Optimizing Interventions in Emergency Services Apparent Cause Analysis to Improve Reliability

Amanda M. Carver MSN RN

An evidence-based doctoral project presented to the Department of Nursing at

Mount St. Joseph University

in partial fulfillment of the degree

Doctor of Nursing Practice

April, 22nd 2024

Kristin Clephane DNP, RN, CPN

_
Kristin Clephane DNP, RN, CPN_
DNP Advisor Name and Credentials

TABLE OF CONTENTS

Abstract

Apparent cause analyses (ACAs) are conducted within healthcare organizations to evaluate patient safety events and create action plans. ACA action plans can vary in levels of reliability. An evidence-based, quality improvement doctorate of nursing practice (DNP) project was conducted within the emergency department of a large pediatric academic medical center to increase the levels of reliability in ACA action plans. The Model for Improvement and the Iowa Model of Evidence-Based Practice served as the framework for the DNP project. An implemented intervention bundle improved the proportion of ACA action items that scored a level 2 reliability or higher from 11% to 46% throughout the project. Further evaluation outside the DNP project timeline is needed to evaluate if the intervention bundle prevents the reoccurrence of patient safety events.

Keywords: apparent cause analysis, ACA, patient safety, reliability

Optimizing Interventions in Emergency Services Apparent Cause Analysis to Improve Reliability

Patient safety is a cornerstone of patient care delivery. In the past two decades, healthcare systems have dramatically changed patient safety approaches following the Institute of Medicine's report "To Err is Human". This report advocated a shift from individual blame towards a system approach to prevent errors and improve patient safety (Institute of Medicine (US) Committee on Quality of Health Care in America, 2000). Healthcare organizations commonly use causal analysis, such as root cause analysis (RCA) and apparent cause analysis (ACA), to investigate adverse patient events or near misses, which are impartial and rigorous approaches to creating actionable solutions (Crandall et al., 2017). In addition, many healthcare organizations have adopted high reliability organization (HRO) theory including the five key concepts of preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise (Weick & Sutcliffe, 2007). As organizations commit to HRO systems design, solutions rooted in reliability principles can prevent failures and improve safe patient care in complex healthcare systems (Nolan et al., 2004).

The doctorate of nursing practice (DNP) project site is a large, pediatric academic medical center in the Midwest with over 700 inpatient beds. The organization performs causal analysis on safety events and near misses through RCAs and ACAs. ACAs are completed more frequently than RCAs and are defined as a limited investigation that addresses an immediate problem and can identify safety trends across an organization (Crandall et al., 2017). ACAs also include an action plan to correct deviations and prevent the event or near miss reoccurrence. Within the DNP project site, ACAs are completed by clinical and medical teams from all areas of the organization, with intermittent support from risk and safety consultants. The purpose of the DNP project is to increase the level of reliability in ACA action plans within the emergency department through facilitated ACAs and measuring the level of reliability for each action item to improve patient safety and prevent the reoccurrence of events over five months.

Problem

Nolan et al. (2004) define reliability as operations functioning with no failures over time. Reliability is measured as the number of actions successful with the intended result divided by the total number of action (Nolan et al., 2004). Reliability is therefore scored into three levels. Interventions with level 1 reliability focus on hard work and vigilance, resulting in one to two failures in ten attempts or an 80-90% success rate (Cincinnati Children's Hospital Medical Center, 2004). Level 2 reliability describes solutions with less than five failures out of 100 opportunities and is rooted in reliability science and human factors principles, resulting in success 95% of the time (Cincinnati Children's Hospital Medical Center, 2004; Nolan et al., 2004). Finally, level 3 reliability solutions involve system redesign, highlighted in the principles of Weick and Sutcliffe's HRO theory, with a success rate of 99% or less than five failures in 1000 opportunities (Cincinnati Children's Hospital Medical Center, 2004). Generally, level 1 interventions are frequently referred to as low or lower levels of reliability, followed by level 2 and level 3, which are often termed as intermediate and high levels of reliability.

Intentional analysis of patient safety events through RCA and ACA encompasses the HRO principle of preoccupation with failure. The ultimate goal of event analysis is solutions that prevent recurrence and make healthcare systems safer. However, Morse and Pollack (2012) found that out of 78 RCA action plans, 46% were identified as weak, 44% as intermediate, and only 10% as strong. As previously examined, solutions with level 1 reliability have a higher failure rate, impacting patient safety. Solutions that encompass level 1 reliability include training, general awareness, personal reminders, and basic standardization (Cincinnati Children's Hospital Medical Center, 2004; Crandall et al., 2017). In another study, Kellogg et al. (2017) identified that in 731 proposed solutions from RCAs, the most common intervention was training, followed by process changes and policy reinforcement, all of which are at a level 1 reliability.

