge of procedures and diagnosis exist, there are others that warrant inclusion of a definition. The following terms were used operationally in this project to provide clarification and prompt ease of comprehension.

6.1. Workflow

A sequence of tasks in a process, including both physical and mental chores occurring sequentially or simultaneously, that must be accomplished for a specified objective to be deemed executed [1] [4].

6.2. Clinical Workflow

This is similar to workflow; however, it includes specific clinical activities that culminates in overall patient care [5].

6.3. Triage

A critical clinical workflow process used for prioritizing patients based on the se-

verity of their presenting symptoms or condition [2]. When implemented effectively, this process assists in reducing preventable medical errors [3].

6.4. Preventable Medical Errors

Planned tasks, such as provider orders or practice standards, which are not performed as intended; preventable medical errors can also include an erroneously implemented plan of care [4].

6.5. Emergency Severity Index (ESI)

A standardized triage tool commonly used throughout the world to measure severity of presenting symptoms and prioritize patient care upon arrival to the ED [2].

6.6. Electrocardiogram (EKG)

A common test completed in EDs that evaluates electrical impulses through the heart and assists in early identification of cardiac abnormalities or events such as MI [22].

6.7. Door-to-Electrocardiogram (DTE) Time

The elapsed time between patient arrival to the ED to completion of the initial EKG measured in minutes [20].

6.8. Cardiovascular Disease (CVD)

An umbrella term used to identify a collection of disorders involving the heart and blood vessels leading to the heart and brain [6].

6.9. Myocardial Infarction (MI)

A type of life-threatening CVD commonly referred to as a heart attack [8]. A heart attack occurs when circulation of blood to the heart stops and results in oxygen starvation [10].

6.10. ST-Elevation Myocardial Infarction (STEMI)

A specific type of heart attack requiring immediate identification and percutaneous coronary intervention for optimal patient outcomes [10].

7. Review of Literature

The identified clinical problem for the proposed project regards the lack of routine attainment of an EKG within 10 minutes of arrival to the ED for patients presenting with complaints of CP. As identified in the SWOT Analysis, opportunities included staff refresher education on the ESI and establishing an EKG suite. One goal for the review of literature was to delve into previous studies to provide a comprehensive explanation of the current state of knowledge surrounding the concern for the project. An additional goal of the literature review was to identify

feasible interventions to solving the problem that aligned with current evidence-based practice.

8. Literature Search Strategy

A literature search was conducted utilizing electronic databases. The EBSCO platform provided by the university library included access to MEDLINE and CINHAL databases. Additional databases included Google Scholar, PubMed, and Sigma Repository. Key search terms included chest pain, emergency department, electrocardiogram, door-to-electrocardiogram time, triage, workflow, clinical workflow, and preventable medical errors. Boolean operators were used to search keywords and terms in numerous combinations. Specific criteria used for the search included peer reviewed primary research conducted within the last five years.

9. Literature Review

The literature revealed that effective and efficient workflows demonstrate improvements in care quality and reduce the potential for preventable medical errors [5]. This is significant because medical errors are identified as a serious health issue and noted in the U.S. as the third highest cause of death [4]. Unfortunately, workflow disruptions tend to occur because of a common dilemma that nearly every ED faces: patient boarding [23]. Overall, the literature revealed that patient boarding disrupts clinical workflows in the ED by reducing the number of readily available physical and human resource which then increase the likelihood of preventable medical errors occurring [20] [24]-[30]. This in turn then negatively impacts the quality of care that newly arriving patients receive as evidence by the identified practice problem. The literature also highlighted other factors that contribute to the occurrence of medical errors. Clinical workflow and triage, physical resources, human resources, and other causes of medical errors were four themes observed in the literature. Patient boarding was identified as a subtheme to clinical workflow and triage.

9.1. Clinical Workflow & Triage

Clinical workflow is comprised of numerous tasks that when disrupted increases the risk that preventable medical errors will occur [5]. Variables that can influence the triage workflow include patient volume, staff training, and interruptions [3]. The ESI is a valid and reliable tool used in the triage clinical workflow process to measure acuity of patient symptoms and determine immediate resource requirements [15] [16]. Adequate training on specific tools increases the usage during the triage process [2], and triage accuracy improves with the use of valid and reliable tools such as the ESI [17]. Efforts should be made to utilize the ESI to improve triage accuracy and reduce the frequency of clinical workflow interruptions.

9.2. Patient Boarding

It was noted that patient boarding in the ED has different definitions, but the

overall premise is the same: patients do not leave the department in a timely manner after the decision to admit is made [31]-[34]. Patient boarding interferes with clinical workflow by reducing the amount of readily available resources during triage and routine care [20] [24]-[30].

9.3. Physical Resources

Some of the basic physical resources necessary during the triage process for patients experiencing CP include an area that provides privacy, a stretcher, and an EKG machine. The authors reported in their study that less than 60% of patients had a DTE completed within the goal of 10 minutes [20]; the primary contributing factor (49.3%) to obtain a timely EKG was unavailability of a bed. The lack of resources noted in a separate study indicated an increase in ED wait times exceeding 3 hours [25]. In another study, insufficient material resources (76.7%) were also identified as the top cause for missed nursing care [24]. Another study similarly reported lack of material resources as the most common reason (92.5%) for rationed nursing care [29]. Physical resources were noted as the main reason for medical errors in the aforementioned studies, but they ranked second or lower in other reports as a major cause. Specific to the project, studies recommend having the required resources always available to minimize the effects on DTE times; they include a dedicated area, EKG machine, and stretcher [2] [20] [25] [35]. Efforts should be made to ensure the basic physical resources are immediately available in an EKG suite for patients presenting with CP.

9.4. Human Resources

One study revealed that insufficient staff was the most significant cause for rationed care amongst nurses [30]. This was also reported as the main reason for missed nursing care in another study [26]. Human resources were the second leading cause for nursing errors according to other studies; it was reported in one article that insufficient staff contributed to 65.5% of rationed care [24] whereas another reported it accounted for 68.7% of their results [29]. Efforts should be made to ensure staffing levels are adequate.

9.5. Other Causes of Medical Errors

A common theme noted in the literature was the inclusion of additional contributors to medical errors. The studies varied in their reports of significance; however, the commonality was that the identified factors still increased the likelihood of a medical error occurring. A breakdown in communication was identified in multiple studies [24] [26] [29] [36] [37]. Poor teamwork was another cause for medical errors [24] [29]. Efforts should be made to promote effective communication and teamwork.

9.6. Limitation and Gaps

One limitation of the literature review regarded the lack of available data strictly

dedicated to the triage clinical workflow process focused on CP patients. The studies provided cumulative insight on the triage process in EDs for patients with all complaints [2] [3] [15]-[17]. Other studies related to DTE time were primarily concerned with patients experiencing STEMI and data beyond the scope of this project related to percutaneous coronary interventions [11] [12] [38]. Additional studies, not dedicated to the ED, were included to highlight the importance of effective workflows [5] [23]-[30] [34] [37]. Another limitation encountered was the exclusion of pediatric patients, identified as anyone under the age of 18 years old, in the reviewed literature. This group was excluded from the project; however, consideration was still given during the literature review because this patient population is considered part of the general ED population with the potential to present with a complaint of CP. This presented a possible gap in knowledge for pediatric patients.

Another limitation was the inconsistent use of terms or phrases in the reviewed literature. It was noted that similar definitions were used to describe preventable medical errors, missed nursing care, missed care, and rationed nursing care. These terms are applicable to numerous healthcare fields; use in the search of literature generated a wealth of information not relevant to the project. This resulted in several of these terms being excluded as part of the literature search strategy.

A possible gap in knowledge revolved around if a singular intervention reduced DTE time. The literature addressed triage. However, triage is a process that involves multiple tasks with the potential to be disrupted during any of them. It was noted in one study that goal DTE time was not achieved even after interventions were implemented [35]; this was the only study that mentioned failure to achieve the benchmark standard time even though there was an improvement in the overall DTE time.