Causal analysis provides value to healthcare organizations to improve patient safety. It is important to note that RCA and ACAs differ in time, resources, and processes; however, both end with an action plan to address findings. Karkhanis and Thomson (2021) describe that RCAs provide an opportunity for complex problem-solving, have a system or process focus, and include team engagement; however, they can have weak solutions.

The emergency services department at the DNP project site performs limited investigations on safety events and near misses through ACAs to create a safer system and prevent the reoccurrence of similar events. One ACA can identify several action items formed as interventions to address the causes or gaps in each occurrence. The structure and participants of the analysis can vary according to the type of event; some ACAs are conducted with nursing leaders or providers, and others can be collaborative. In addition, the project site has two main emergency rooms at different locations and several urgent care centers within the hospitals and throughout the community. This results in some ACA action plans being developed for a specific location but limiting the visibility of proposed solutions across the mesosystem.

To determine the levels of reliability for the proposed solutions in ACAs conducted by emergency services, a patient safety consultant performed an informal review of past ACAs. In this review, several action plans had level 1 reliability solutions and interventions focusing on training individuals. Some ACA action plans that required multidisciplinary collaboration had level 2 interventions, although inconsistent throughout the ACAs reviewed. In addition, action plans were limited in scope, completion dates, detail, and ongoing sustainment activities. There was no indication from the plans if events and proposed interventions were visible or shared across the mesosystem or if common themes were tracked to show that system-level interventions were needed.

This informal review provided opportunities for improvement. The project site has adopted principles of HRO theory outlined by Weick and Sutcliffe (2007), including preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise. In addition, safe care delivery is a foundational priority for the organization. Levels of reliability are frequently discussed, documented, and tracked in quality improvement projects but not consistently in action plans from ACAs. Action plans resulting from safety opportunities that are limited to level 1 reliability can lead to reoccurrence of patient safety events or themes that impact safe care delivery. Following these findings, the information was shared with the safety officer, patient safety leaders, and emergency services nursing and physician leadership who endorsed improving the action plan reliability of ACAs within the department. A systematic literature search identified interventions to address the current problem and thus, improve action plan reliability.

Evidence Search

PICO Question

The following PICO question guided the evidence search: ‘In causal analysis (P), how do high-reliability solutions or interventions (I), compared to low-reliability solutions or interventions (C), affect the reoccurrence of patient safety events (O)?

Search Strategy

Selected databases for the evidence review included CINAHL, Medline, and PubMed. Using the key terms “patient safety analysis” and “apparent cause analysis” a combination of “high reliability” and “prevention or reduction or minimize” was searched throughout the databases (Appendix A). The search was further narrowed to limit inclusion criteria of academic or scholarly journals in English language between 2008 and 2023. In total, 141 articles resulted from the search. After duplicate articles were removed, a total number of 15 articles were selected for review. Four articles were removed after rapid critical appraisal. Additional hand searching through Google Scholar for background information and references from reviewed articles with the same inclusion criteria was performed. The search resulted in 11 articles selected for review and the synthesis of findings presented here.

Evidence Synthesis

Melnyk and Fineout-Overholt (2019) define evidence-based practice as clinical decision making that incorporates research, clinical expertise, and patient choices to ensure the best outcomes. Evidence includes sources of knowledge from research and practice to guide decisions that provide effective healthcare for patients, groups, communities, and healthcare systems (Melnyk & Fineout-Overholt, 2019). Critical appraisal and synthesis of the evidence guide clinicians in making recommendations and plans for practice changes that address a clinical question or problem.

Critical Appraisal

Melnyk and Fineout-Overholt (2019) describe critical appraisal as a step of the evidence-based process composed of four phases. The four phases include a rapid critical appraisal to find relevant studies, evaluation and comparison of the data, synthesis from the body of evidence, and recommendations for practice change (Melnyk & Fineout-Overholt, 2019). Following the evidence search to answer the PICO question, a rapid critical appraisal tool was used to evaluate all relevant articles.