9.7. Change Recommendations

The review of literature provided evidence that supports the need for effective and efficient triage, a clinical workflow process found in EDs, to assist in reducing preventable medical errors [3]-[5]. The literature revealed using a valid and reliable triage tool improved triage accuracy [17]. It was also reported that when training was provided, the use of triage tools increased [2]. Several studies suggested having the necessary resources readily available at all times to help mitigate the issues created by patient boarding; this included a dedicated area, EKG machine, and stretcher [2] [20] [25] [35]. The following PICOT question was developed from recommendations in the literature: For newly arriving walk-in patients with chest pain in the emergency department, will use of the Emergency Severity Index and implementation of an electrocardiogram triage suite compared to current practice reduce door-to-EKG time within 8 weeks? Training on the use of the ESI triage tool and implementation of an EKG triage suite are two evidence-based interventions extracted from the literature that support the project goal. The project aim was to assist staff at the practice site consistently meet the benchmark stand-

ard DTE time of 10 minutes established in the evidence-based CP guideline jointly produced by the AHA and the ACC [9]. Implementing these interventions were intended to improve the triage clinical workflow process to influence patient outcomes as guided by the Donabedian model.

10. Theoretical Foundations

The scholarly project is based on the Donabedian theoretical foundation, a model developed to evaluate care quality [39]. It has since evolved to include assessing healthcare services through three dimensions: 1) structure related to resources, 2) processes, and 3) outcomes [40]. These three dimensions, or triad, are interrelated with a domino-like effect where the structure impacts processes related to providing care, which then influences the results of care services on health outcomes [41]. One part of the intervention for the scholarly project included addressing the structural dimensions of the Donabedian framework regarding adequate physical resources. This was to help improve the clinical workflow which is defined as a process involving multiple tasks that results in delivered care [1] [5]. Improving the triage workflow addressed a second dimension of the Donabedian framework. This improved the last dimension of patient outcomes. Combined, the triad allowed the DNP student to develop a thorough review of healthcare quality and offered a framework to analyze and improve systems responsible for the delivery of care [40].

The project is also based on Lewin's Change theory. This theory offers a systematic approach for planning, implementing, and evaluating change efforts [42]. There are three phases necessary for effective change to occur identified as 1) unfreezing, 2) change, and 3) refreezing [43]. In the first phase, the change agent identifies a need for change and creates awareness for others. In phase two, the anticipated modifications for improvement are presented and implemented. In phase three, the changes are reinforced and hardwired into the organization for long-term sustainability. For the project, the need to reduce DTE time was identified by the student while reviewing monthly data provided by the organization's CP coordinator. The student then created awareness for the ED leadership to gain support of the project. The second phase was completed during the education and training sessions conducted during shift huddle before implementation of the EKG suite occurred. The final phase was executed after data analysis occurred and confirmed the change was effective in reducing DTE times.

11. Methodology

11.1. Purpose of the Project

The purpose of this quality improvement project was to investigate if reviewing the ESI with the ED team and implementing an EKG suite would improve the triage clinical workflow and decrease the DTE time for newly arriving walk-in patients presenting to an ED with a cardiac related complaint of CP. The reality of the situation at the project site was that clinical workflow obstacles exist because

of common dilemmas like overcrowding and boarding in EDs which decreases available resources necessary to care for newly arriving patients; this in turn increased the risk of preventable medical errors occurring [20]. At the practice site, the average DTE time in the second quarter of 2025 for this specific patient population was 18.27 minutes which exceeds the benchmark standard time. A DTE time exceeding 10 minutes for patients experiencing CP is considered a preventable medical error as it is an evidence-based practice standard established in the CP guideline [9]. Cardiac related CP can occur in any patient population without regard to demographics at any time of day. While CP is not always due to a cardiac source, it can be fatal if it is [10]. The goal of this project was to improve the triage clinical workflow by ensuring ED staff were trained on using the ESI and always had the necessary space and equipment readily available for adult patients presenting to the department with CP to reduce DTE time. This in turn allowed for prompt identification of major adverse cardiac events like STEMI to improve quality of care and patient outcomes [9] [11] [12].

11.2. Clinical Question

The specific question the scholarly project aimed to address in PICOT format was: For newly arriving walk-in patients with chest pain in the emergency department, will use of the Emergency Severity Index and implementation of an electrocardiogram triage suite compared to current practice reduce door-to-EKG time within 8 weeks? The PICOT question is related to the clinical problem of disruptions in the triage clinical workflow due to ED overcrowding and patient boarding that results in preventable medical errors such as the untimely attainment of an EKG for walk-in patients with complaints of CP. The obstacles that contributed to the inefficient triage workflow process included inadequate training on the ESI tool, no consistently available space, and lack of a dedicated EKG machine.

The intervention, or independent variable, for this quality improvement project had two parts. First, it included training for registered nurses (RNs) on use of the ESI tool. The triage nurse used the ESI level and chief complaint to prioritize patients requiring an EKG. The second portion of the intervention was the establishment of an EKG suite. The EKG suite was a repurposed triage room. It consisted of a stretcher and a dedicated EKG machine. The suite remained stocked with extra supplies such as EKG paper, electrodes, and clippers. The data collection approach included retrospective chart review prior to the intervention implementation and post implementation specific to patients presenting with a cardiac chief complaint of CP. The measure under evaluation, also known as the dependent variable, for the project was DTE completion time.

11.3. Project Methodology and Design

The project had a quantitative quasi-experimental methodology which was useful in observing if there was a causal effect from an intervention [18]. A volunteer unit secretary collected de-identified data for a specific amount of time before the

intervention was implemented. Similarly, de-identified data was collected for the same amount of time post implementation of the intervention by the same volunteer. The difference between CP patients' arrival times to the ED and EKG completion time allowed for the derived outcome measure, DTE time, to be calculated. From this data, descriptive statistics and inferential statistics were then applied to determine project success.

The scholarly project was conducted in a pre-intervention and post-intervention design. This design method allowed for evaluation of the outcome measure prior to implementation of the intervention and post implementation [18]. The pre-intervention and post-intervention data was collected by retrospective chart review of the electronic health record prior to the intervention implementation and post implementation specific to patients presenting with a cardiac related chief complaint of CP. The measure the student evaluated was time. The first tracked time was patient arrival time to the ED (arrival time). This was the time the patient checked in to the ED via kiosk or their information directly taken by the staff member serving as the receptionist in the triage area. The second tracked time was EKG completion time. As the name implies, this was the time that the EKG was completed. In most situations, the arrival time was automatically populated in the electronic health record whereas the EKG completion time was manually entered by the technician into the electronic health record. Adjustments to the arrival time would have been required if a patient delayed checking in for evaluation; this is discussed further in the inclusion criteria. The difference between the arrival time and EKG completion time was the outcome measure for the proposed project: DTE time. A unit secretary voluntarily collected data directly from the electronic health record through an embedded triage audit report providing both arrival time and EKG completion time. No identifying patient information was gathered during the data collection process. All data was de-identified.

11.4. Setting

The practice setting for this project was an ED at tertiary hospital and accredited CP center located in a major metropolitan area of Texas in the U.S. The ED consisted of 20 individual patient rooms, 2 triage rooms, 1 treatment/procedure room, 8 vertical three spaces, and 5 rapid intake areas. The ED also had the capability to accommodate an additional 14 hall beds for a total of 50 patient care areas when patient boarding was necessary. The average daily census fluctuated between 80-115 patients per day. Department productivity levels allowed for 26 staff members to be scheduled in a 24-hour period. This included a combination of dayshift, mid-shift, and night-shift employees. The staffing matrix consisted of RNs, licensed vocational nurses, advanced paramedics, and unit secretaries. The care providers in the ED at any given time consisted mostly of RNs, and it is this group that mainly impacted the triage clinical workflow process. Therefore, the focus of the project involved primarily nurses who were assigned to the triage area.

11.5. Population and Sample Selection

The specific population was walk-in patients presenting to the ED with a cardiac related complaint of CP. At the practice site, there were an average of 10 walk-in patients a day that arrived with CP due to CVDs. Nonrandom, purposive sampling was used which allowed for criteria to be established for participation [18]. A free, online sample size calculator (see **Appendix D**) was used for power analysis to determine the appropriate a-priori sample size of 102. A unit secretary volunteer collected unpaired data for several days before and after implementation of the intervention. The volunteer included all qualifying samples from the pre- and post-intervention groups, collecting data until both sample sizes were sufficient at 51 each.

Criteria for inclusion for the patient population included "newly arriving" defined as presenting to the ED less than 30 minutes before checking in. On occasion, patients have decided to delay checking in. The 30-minute window allows for capture of these patients without significantly distorting data. The delayed check-in can directly impact the mean DTE time because the arrival time for these patients is adjusted to reflect the true arrival time; this time is the moment the patient physically enters the ED rather than the time they decide to check in for evaluation. While it is rare for CP patients to postpone seeking care while physically in the ED waiting room, it has been observed by staff at the practice site. The 30-minute window was established to mitigate the impact on the DTE time from extensive delays because the impact is not the result of inadequate ESI training or the triage process in place in these situations. No patients experiencing CP delayed checking in for this project.

Additional inclusion criteria for the patient population included: 1) age 18 years or older, 2) any gender, 3) identification as walk-in, 4) triage classification as cardiac related, 5) any ESI level, and 6) complaint of CP or variations like chest pressure, discomfort, and tightness. Exclusion criteria for the project included patients brought in via emergency medical services (EMS) or by peace officers. Additional exclusion criteria included cardiac related or potentially cardiac related complaints without CP; these included complaints such as high blood pressure, dizziness, short of breath, and palpitations. For the patient population, obtaining informed consent was not necessary since obtaining an EKG for these individuals is a standard and routine practice. Additionally, collected data was not patient specific, but generalized to a group with a defined complaint. All data was de-identified. No personal identifiable information was collected.

One way to maintain confidentiality is through anonymous data collection [18]. Data specific to the quality improvement project was retrospectively collected with the assistance of a department unit secretary. Data was collected using a triage audit report within the electronic health record that included all patients with a cardiac related complaint of CP triaged by any RN. The volunteer removed any information that could be used to identify participants, both RNs and patients, to maintain anonymity and ensure confidentiality.

11.6. Project Planning and Procedures

Project planning was implemented because it is considered the blueprint, or guide, which steers the project while identifying necessary tools, parameters, and establishes necessary timelines leading to the overall success of a project [44]. Various tools were used in planning of the project such as budgets, a SWOT analysis, and a work breakdown structure. Project planning assisted the team in thinking systematically by identifying how various pieces of the project influenced another. This led to the development of the PICOT question presented in the project by establishing a clear goal with a measurable outcome which are considered project success factors [45].

11.7. Interdisciplinary Collaboration

Communication is considered a vital component of project planning and implementation; it is imperative to disseminate "the right information, at the right time, with the right people, and in the right format" [14]. The method of communication exchange is equally important. Individuals should be versed in the chosen communication strategy especially if it requires a specific skill or knowledge base to understand the relayed message [46]. Throughout the project, methods of effective communication included in-person interaction, teleconferences, and electronic mail correspondence to create and sustain a dynamic team dedicated to the project's success.

Organization support was gained through a top-down approach from internal stakeholders. The internal stakeholders included the Assistant Chief Nursing Officer and Director of Emergency Services who were presented with an overview of the project and how it could potentially lead to financial gain and improved patient outcomes. Financial gain was identified in the form of cost-avoidance through minimizing the risk that the organization could lose accreditation as a CP center; accreditation is granted by the ACC which is an external stakeholder. A description of cost-avoidance is circumventing future costs as a result of practice or process changes [14].

Cost-avoidance was also highlighted through maintaining a stream of revenue by fostering trust in the community, an external stakeholder, as an accredited CP center; this is because current and future patients have a choice on where to seek care. The benefit of cost-effectiveness was also emphasized because implementing a cost-efficient intervention has "the potential to reduce disease burden" [14]. This was proposed through measuring the mortality rates of STEMI patients. While measuring STEMI mortality rates was not part of this scholarly project, it is a key performance indicator measured and tracked by the organization's quality department. A reduction in mortality rate is one indication of improvements in patient outcomes [12]. Support was then obtained from the staff members, additional internal stakeholders, directly involved in the project by presenting value in the form of improved patient outcomes and patient satisfaction. The risks and benefits associated with both internal and external stakeholders drive the sustainability of

the project.

Members of the project team included the DNP student, project chair, committee member, content expert, and a unit secretary volunteer. The student's role was self-assigned as the author and project manager. A project manager should have critical thinking skills and problem-solving abilities manifested in effective communication to drive the project forward [46]; this was evident by the student's responsibility in selecting relevant team members to assist with the project. Aside from developing the team, the student was responsible for project planning, staff training and education, implementation, monitoring for consistency and opportunities to reinforce the modified triage workflow, evaluation of project progression, and data analysis. The project chair and committee member were assigned to the project team, and they possessed valuable knowledge in the development of the project focus and organization of the project manuscript. The unit secretary volunteer collected raw data that was then purged of personal identifiable information; this allowed for the preservation of data confidentiality and anonymity. The content expert provided insight on the clinical problem and feasibility of the project interventions for sustainability. Each of these individuals contributed to the success of the project through an interconnected team approach by providing insight, presenting different avenues to consider, offering guidance, and task assistance.

11.8. Feasibility

The factors necessary to make the project a success included adequate time to educate staff on the evidence-based interventions and elements of the EKG suite. These elements consisted of a suitable area to convert to an EKG suite, a dedicated stretcher for the space, and an EKG machine specifically for the suite. Additionally, a volunteer ensured the confidentiality and anonymity of participants during data collection. A triage audit report embedded within the electronic health record allowed for data collection during a specified time period pre and post intervention. There were two budgetary needs addressed which the student was able to self-fund. One budget was for staff education prior to implementation (see **Appendix E**); the second budget was for the project portion to include post-project presentation material (see **Appendix F**). While there was no immediate financial gain from project implementation, patient satisfaction was stressed for timely evaluation of CP. A patient's negative perception about a hospital's quality of care could result in the spread of undesirable opinion via word-of-mouth leading up to $400,000 in lost revenue over the span of an individual's life [47].

11.9. Project Intervention Procedures and Data Collection

At the practice site, lack of training on use of the ESI and insufficient resources impeded the triage clinical workflow. Part of the intervention for this quality improvement project included educating RNs employed in the ED on using the ESI.

These nurses then utilized the ESI tool to assign a triage level to patients upon arrival to the ED that was used in conjunction with the patient's chief complaint to prioritize patients experiencing CP and required an EKG. The second portion of the intervention was the establishment of an EKG suite. Workflow disruptions occur when the individual performing the EKG must waste time searching for a suitable place to perform the EKG or waste time searching for the actual EKG machine. These issues were both mitigated by creating a specified space with dedicated equipment strictly for EKG completion.

The EKG suite was created by repurposing a triage room. It consisted of a stretcher, a dedicated EKG machine, and was stocked with basic supplies needed to complete an EKG such as paper, electrodes, and clippers. Patients identified by the triage nurse requiring an immediate EKG were escorted to the suite for EKG completion. Once the EKG was obtained, the patient was then moved to the next appropriate care area. This ensured the EKG suite was nearly immediately available for another patient. It was noted that dedicated space and equipment are recommended interventions from previous research to help reduce DTE times [25]. One study specifically recommended having a dedicated EKG machine and EKG technician in the triage area of the ED [35]. Another study recommended not just having a machine but included a demarcated space specifically for EKG completion [20]. Due to the feasibility of having a dedicated EKG machine and demarcated space in the triage area for timely DTE completion, they constituted a combined intervention, the EKG suite, for the project.

Prior to implementation of the project, a letter of cooperation (see **Appendix G**) was obtained from the organization. Specifically, the letter was obtained from the Director of Emergency Services who possessed approval authority for the project from the organization's Chief Nursing Officer. The student was required to submit a request for an Institutional Review Board (IRB) through Oklahoma Wesleyan University (OKWU) for approval. An exempt IRB determination (see **Appendix H**) was granted for the project. The practice site did not require an additional IRB. Since this project consisted of a process change that is already a standard of care, no informed consent was necessary.