The evidence search yielded 15 articles relevant to the PICO question. Although the clinical problem is focused on ACA action plan level of reliability within emergency services, the search intentionally included the use of studies that focused on RCAs and HRO principles to expand findings. A rapid critical appraisal checklist outlined by Melnyk and Fineout-Overholt (2019) was conducted on each article for type of study. Melnyk and Fineout-Overholt (2019) rapid critical appraisal checklists include a scoring system tailored for the type of research or practice-based study focusing on validity, reliability, and applicability to the clinical question. Four studies were removed after rapid critical appraisal resulting in 11 studies for further evaluation (Auschra et al., 2022; Brilli et al., 2013; Crandall et al., 2017; Cropper et al., 2018; Hettinger et al., 2013; Hillard et al., 2012; Kellogg et al., 2017; Morse & Pollack, 2012; Muething et al., 2012; Parikh et al., 2020; Veazie et al., 2022). These studies were organized into an evidence synthesis table for evaluation and information extraction. Evidence synthesis included determining the level of evidence for each study as Polit and Beck (2017) outlined. Levels of evidence ranged from level I found in systematic reviews to level VIII found in case reports and expert opinion (Polit & Beck, 2017). See Appendix B for the evidence synthesis table.

Evidence Synthesis Summary

Evidence of the Problem

The evidence shows that multiple healthcare organizations across the United States have adopted HRO theory and principles to create safer systems with the goal of eliminating patient harm. This can involve incorporating HRO theory from individual hospital units to a whole organizational approach (Auschra et al., 2022). RCAs solutions are commonly referenced as a tool for healthcare organizations to create safer solutions through interventions focused on eliminating patient harm (Hettinger et al., 2013; Kellogg et al., 2017). ACAs, although more limited in scope and duration than an RCA, are a tool to provide safety solutions following patient safety events or near misses (Crandall et al., 2017; Parikh et al., 2020). However, organizations have varying approaches to the framework and metrics of HRO principles and how they influence outcomes (Auschra et al., 2022; Veazie et al., 2022).

Solutions in causal analysis action plans can be varied. Training was commonly found as a solution in RCA action plans, followed by process changes and reinforcement of policies (Kellogg et al., 2017). Comparatively, Hettinger et al. (2013) found that out of 782 RCA solutions, the most common categories of solutions involved process, training, and policy. Crandall et al. (2017) measured a baseline level of reliability across ACA action plans to be 86.4% prior to interventions, which is within level 1 reliability. The evidence describes that level 1 reliability solutions in RCAs and ACAs are commonly planned solutions. Level 1 solutions have a higher failure rate and usually rely on vigilance and hard work to create solutions (Cincinnati Children’s Hospital Medical Center, 2004; Crandall et al., 2017).

Interventions, Outcomes, and Measurement

Several studies implemented a comprehensive safety program based on HRO theory and principles to improve safety (Brilli et al., 2013; Cropper et al., 2018; Hillard et al., 2012; Muething et al., 2012). Common interventions in the safety programs included training for staff and leadership, safety coaching, and safety governance (Brilli et al., 2013; Cropper et al., 2018; Hillard et al., 2012; Muething et al., 2012). Improvements to the RCA process was identified as part of the bundles (Brilli et al., 2013; Hillard et al., 2012; Muething et al., 2012). Hillard et al. (2012) and Muething et al. (2012) described effective action plans as part of the changes in the RCA process to prevent reoccurrence and reduce overall serious safety events. The studies that implemented safety programs grounded in HRO theory as part of an organizational intervention measured and had significant improvements in serious safety event rates (SSER) (Brilli et al., 2013; Cropper et al., 2018; Hillard et al., 2012; Muething et al., 2012). This evidence suggests that reliable and effective action plans in organizations with safety programs modeling HRO theory can decrease serious patient safety events.

Hettinger et al. (2013) and Morse and Pollack (2012) measured action plan effectiveness in RCAs. Morse and Pollack (2012) classified action items from 78 RCA plans as strong, intermediate, and weak by referencing the National Center for Patient Safety Hierarchy of Actions. The study found that 90% of RCA events with at least one intermediate or strong action item led to 95% successful implementation (Morse & Pollack, 2012). Hettinger et al. (2013) reviewed 782 solutions within 334 RCA cases and created a model that categorizes solutions into highly effective and sustainable to prevent a reoccurrence of safety events. Information technology and institutional approaches to solutions were rated as the highest and most effective, followed by solutions aimed at improving the physical environment, process, and paperwork (Hettinger et al., 2013). Hettinger et al. (2013) identified solutions focused on training, review, policy, and compliance checks as low impact on sustainability and effectiveness. The two studies identified models and toolkits rating the strength of solutions which closely mirror design concepts for improving reliability described by Cincinnati Children’s Hospital Medical Center (2004) and Nolan et al. (2004).

Crandall et al. (2017) and Parikh et al. (2020) specifically addressed improvement in ACAs. Facilitated ACAs with safety expertise involvement was an intervention to improve structure, process, and action planning (Parikh et al., 2020). Facilitated ACAs included a discussion with a team of local experts and leaders, safety team members which involved a 30-minute discussion of the event, followed by the development of action items. At the DNP project site, RCA action planning has consistent facilitation and resources. Crandall et al. (2017) improved overall ACA action plan reliability from 86.4% to 96.1% by implementing a high reliability tool kit, scoring system, and ACA action planning review from the safety team for more effective solutions. Specific tactics and intervention examples were built into a high reliability toolkit categorized by levels 1, 2, and 3 reliability resulting in outcome measures that showed improvement in action plan strength over time (Crandall et al., 2017).

Recommended Practice Change

As a result of the synthesis of evidence, the recommended practice change was the implementation of an evidence-based, quality improvement project in the emergency services department at the DNP project site to increase levels of reliability in ACA action plans. Interventions included a facilitated ACA approach and incorporation of level 2 or higher reliable solutions from September 2023 through March 2024. To determine the project's progress and success, the levels of reliability were scored for each ACA solution following the current reliability design toolkit at the project site and measured over time (Cincinnati Children's Hospital Medical Center, 2004). The project outcome goal is to increase the proportion of ACA action plans from a level of reliability 1 to a level of reliability 2 or higher by March 2024.

Evidence-Based Practice Model and Theoretical Framework

Evidence-based practice models provide clinicians with design and implementation approaches for evidence-based practice change (Melnyk & Fineout-Overholt, 2019). Several evidence-based practice models provide guidance to address the challenges of practice changes within healthcare organizations and stimulate evidence-based inquiry (Melnyk & Fineout-Overholt, 2019). Theoretical frameworks provide models to support implementing the change, considering different strategies and elements of organizational change (Melnyk & Fineout-Overholt, 2019). Regardless of the model chosen, Melnyk and Fineout-Overholt (2019) identify four critical elements needed to implement change, including: identifying a vision, belief and confidence to make the change, a well-formed strategic plan, and other characteristics such as agility, action, persistence, and patience.

Evidence-Based Practice Model

The Iowa Model provides a multiphase process rooted in change management and feedback loops and promotes team-based decisions (Melnyk & Fineout-Overholt, 2019; Schaffer et al., 2012). This model applies to this project because it is relevant for organizational change management and interprofessional team-based decisions. In addition, the Iowa Model features testing the practice change before implementation, which connects to quality improvement methods. Schaffer et al. (2012) describe that quality improvement fits within the umbrella of evidence-based practice. The Iowa Model provides steps through the evidence-based process, from initial inquiry to disseminating results.

Application of the Iowa Model

The steps of the Iowa Model provided a guide to implement phases of the evidence-based practice change to improve ACA action plan reliability within the emergency services setting. The Iowa Model's first step is identifying the issue, trigger, or opportunity that leads to the clinical inquiry (Iowa Model Collaborative, 2017). The model includes the beginning of an evidence-based inquiry that coincides with Melnyk and Fineout-Overholt (2019) cultivation of a spirit of inquiry and follows the steps of evidence-based practice. In the initial phase of the ACA improvement project, a patient safety consultant identified a clinical issue related to the action plans formulated in current ACAs. The clinical inquiry led to a brief search of current reliability tools used within the organization and its application in forming solutions and interventions.

After identifying an opportunity for improvement, the next phase of the Iowa Model is to state a clinical question (Iowa Model Collaborative, 2017). A PICO question was formulated to guide a systematic evidence search to determine if the previously described levels of reliability within causal analysis action plans prevent the reoccurrence of patient events. The model has a key decision point to determine if the clinical problem is a priority within the organization. In this project, key stakeholders and practice experts were consulted to determine if the clinical problem aligned with organizational priorities and had urgency to pursue.

Forming a team, appraisal, and synthesis of the evidence are the next phases of the Iowa Model (Iowa Model Collaborative, 2017). This phase also provides a feedback loop to determine if there is sufficient evidence to implement an evidence-based practice change or if more research is needed (Iowa Model Collaborative, 2017; Melnyk & Fineout-Overholt, 2019; Schaffer et al., 2012). To improve ACA action plan reliability, the evidence was searched, appraised, and synthesized by the DNP student to provide evidence to support the practice change. This team will have evidence-based guidance to determine interventions and measurements to design, implement, and evaluate the practice change within the setting.

The Iowa Model outlines an essential step of piloting the practice change to test and identify issues before larger-scale implementation (Melnyk & Fineout-Overholt, 2019).

Following the model, the project of improving ACA action plan reliability had identified resources and stakeholder approval established, baseline data measurement, well-defined interventions to test, outcome measurements, and an evaluation plan. Methods for designing and testing the change, as outlined in the Model for Improvement occurred during this phase and to determine if the proposed interventions result in an improvement (Langley et al., 2009). The details of the Model for Improvement are outlined in the theoretical framework section.