The first part of the implementation phase included staff education (see **Appendix I**). The ED RNs received education during shift huddle over the span of a week. Shift huddle occurred twice a day, once in the morning and once in the evening. The education and training consisted of reviewing the ESI and modification to the triage clinical workflow process with implementation of the EKG suite. Establishment of the EKG suite took no longer than 45 minutes. It involved removing unnecessary items such as an infant scale and extra chairs and replacing them with the stretcher, EKG machine, and other necessary items.

A unit secretary voluntarily conducted retrospective chart reviews utilizing a triage audit report tool embedded in the electronic health record to collect pre-intervention and post-intervention data specific to patients presenting with a cardiac chief complaint of CP. The collected data were times; the first was patient

arrival time and second was EKG completion time. Data integrity was maintained through establishing clear criteria, utilizing a single volunteer, and providing the volunteer with easy-to-follow instructions on how to access the triage audit report tool. Data was exported to a portable document format file, a type of electronic document, where any personal identifiable information was then erased. The raw data, void of personal identifiable information, was then printed and provided to the student. The electronic versions were deleted. The student reviewed the data for completeness before utilizing Microsoft Excel and IBM SPSS Statistics version 26 for calculations and statistical analysis. The printed data was protected and securely stored, locked in a filing cabinet, at the project site in the ED manager's office when not in use. The ED manager's office was always locked; this served as an additional safety measure. Human subject protection was ensured by maintaining ethical standards through adherence to the Health Insurance Portability and Accountability Act where no personal identifiable information was collected on patients or RNs participating in the project.

11.10. Instruments or Data Source

The ESI scale is a valid and reliable tool used in triage to measure severity of symptoms and necessary resources to treat a patient presenting to the ED [15] [16]. The ESI has been shown to have a significant inter-rater reliability rating as demonstrated by Cohen's Kappa score of 0.75, yielded an average sensitivity of 74.3%, and indicated specificity of 94.4% [15]. This tool is publicly available and is integrated into the electronic health record at the project site. Data was collected from the electronic health record and included timestamps for patient arrival and EKG completion times. Data was collected retrospectively utilizing a triage audit report tool embedded in the electronic health record.

11.11. Limitations or Biases

There were two noteworthy limitations throughout the project. One limitation of this project was the high turnover rate at the practice site. There were fewer experienced RNs who are considered proficient in triage compared to the number of inexperienced staff. Effort to mitigate the impact on the project included recommending not assigning new hires to the triage role until they received proper education. This was because the inexperience and lack of education had the potential to result in inconsistent ESI level assignment if inexperienced staff misidentify the chief complaint due to the variability in patients' description of symptoms. An effort to mitigate this involved posting a list of phrases in the triage area that patients commonly use to describe CP such as discomfit, pressure, and tightness. Another limitation of the project was from a data entry perspective. The EKG completion times were manually entered into the electronic health record which were later collected. If the times were incorrectly entered, this could interfere with the results. To mitigate this, staff were reminded to verify data entries were correct before saving to the electronic health record.

11.12. Ethical Considerations

Human subject protection was promoted through maintaining ethical standards. Prior to the start of the project, the DNP student completed mandatory human subject protection training (see **Appendix J**). The student abided by the Health Insurance Portability and Accountability Act to ensure privacy and security of data was protected for staff and patient information throughout the project. Data was confidentially collected by a unit secretary voluntarily. The unit secretary expunged any personal identifiable information such as patient names, ages, date of birth from all records provided to the student to maintain anonymity. Only times were collected for the project. The project fostered the principles of respect, justice, and beneficence through integration of Kingdom nursing and embracing a Christian worldview regarding the concept of love for all without regard to demographics of any kind [48]. Love in this sense does not include romantic emotions, but it refers to actions and behaviors that improve the wellbeing of others [49]. This included fostering consistency in the triage process to promote health equity by ensuring all patients who met the inclusion criteria for CP received the same high-quality care [50] [51].

The project was subjected to an IRB for approval through OKWU and was granted an exempt review. The project site did not require an additional IRB. A letter of cooperation was obtained from the organization which granted permission to conduct the project. All data will be stored securely for seven years from the project's approval date and then destroyed per OKWU's policy.

11.13. Data Analysis Procedures

The pre-intervention and post-intervention data sets were first evaluated for completeness to ensure necessary elements were available to calculate DTE time. Microsoft Excel was used for data organization. The DTE times were manually calculated by the student using the arrival times and EKG completion times; these singular times were then organized from shortest to longest for the student to view the data spread (see **Appendix K**). The descriptive statistic measure of central tendency, mean, was then calculated for the two raw data sets using the appropriate formula function in Excel. This provided limited insight into the project results to indicate if a change had occurred. The student observed the pre-intervention DTE mean was higher than the reported 2025 second quarter DTE mean. This prompted the student to complete a data dispersion comparison with a box and whisker chart using Excel that highlighted data outliers. The box and whisker graph was chosen because it is regarded as a widely accepted tool used in the identification of outliers [52]. Due to the possibility of the outliers indicating errors in the entered EKG times, the two longest outliers were removed from both groups. Removing the outliers was considered an appropriate corrective measure to enhance the overall data quality [53], and the student completed analysis for the adjusted data. The mean for each data set was again calculated during statistical analysis through a one-tail Welch's *t*-test.

IBM SPSS Statistics version 26 was used to calculate the one-tail Welch's *t*-test. This parametric test was used because the project outcome measure provided interval data. The Welch's *t*-test was also chosen for the unpaired data because it was assumed the sample variances were unequal. The data analysis technique aligns with the project design and PICOT question because two unpaired data sets were collected to compare their means after an intervention had been implemented; this is the basis for the Welch's *t*-test. The level of statistical significance used for the quantitative analysis was a-priori ($p < 0.05$).

11.14. Descriptive Data

The ED had a fluctuating average daily census between 80 - 115 patients per day, and the department productivity levels allowed for up to 26 staff members to be scheduled in a 24-hour period. The staffing mix that influenced the triage process consisted of RNs, licensed vocational nurses, and advanced paramedics. RNs comprised the largest group of care providers within the ED at any given time and had the most influence on the triage clinical workflow process. It was for this reason that the focus of the education portion of the project primarily involved all RNs assigned to the triage area.

The participants were those identified as newly arriving walk-in patients to the ED with a cardiac related complaint of CP. The practice site had an average daily census of 10 walk-in patients a day with CP symptoms due to CVDs. An a-priori total sample size of 102 was calculated for power analysis using a free, online sample calculator. Fifty-one de-identified nonrandom, purposive samples were collected both pre- and post-intervention by a unit secretary volunteer. Inclusion criteria for the patient population consisted of "newly arriving" defined as checking in to the ED within 30 minutes of arrival to the facility. The following were additional inclusion criteria: 1) age 18 years or older, 2) any gender, 3) identification as walk-in, 4) triage classification as cardiac related, 5) any ESI level, and 6) complaint of CP or variations like chest pressure, discomfort, and tightness. Specific demographic data regarding staff or patients was not collected to ensure privacy and confidentiality.

12. Results

The raw data (see **Figure 1**) showed a reduction in mean DTE time of 11.53 minutes from pre-intervention ($M = 22.24$) to post-intervention ($M = 10.71$). **Table 1** shows the raw post-intervention results ($M = 10.71$, $SD = 6.47$) compared to the raw pre-intervention results ($M = 22.24$, $SD = 25.34$) and indicates statistical significance with $t(56.49) = 3.15$, $p = .001$, and $d = 0.62$. The *t*-statistic and critical *t*-values for the raw data ($t(56.49) = 3.15$, critical *t*-value = 1.67) also confirmed statistical significance. Due to the higher pre-intervention mean ($M = 22.24$) compared to the ED's second quarter mean for 2025 ($M = 18.27$), a data dispersion comparison using a box and whisker chart (see **Figure 2**) was done for the raw data.

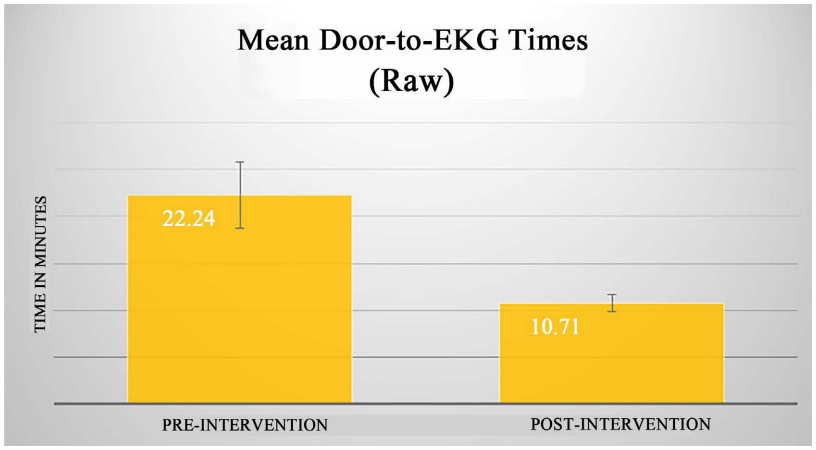

Figure 1. Comparison of pre-intervention to post-intervention mean DTE times—raw data.

Table 1. One-tail Welch's *t*-test: Two-sample assuming unequal variances—raw data.

	Pre-Intervention	Post-Intervention
Mean (*M*)	22.24	10.71
Variance	641.86	41.85
Observations	51	51
Standard Deviation (*SD*)	25.34	6.47
Hypothesized Mean Difference	0	
t stat	3.15	
df	56.49	
p	0.001	
t (critical value)	1.67	
d	0.62	

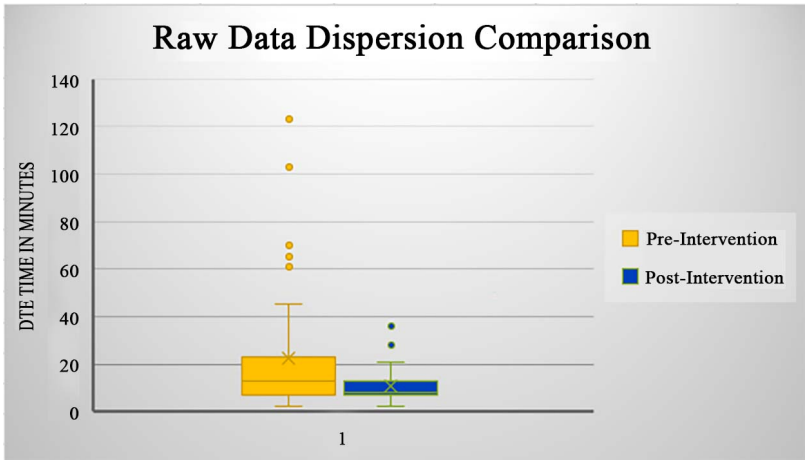

Figure 2. Raw data dispersion comparison.

The box and whisker graph highlighted outliers in both data sets. The outliers indicated a possibility that the EKG completion times had been incorrectly entered. Data entry errors caused by humans are known concerns [54] and was identified as a limitation for the project. After evaluating the data dispersion, it was

decided to adjust the data by removing the two longest outliers from both pre-intervention and post-intervention groups. The two longest outliers were 123 and 103 minutes for the pre-intervention group. The two longest outliers were 36 and 28 minutes for the post-intervention group. This brought the adjusted pre-intervention mean (M = 18.53) to a similar time compared to the ED's 2025 second quarter mean (M = 18.27). The remaining outliers in the pre-intervention group were not removed to account for the potential that the data was indeed correct leading to scholarly inquiry [54] and emphasizing necessity of the project.

Similar to the raw data, the adjusted data (see **Figure 3**) showed a decrease in mean DTE time. The adjusted data showed a reduction in mean DTE of 8.69 minutes. **Table 2** shows the adjusted post-intervention results (M = 9.84, SD = 4.82) compared to the adjusted pre-intervention results (M = 18.53, SD = 17.53) and indicates statistical significance with $t(55.23) = 3.35$, $p < 0.001$, and $d = 0.68$. The t-statistic and critical t-values for the adjusted data ($t(55.23) = 3.35$, critical t-value = 1.67) also confirmed statistical significance.

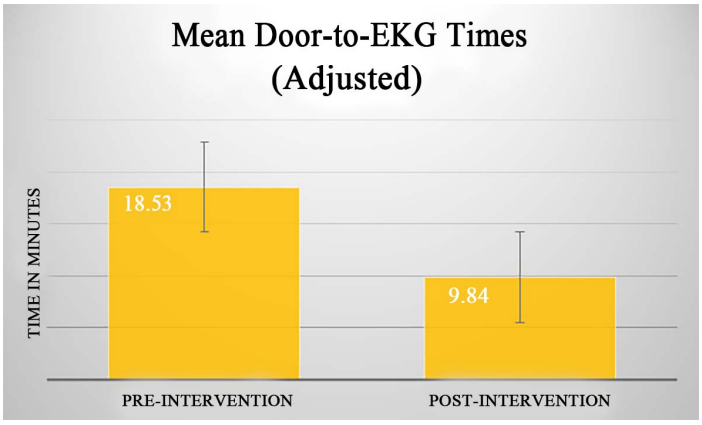

Figure 3. Comparison of pre-intervention to post-intervention mean DTE times—adjusted data.

Table 2. One-tail Welch's t-test: Two-sample assuming unequal variances—adjusted data.

	Pre-Intervention	Post-Intervention
Mean (M)	18.53	9.84
Variance	307.17	23.26
Observations	49	49
Standard Deviation (SD)	17.53	4.82
Hypothesized Mean Difference	0	
t stat	3.35	
df	55.23	
p	<0.001	
t (critical value)	1.67	
d	0.68	

In relation to the PICOT question, both the raw data and adjusted data showed project success by a reduction in mean DTE times by 11.53 and 8.69 minutes, respectively. After initial data analysis, a data dispersion comparison (see **Figure 2**) was done for the raw data due to the higher pre-intervention mean (M = 22.24) compared to the ED's second quarter mean for 2025 (M = 18.27). The student decided to adjust the data by removing the two longest outliers from both pre-intervention and post-intervention groups to improve the overall data quality. This brought the adjusted pre-intervention mean (M = 18.53) to a similar time compared to the site's 2025 second quarter mean (M = 18.27). Statistical significance was shown for both the raw ($t(56.49) = 3.15$, $p = .001$, $d = 0.62$) and adjusted ($t(55.23) = 3.35$, $p < 0.001$, $d = 0.68$) data. While the mean for the raw data (M = 10.71) was higher than the benchmark standard of 10 minutes, the mean for the adjusted data (M = 9.84) was within the goal time.

Both the raw data and adjusted data indicate clinical significance as there was a notable decrease in the mean DTE times. While the post-intervention DTE mean from the raw data still exceeded the 10-minute standard, it had significantly decreased. The post-intervention DTE mean from the adjusted data was less than the 10-minute benchmark. In both cases, the reduction in mean DTE time is clinically significant as the shorter times can lead to improved outcomes for patients experiencing CP.

The results of the project are consistent with findings from previous studies. A modified triage process for CP patients was shown to reduce DTE times [38]. Dedicated resources for EKG completion were also shown to facilitate a reduction in DTE time [20] [31] [35]. The raw data showing a mean DTE time exceeding the 10-minute standard, even though there was an overall decrease in mean DTE time, is also consistent with other studies noting process and operational difficulties that increase the challenge of obtaining timely EKGs [12] [35]. Overall, the interpretation from the data indicates that adequate training on the ESI and implementation of an EKG suite does reduce mean DTE times for newly arriving ED walk-in patients experiencing CP.

13. Strengths and Limitations

The project had several strengths. The quantitative quasi-experimental methodology was beneficial because it assisted in determining it there was a causal relationship between the intervention and outcome [18]. The staff were receptive to the education on the ESI, and the project site had the necessary resources to establish a permanent EKG suite. There was also substantial buy-in from ED staff, department leadership, and cooperative support from the ED providers.