After the pilot, determining whether the evidence-based practice change is appropriate for adoption is the next step of the Iowa Model (Iowa Model Collaborative, 2017). If the change is deemed applicable, sustaining the change will be warranted. Sustaining the change includes engaging department stakeholders, hard-wiring the new process into practice, monitoring, and ongoing reinforcement (Iowa Model Collaborative, 2017; Melnyk & Fineout-Overholt, 2019). The identification of champions and sustainment monitoring will be needed to ensure that interventions to improve reliability in ACA action plans continue after initial testing.

The last phase of the Iowa model is the dissemination of the results (Iowa Model Collaborative, 2017). Melnyk and Fineout-Overholt (2019) discuss that dissemination includes professional learning within and external to the organization that implemented the practice change. Following the planned change of ACA action plan reliability, the first dissemination occurred within the pilot department, but extend to applicable sites of care beyond emergency services. An original figure was created to depict how the DNP project steps aligned with the Iowa Model (Appendix C).

Theoretical Framework

Theoretical models provide a framework for the implementation of a practice change. The Model for Improvement (Langley et al., 2009) complements the Iowa Model during the design and piloting of the practice change. The Model for Improvement focuses on three questions, Langley et al. (2009) state:

- What are we trying to accomplish?
- How will we know that a change is an improvement?
- What changes can we make that will result in an improvement? (p. 24).

Synthesis of the evidence guides interventions and measurements to focus on addressing the clinical problem. The Model for Improvement brings key tactics to support planning for the test of change, using driver diagrams, plan-do-study-act cycles (PDSA), and data tracking to evaluate if the improvements have made the intended outcome (Langley et al., 2009).

Application of The Model for Improvement

The Iowa Model provides phases for the evidence-based practice change. After the synthesis of the evidence, interventions to address the clinical problem are established to begin piloting the practice change. The Model for Improvement included a driver diagram that will inform the project's overall structure. The driver diagram included a global aim, smart aim, and intended population, followed by drivers and interventions needed to implement the change successfully. The driver diagram functions as a tool that organizes the project and theory for improvement during testing and is frequently updated (Langley et al., 2009). The driver diagram includes a detailed description of the outcome measurement. The DNP student designed the driver diagram, including the outcome measurement, to reflect the practice change of improving ACA reliability within emergency services and shared to key stakeholders within the project team. The measurement for the smart aim is to increase the proportion of levels of reliability level in ACA action plans from a level 1 reliability to a level 2 reliability or higher by 50% by March 2023.

The Model for Improvement includes methods to evaluate data and variation (Langley et al., 2009). A run chart measured the baseline ACA action plan strength and annotated as interventions from the driver diagram were tested. The run chart provided an evaluation method to determine how the interventions have improved reliability in ACA action plans over time.

The PDSA cycle is one of the key components of the Model for Improvement and completes the overall framework turning the proposed interventions into actionable items (Langley et al., 2009). The Institute for Healthcare Improvement (2017) describes that PDSA cycles provide a tool to document the test of change. The PDSA cycle comprises four interrelated steps to test the improvement and can be used multiple times as a cycle or as adjacent ramps that test different interventions (Langley et al., 2009). To improve action plan reliability, the PDSA cycle was used to evaluate the interventions tested. Moving to the next phase of the PDSA cycle, the interventions were tested in the specified environment, including documentation of any observations, such as barriers. The study portion evaluated if specific interventions to increase ACA reliability have improved by following the data and summarizing the test outcomes. Finally, the last phase of the PDSA cycle determines if the interventions should be acted upon, usually framed as adopted, adapted, or abandoned (Institute for Healthcare Improvement, 2017). Appendix D provides a visual of how the Model for Improvement is applied to the project to increase the reliability of ACA action plans.

Project Plan

The DNP project purpose is to implement an evidence-based, quality improvement project to increase levels of reliability in ACA action plans. The project aimed for improvements to a specific department, involving key stakeholders, and within a specified timeframe. This project incorporated the published evidence, the Iowa Model, and the Model for Improvement to test interventions and measure outcomes.

Population

All ACA action plans within the project's site emergency department addressed safety improvements towards the patient population served. Action plans were completed with identified staff members and leaders of the department to ensure corrective action. ACAs are a method to perform a causal analysis and are more limited in scope and resources compared to an RCA (Parikh et al., 2020). For this project, RCA analysis will be excluded from the interventions and measurements as the clinical concern is increasing levels of reliability for ACAs to prevent the reoccurrence of patient safety events. ACAs can be requested by the risk management or safety department if any event or near miss meets the criteria defined by the organization. In addition, area or divisional leaders can opt to conduct an ACA based on their initial review following an event or near miss. For the project, interventions will begin on all ACAs action plans within the emergency service department from September 2023 through March 31st, 2024.