The project also had limitations. One limitation was the manual entry of completed EKG times into the electronic health record. There was a possibility that the times were incorrectly entered which could then impact the DTE time. Staff were reminded to review the times for accuracy prior to saving data to the electronic health record in an effort to mitigate the limitation. This limitation was

taken into consideration when seemingly excessive outliers were identified during the initial data analysis before deciding to adjust the data. Another limitation was observed at the initiation of the project. Medical students and new resident doctors would use the recently established EKG suite as a space for general patient evaluation. ED staff were instructed to provide real-time information to these personnel about the use of the EKG suite as a method to mitigate the limitation. A third limitation was the use of agency staff in triage. These individuals were not completely familiar with the departmental processes. To mitigate the effects, only one agency personnel was assigned with an experienced full-time employee. This limitation was also considered during data analysis, and it was assumed that some of the outliers were correct as a result. As such, not all outliers were removed when adjusting the data. Additionally, the dual-intervention design did not afford the student the ability to distinguish between individual effects on the project results from ESI training versus implementation of the EKG suite. To mitigate this limitation, the interventions were combined. The project also had potential for measurement bias by using a single, non-blinded volunteer for data collection. This concern was mitigated by providing the volunteer with comprehensive training and utilizing a standardized approach to collecting the data [55].

14. Plans for Sustainability

Long-term sustainability of the project is possible as essential elements are already in place at the project site. Dedicated equipment has already been assigned to the EKG suite. New hires will need to receive ESI training which is available through the organization. New employees will also need to receive training on the modified triage process for walk-in patients experiencing CP; this can be incorporated into department orientation and onboarding training which occurs every two weeks. Continued support and cooperation from the ED providers is necessary to prevent improper use of the EKG suite as a generalized patient evaluation space simply because of availability and convenience. To ensure continued improvement and sustainability, the ED leadership team will need to routinely evaluate DTE times during the organization's monthly emergency medicine departmental quality meetings and provide corrective action when needed. Project sustainability is necessary because of the domino-like effect DTE times have on various aspects of healthcare such as quality of care, mortality rates, and patient outcomes.

15. Implications & Recommendations for Practice

The project adds to the current academic body of knowledge by supporting previous research results demonstrating a reduction in DTE time by ensuring necessary resources are always available to complete timely EKGs [20] [31] [35]. The project's raw data post-intervention mean DTE time ($M = 10.71$) also adds to the current body of knowledge that highlighted the difficulties for some facilities to meet the 10-minute standard even after interventions were implemented [35]. The inability of staff to obtain an EKG within 10 minutes every time indicates there

are still gaps surrounding the triage process. As noted in the SWOT analysis, inexperienced staff and the use of agency personnel could be factors contributing to the issue. Future studies could explore the relationship between the years of experience nurses have working in triage and DTE times. Future studies could also investigate how various tasks, such as creating the electronic health record or entering patient information into the EKG machine, interfere with DTE times.

The following conclusions were drawn from the data. EDs should ensure adequate training on the use of a valid and reliable triage tool. EDs should establish an EKG suite to reduce DTE times. These conclusions revealed practical implications. First, ensuring staff receive sufficient ESI training and implementing an EKG suite can result in improved performance metrics and better patient outcomes. Reducing DTE times, one performance metric, can improve patient outcomes by lowering STEMI mortality rates [12]. This in turn can then reduce the cost burden on the healthcare system associated with the length of hospital stay [56]. Additionally, cost-effective modifications to hospitals' triage clinical workflow processes can result in organizational financial gain through cost-avoidance [14]. Finally, an EKG suite would allow staff to have readily accessible resources which can improve staff satisfaction, reduce occupational stress, and improve work performance [57]. These practical implications can be generalized to any emergency setting to include freestanding EDs, EDs in smaller communities and those in rural settings with little to no change in the interventions. For facilities with limited space, an entire suite may not be feasible. However, utilizing privacy screens to create a dedicated space is a possibility. Wherever established, the EKG space would require a location close to the patient reception and triage areas to expedite EKG completion.

16. Summary

Triage is a critical clinical workflow process used to prioritize patients in EDs based on the severity of symptoms or condition [2]. Effective triage reduces the chance of preventable medical errors from occurring [3]. This is significant because medical errors are identified as a serious health issue and noted in the U.S. as the third highest cause of death [4]. Unfortunately, in EDs across the world, there are obstacles that increase the risk of hindering the triage process that then negatively impact patient care and reduce the quality of care [5]. Such barriers observed at the project site included inadequate staff training on a valid and reliable triage tool and insufficient resources leading to the regular occurrence of a specific preventable medical error. The identified preventable medical error, DTE times in excess of the benchmark standard of 10 minutes, then prompted interest in the development of this quality improvement project. The standard of practice is to obtain an EKG within 10 minutes of arrival for patients with CP per the CP guideline jointly produced by the AHA and the ACC [9]. Therefore, it is considered a preventable medical error when an EKG is not obtained within 10 minutes from time of arrival to the ED for patients with CP. A complaint of CP is the

second leading cause of visits to EDs in the U.S. [9], and it is the symptom most often associated with MIs [7]. This is concerning because the foremost causes of death worldwide are from CVDs [6], and MIs are the most prevalent [8].

At the project site, the 2025 second quarter mean DTE time was 18.27 minutes. The PICOT question the project aimed to address was: For newly arriving walk-in patients with chest pain in the emergency department, will use of the Emergency Severity Index and implementation of an EKG triage suite compared to current practice reduce door-to-EKG time within 8 weeks? The purpose of the project was to determine if implementing interventions to refine the triage clinical workflow process in an ED for newly arriving patients experiencing CP by improving triage accuracy and reducing barriers caused by overcrowding and boarding could reduce the mean DTE time at the project site.

A review of available literature indicated that effective and efficient clinical workflows improve care quality and decrease the potential for the occurrence of preventable medical errors [3]-[5]. The literature supported the use of a valid and reliable triage tool to improve triage accuracy [17]. Studies also supported ensuring necessary resources are always available which included a devoted space, machine, and stretcher strictly for EKGs to promote timely completion [2] [20] [25] [35].

The student completed all required training and obtained necessary approvals prior to the initiation of the project. The quantitative quasi-experimental project was guided by Donabedian's Framework and Lewin's Change Theory. The project was conducted in a pre- and post-intervention design. The student provided ESI training to the ED staff before the implementation phase of the project. During the implementation phase utilizing the ESI and EKG suite, the student also conducted informal weekly check-ins to gather feedback regarding any unexpected barriers or obstacles. De-identified data was collected by a unit secretary volunteer pre-intervention and post-intervention. This data was then provided to the student for analysis. Descriptive statistics and inferential statistical analysis were used to determine statistical significance. The data showed a decrease in mean DTE time. The adjusted data showed a reduction in mean DTE of 8.69 minutes. The adjusted post-intervention results ($M = 9.84$, $SD = 4.82$) compared to the adjusted pre-intervention results ($M = 18.53$, $SD = 17.53$) indicate statistical significance with $t(55.23) = 3.35$, $p < .001$, and $d = 0.68$. The t-statistic and critical t-values for the adjusted data ($t(55.23) = 3.35$, critical t-value = 1.67) also confirmed statistical significance. The results support that EDs should ensure sufficient training on the use of a valid and reliable triage tool in conjunction with establishing an EKG suite to reduce DTE time.

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Conflicts of Interest

The author declares no conflict of interest with respect to the quality improvement scholarly project, authorship, and/or publication of this article.