Setting

The setting for the project is the emergency service department of a level 1 pediatric trauma center with over 700 beds in a large, urban Midwest city. The emergency service department has two separate locations**,** totaling over 63 pediatric emergency rooms. ACAs conducted within the department include oversight from the nursing clinical directors, managers, and physician leaders to ensure ACA completion and interventions in the action plan.

Project Aim and Outcome

The DNP project aimed to increase the levels of reliability in ACA action plans within the emergency service department from level 1 to level 2 or higher by March 31st, 2024 to prevent the reoccurrence of patient safety events. This included a process outcome measurement to increase the levels of reliability (LOR) score in ACA action plans from a LOR 1 to LOR 2 or higher by March 31st, 2024. The process outcome measurement was analyzed during the project timeframe as interventions were implemented. Following the Model for Improvement, this determined if the interventions made the intended improvement (Langley et al., 2009). The overall patient outcome goal, preventing the reoccurrence of patient safety events, is a long-term measure outside the timeframe of the DNP project.

Interventions

To increase reliability of ACA action plans, a bundled approach of interventions occurred. Three main interventions include facilitated team ACA analysis, utilizing an internal level of reliability toolkit to build interventions, and scoring each action item based on levels of reliability.

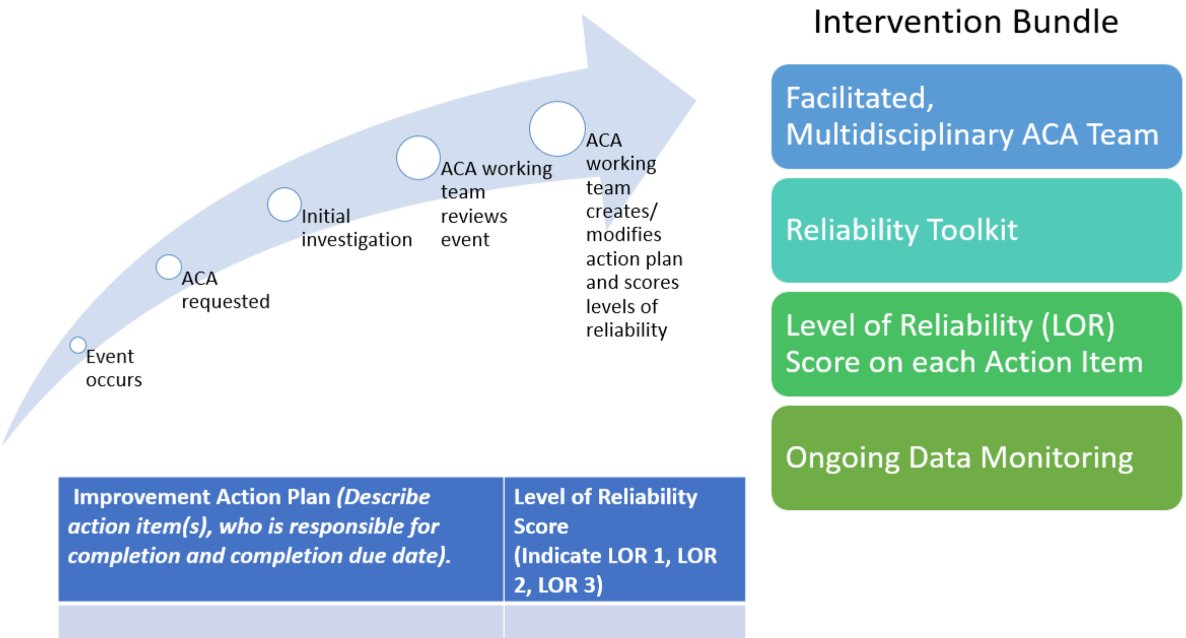
The purpose of facilitated ACA meetings is to bring key stakeholders, safety consultants, and quality improvement support to the causal analysis to formulate interventions that provide correction and prevent harm reoccurrence within the system. Parikh et al. (2020) describe the guiding principle of facilitated ACAs is not to focus solely on the errors, but rather on the solutions to prevent harm. In addition, core elements of facilitated ACAs include the right team, analysis, and action (Parikh et al., 2020). Crandall et al. (2017) describe that ACA stakeholders include clinical experts who work within the event setting. In current practice, RCAs within the organization have a standard, facilitated approach with support and resources assigned during the cause analysis and in action plan creation. However, this was not current practice for ACAs at the project site and was a recommended practice change for the DNP project.