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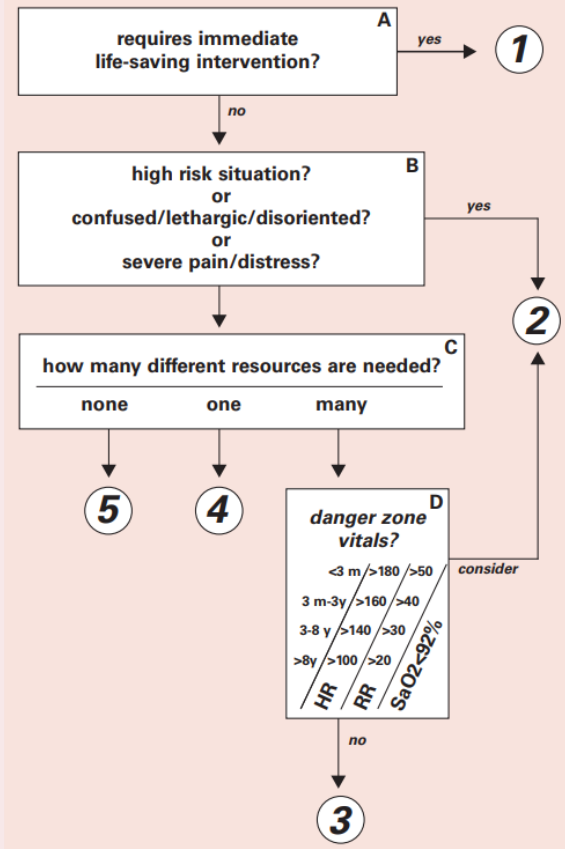
Appendix A

Emergency Severity Index



A. Immediate life-saving intervention required: airway, emergency medications, or other hemodynamic interventions (IV, supplemental O2, monitor, ECG or labs DO NOT count); and/or any of the following clinical conditions: intubated, apneic, pulseless, severe respiratory distress, SPO_2<90, acute mental status changes, or unresponsive.

Unresponsiveness is defined as a patient that is either:
(1) nonverbal and not following commands (acutely); or
(2) requires noxious stimulus (P or U on AVPU) scale.

B. High risk situation is a patient you would put in your last open bed.

Severe pain/distress is determined by clinical observation and/or patient rating of greater than or equal to 7 on 0-10 pain scale.

C. Resources: Count the number of different types of resources, not the individual tests or x-rays (examples: CBC, electrolytes and coags equals one resource; CBC plus chest x-ray equals two resources).

Resources	*Not Resources*
• Labs (blood, urine) • ECG, X-rays • CT-MRI-ultrasound-angiography	• History & physical (including pelvic) • Point-of-care testing
• IV fluids (hydration)	• Saline or heplock
• IV or IM or nebulized medications	• PO medications • Tetanus immunization • Prescription refills
• Specialty consultation	• Phone call to PCP
• Simple procedure =1 (lac repair, foley cath) • Complex procedure =2 (conscious sedation)	• Simple wound care (dressings, recheck) • Crutches, splints, slings

D. Danger Zone Vital Signs
Consider uptriage to ESI 2 if any vital sign criterion is exceeded.

Pediatric Fever Considerations
1 to 28 days of age: assign at least ESI 2 if temp >38.0 C (100.4F)

1-3 months of age: consider assigning ESI 2 if temp >38.0 C (100.4F)

3 months to 3 yrs of age: consider assigning ESI 3 if: temp >39.0 C (102.2 F), or incomplete immunizations, or no obvious source of fever

©ESI Triage Research Team, 2004 – (Refer to teaching materials for further clarification)

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Appendix B

Permission to Use ESI

Copyright notice

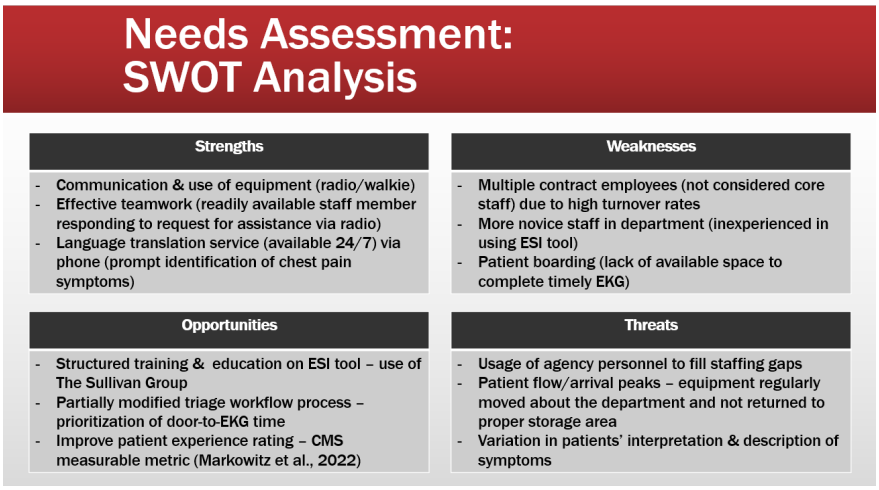
The Emergency Severity Index Version 4 Triage Algorithm (the "Algorithm") is the intellectual property of The ESI Triage Research Team, LLC (the "Author"). The Author has applied for copyright with the United States Copyright Office. The Algorithm is the sole and exclusive property of the Author, and the Agency for Healthcare Research and Quality has a license to use and disseminate the two works derived from this algorithm: the training two-DVD set ("Emergency Severity Index Version 4: Everything You Need to Know") and the implementation handbook ("Emergency Severity Index Version 4: Implementation Handbook"). The Author hereby assures physicians and nurses that use of the Algorithm as explained in these two works by health care professionals or physicians and nurses in their practices is permitted. Each professional user of these two works is granted a royalty-free, non-exclusive, non-transferable license to use the Algorithm in accordance with the guidance in these two works.

The Algorithm may not be changed in any way by any user. The algorithm and the contents of the DVD set and implementation handbook may be incorporated into additional training materials developed by a user, on the condition that no fee is charged by the user for the Algorithm, the contents of these two works, or the additional training materials.

The Algorithm has been rigorously tested and found to be both reliable and valid, as described in the research references included in these two works. However, the Author and the Agency for Healthcare Research and Quality require that the implementation and use of the Algorithm be conducted and completed in accordance with the contents of these two works using the professional judgement of authorized physicians or nurses and staff directed and supervised by them. Each health care professional who decides to use this algorithm for emergency triage purposes does so on the basis of that health care provider's professional judgment with respect to the particular pateint that the provider is caring for. The Author and the Agency for Healthcare Research and Quality disclaim any and all liability for adverse consequences or for damages that may arise out of or be related to the professional use of the Algorithm by others, including, but not limited to, indirect, special, incidental, exemplary, or consequential damages, as further set forth below.

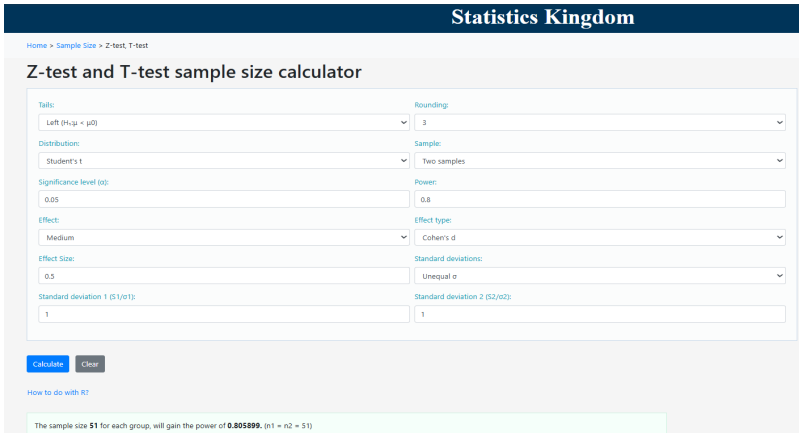
Appendix C

SWOT Analysis



Appendix D

Sample Size Calculator



Appendix E

Staff Education Budget

Estimated Budget for Staff Education

Item Description	Quantity	Cost per item	Total Cos	Considerations if Replicating
Snacks per session	14 sessions	$15	$210	
Presentation Material	1	$150	$150	
Personal Time	5hrs	$45	($225)	Paid if Replicating
		Total Out of Pocket Budget Needs for Student	$360	
		Total Budget Needs if Replicating	$585	

Appendix F

Estimated Project Budget

Estimated Project Budget				
Item Description	Quantity	Cost per item	Total Cost	Considerations if Replicating
Ream of Copy Paper	1	$10	$10	
Printer toner	1	$150	$150	
Physical Space for Triage Suite (Already available)	1	$0	?	Cost would be based on construction estimate for individual facilities if needed to build a space
Designated EKG Machine (Already available)	1	$4,500	($4,500)	Paid if replicating
Designated Stretcher (Already Available)	1	$2,500-$4,000	($4,000)	Paid if replicating
Emergency Severity Index Triage Training (Covered by organization)	50	$390	($19,500)	Paid if replicating
Secreterial Hours for Data Scrubbing of personal identifiable info (Volunteered)	4	$20	($80)	Paid if replicating
Post-project presentation/poster	1	$150	$150	
Estimated Pay Requirements (PTO for project completion)	96hrs	$45	($4,320)	paid if replicating
Estimated Pay Requirements for 1 person replicating project	87.5hrs	$45	($3,937.50)	paid if replicating
	Total Estimated Out of Pocket Budget Needs		$310	
	Total Estimated Budget Needs if Replicating		$36,657.50	Does not include cost for construction of EKG suite

Appendix G

Letter of Cooperation

[redacted]

Letter of Cooperation

Date: 08/01/2025

Institutional Review Board

[redacted]

Dear IRB Members,

After reviewing the proposed Capstone Quality Improvement Project, *"Implementing an Electrocardiogram Suite in the Emergency Department to Decrease Door-to-EKG Time"*, presented by *Kimberly Evette Ortuno*, I have granted authorization for *Kimberly Evette Ortuno* to conduct a Quality Improvement Project at our Hospital in the Emergency Department (ED).