To operationalize the interventions, the Iowa Model and the Model for Improvement guided the interventions. The emergency service department established a team in September 2023 to evaluate all ACAs. To conduct facilitated ACAs, the group expanded to include a safety consultant, risk manager, physician leaders, nursing directors, and managers from emergency services to meet weekly for one hour to review events and action plan creation. The safety consultant evaluated and tracked all ACAs requested. Prior to the meeting, clinical leaders who received the request for an ACA investigated to collect the facts of the event and any learnings. During the meeting, one to two ACAs were evaluated, facilitated by the director of quality improvement and safety within emergency services and the safety consultant assigned to the site of care. The meeting was structured to include 15 to 30 minutes of event analysis followed by action planning.

Action plans within the ACA document included scoring using a level of reliability toolkit during the facilitated ACA meeting (Cincinnati Children's Hospital Medical Center, 2004). The toolkit was presented at the beginning of the intervention phase for all members of the ACA team to review. The safety and quality consultant presented the reliability concepts outlined in the toolkit to the ACA working team. This ongoing education utilized a team-based learning approach as the toolkit was available at each ACA working team meeting. The safety and quality improvement consultant provided the toolkit for reference, scoring, and tracking each action item during the ACA team meetings. If all action items planned in the ACA fell within a LOR of 1, the safety consultant supported the project team to formulate action items of a LOR 2 or higher following the level of reliability toolkit example. Figure 1 provides a visualization of the ACA working team process and intervention bundle.

Figure 1

Visual of Implementation Bundle

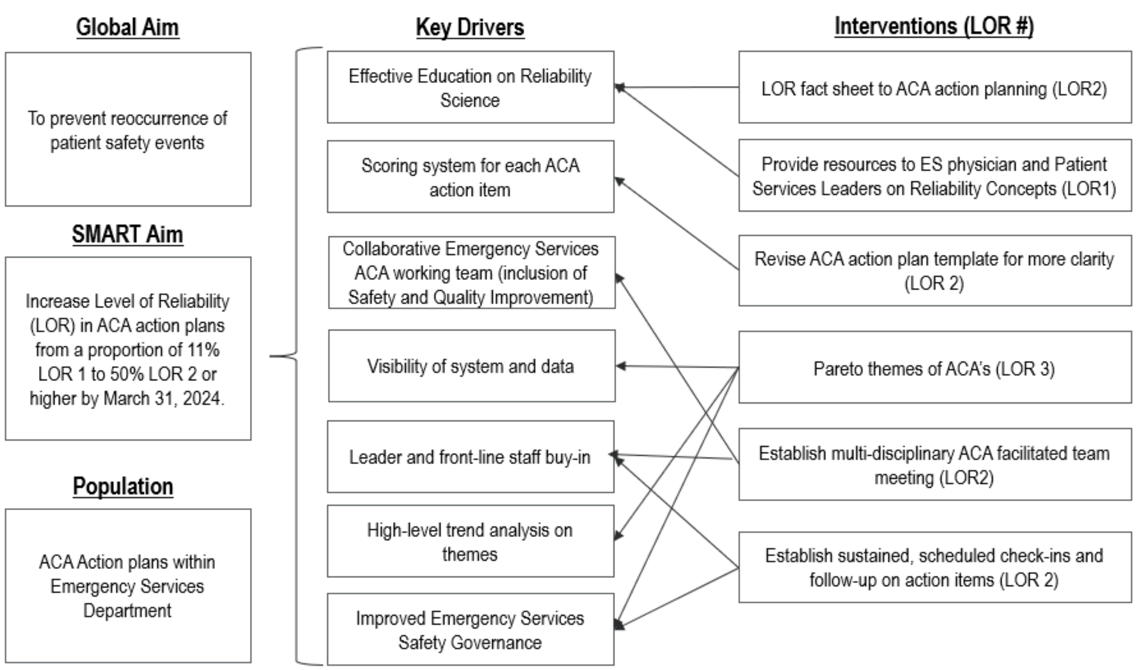


The level of reliability toolkit gives specific examples of interventions associated with the level of reliability (Cincinnati Children's Hospital Medical Center, 2004). For example, interventions attributed to level 1 reliability include training, general awareness, basic standardization, memory aids, and feedback mechanisms (Cincinnati Children's Hospital Medical Center, 2004). Level 2 interventions focus on intentional redundancy, decision aids, scheduling of key tasks, real-time identification of failures, and standardization of essential tasks (Cincinnati Children's Hospital Medical Center, 2004). Finally, level 3 interventions follow HRO theory principles (Weick & Sutcliffe, 2007) and also include making the system visible and clear, unambiguous communication techniques (Cincinnati Children's Hospital Medical Center, 2004). Over time, themes from the ACAs will be tracked to support system-level visibility internal to the project site. The collection of these themes is an important indicator to trend overall improvements, although the themes were not outlined in the DNP paper given the timeline of interventions.