This letter confirms that I, as an authorized representative of [redacted], allow *Kimberly Evette Ortuno* access to conduct study-related activities at the listed site, as outlined below.

- Project Site: [redacted]
- Project Purpose: The purpose of this quality improvement project is to provide education to ED staff on the Emergency Severity Index algorithm to improve triage accuracy and establish an EKG suite to ensure resources are always available to complete a timely EKG for patients experiencing chest pain (CP). The overarching aim of this project is to assist the organization's ED staff consistently obtain door-to-EKG completion times for patients presenting with a chief complaint of CP within the benchmark standard time of 10-minutes as established in an evidence-based CP guideline.
- Project Activities: Project related activities will include providing staff with education and training on a valid and reliable triage tool, redesigning a triage consultation room into an EKG suite, collection of de-identified aggregate data pre/post implementation of project interventions, and engaging in regular communication with ED staff and leadership to reinforce change efforts for project success.
- Site Support: The study site agrees to provide time for the investigator to conduct education and training during shift huddle. The study site agrees to provide the necessary space and equipment to create an EKG suite. The study site permits the investigator to the use of department office equipment such as computers and printers. The study site agrees to allow collaboration and obtain voluntary assistance from a unit secretary in data retrieval at a time that it does not interfere with daily operation. The study site agrees to store data in a locked location in the ED leadership's office to maintain security and confidentiality.
- Data Management: Data will be retrospectively collected from the electronic health record. The data will include two tracked times. The first time will be patient arrival time to the ED. The second time will be EKG completion time. Data will be specific to patients triaged with a cardiac presentation and complaint inclusive of chest pain (or commonly interchanged descriptions like pressure or tightness). No personal identifiable information will be collected. All aggregate data will be de-identified. The owner of the data will maintain confidentiality and security of the data for 7 years per [redacted] University's policy. After 7 years, the data will be properly disposed of via secure shredding for paper documents and electronic records deleted. The investigator will not disclose the site name or exact location of the site.

I understand that this site's participation will only take place during the study's active Institutional Review Board (IRB) approval period. All study-related activities must cease if IRB approval expires or is suspended. I understand that participation will be voluntary; [redacted]' employees/patients/clients/students/etc. will not be penalized or rewarded for their participation.

If the IRB has any concerns about the permission being granted by this letter, please contact me by phone at [redacted] or email at [redacted]

Sincerely,

[redacted]

Director of Emergency Services

Title

[redacted]

Printed Name

1 August 2025

Signature Date

Appendix H

IRB Approval

[redacted] UNIVERSITY [redacted]

Date: August 13, 2025

From: The Institutional Review Board (IRB)

Re: 08132025-1

Study Title: "Implementing an Electrocardiogram Suite in the Emergency Department to Decrease Door-to-EKG Time"

Dear Kimberly,

On behalf of [redacted] University's Institutional Review Board (IRB) has reviewed and approved your project titled "Implementing an Electrocardiogram Suite in the Emergency Department to Decrease Door-to-EKG Time."

Please take special note of the following important aspects of your project:

- Changes made to your study may change the status of your study to human subjects research. Therefore, the IRB must be notified and approve any changes to your study before they can be implemented.
- If there are any unanticipated problems or complaints from participants during your data collection, you must notify the IRB board within 24 hours of the data collection problem or complaint with your resolution.
- You agree to 1) not to name the Facility in his or her writing 2) not name any of the Facility's employees or students in his or her writing, 3) not to provide any other information that would lead readers to easily identify Facility or any of its employees or students.

The [redacted] University IRB wishes you the best as you conduct your research!

Sincerely,

The IRB Review Board

Reviewed by: Dr. [redacted]

[redacted]

Appendix I

Staff Education Handout

Implementing an Electrocardiogram Suite in the Emergency Department to Decrease Door-to-EKG Time

Triage

Definition: a critical workflow process used in emergency departments (EDs) for prioritizing patients based on the severity of their presenting symptoms or condition (Alumran et al., 2020)

Consequences of workflow disruption result in preventable medical errors that then increases the risk of patient harm and reduces the quality of care delivered (Rodziewicz et al., 2024; Sami et al., 2022; Zheng et al., 2020).

Chest Pain & EKGs

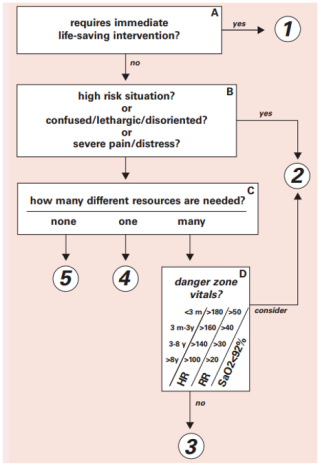
Chest Pain: Most common symptom of a heart attack (Sharma et al., 2021)
- Needs immediate evaluation for prompt identification of major adverse cardiac events like STEMI (Merschel, 2021)

EKGs: DTE Benchmark Standard Time for Patients with Chest Pain: **10 Minutes** (Gulati et al., 2021).
- If not obtained within 10 minutes of arrival to the ED, it is considered a preventable medical error

Why? Obtaining an EKG within 10 minutes could reduce mortality rates by 50% in ED STEMI patients (Yiadom et al., 2024).

Emergency Severity Index (ESI):

A valid and reliable algorithm tool used in the triage process to measure acuity of patient symptoms and immediate resource requirements (Lim et al., 2020; Suamchaiyaphum et al., 2024).



Partial Triage Process Redesign:

1) Patient Arrival: Patient checks in on kiosk

2) Intake/Recept Staff: Registers the patient

3) Intake/Recept Nurse: Uses ESI to identify triage category and chief complaint

*If the patient is identified by: **a)** *Triage Category: Cardiac* and **b)** *Chief complaint: Chest Pain* the intake/recept nurse alerts team via radio/walkie and requests assistance if available*

4) Obtain EKG: The patient is immediately escorted to the EKG suite and EKG is completed

5) EKG Interpretation: The printed EKG is promptly handed directly to the ED provider for interpretation

6) Triage Assessment: Intake/Recept nurse or other available nursing staff completes & documents rapid initial assessment

7) Treatment Area: Intake/Recept nurse or other available staff moves patient to appropriate treatment area to continue workup.

Note: Follow appropriate standard triage processes for all other patients. (Ex] Stroke, Sepsis, Trauma, etc.).

Appendix J

Human Subjects Protection Training

Appendix K

Individual DTE Times Organized Shortest to Longest

Raw Data		Raw Data cont.	
Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
2	2	14	9
3	3	14	10
4	3	15	10
5	4	16	10
6	4	17	11
6	5	17	11
6	5	19	11
6	6	22	12
6	6	22	12
6	6	22	12
7	6	22	12
7	6	22	13
7	7	23	13
7	7	24	14
8	7	26	14
8	7	26	15
8	7	39	17
8	7	41	17
9	7	45	18
9	8	61	18
9	8	65	20
9	8	70	21
11	8	72	21
12	8	103	28
12	8	123	36
13	8		