The interventions were piloted and evaluated within the DNP project setting. The safety and quality improvement consultants created a key driver diagram following the Model for Improvement (Langley et al., 2009) to guide the plan, track, and document PDSA cycles for rapid learning. A run chart measured the level of reliability score proportion for each action plan, annotated as interventions were applied between September 2023 and March 2024. In addition, a Pareto chart counted the number of scored ACA action items that fall within level one, two, or three reliability before and after interventions. See Figure 2 for details of the key driver diagram and the application to the overall project aim.

Figure 2

Key Driver Diagram



Note. Key driver diagram to improve ACA action plan reliability. Adapted from: "Key Driver Diagram" by James M. Anderson Center for Healthcare Excellence, n.d., Cincinnati Children's

Hospital Medical Center. Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

Strategic Planning

Planning strategies for the DNP project included ethical considerations, collaboration with key stakeholders, and driving and restraining forces that impacted the project's success. The following sections outline the details and methods for the project's strategic planning.

Ethical Considerations

The DNP's project's interventions and data collection methods have ethical considerations before implementation. The DNP student completed an online Protecting Human Research Participants course before project implementation. In addition, a Human Subject Determination form was completed and submitted to the internal review board (IRB) chair at Mount St. Joseph University to determine if the project was human subject's research under the United States Department of Health and Human Services (DHHS) regulatory definition. The IRB chair determined that the project was not human research per the definition and did not require submission to the IRB. The project is considered evidence-based quality improvement and does not contribute to generalizable knowledge. In addition, the project proposal was submitted though the project's site internal IRB review board and determined not to be human subjects research.

The DNP project was approved through the project's site Center for Professional Excellence, in compliance with policy for student projects. Signed approval was obtained by the patient safety and regulatory director, vice president and assistant vice president of nursing, and Mount St. Joseph faculty advisor. ACAs were reviewed through the project setting's organizational policy and at the project site to protect patient health information and only accessible to the ACA review team members as per current practice. Only the reliability score of each action item is shared, not event details, action plan details, or dates during external dissemination. High-level ACA themes will continue to be monitored internally as quality improvement opportunities and not disseminated within the DNP project.

Stakeholders

Collaboration with stakeholders is essential for project success and completion. The emergency services stakeholders included the director of quality and safety for emergency services, the vice president and assistant vice president of nursing for emergency services, nursing clinical directors and managers, the associate chief of staff, and medical directors for all the emergency service locations. Resource stakeholders supporting the work include a safety consultant and a quality improvement consultant. Macrosystem stakeholders include the chief safety officer, patient safety and regulatory director, and risk management.

Key stakeholders involved the working team reviewing and scoring the reliability of action plans for the ACAs. The members included the director of quality and safety for emergency services, assistant vice president, nursing directors and managers, associate chief of staff, medical director, risk management, safety consultant, and quality improvement consultant. The safety consultant has joined established working meetings with the emergency services key stakeholders to evaluate ACA processes, themes, and action planning. In addition, the safety consultant attended several meetings to begin project planning and socializing the evidence findings and proposed interventions amongst the nursing clinical directors and a quality improvement specialist who agreed with the project goal of improved action planning from ACAs.

Driving and Restraining Forces

A force field analysis was drafted to determine forces impacting the overall project. A force field analysis is a tool to assist in identifying potential driving forces that help support the project and any restraining forces that may impact success (Moran et al., 2020). After identifying these forces, potential actions to address any restraining forces were drafted. See Figure 3 for details of the force field analysis created for the DNP project and interventions.

Figure 3

Force Field Analysis

Force Field Analysis			
	Forces		
Interventions	**Driving Forces (For)** →	**Restraining (Against)** ←	**Action To Be Taken**
Facilitated ACA	Ongoing ACA evaluations.	Potential for lack of ACAs.	Plan for action plan reviews if lack of ACAs and to engage sustainment of interventions.
	Weekly meetings established.	Not enough team members present for facilitated ACAs due to scheduling.	Monitor closely team attendance and revise timing of meetings if needed.
	Organization, project support from safety consultant	Meetings may not meet objective on finishing ACA action plans.	Clear agendas to what ACAs may be reviewed and timeframe.
Level of reliability scoring for each ACA action item.	Reliability toolkit available through the organization as a standard.	Not every team member may agree on the scoring.	Quality support and safety support as third parties to score levels of reliability during the meeting for team approval.
Level of reliability toolkit to advise type of interventions.	Safety consultant support endorsed by team as needed for action plan advisement.	Some interventions may not meet the design concepts on the toolkit.	Change concept fact sheet brought in addition to help supplement and generate intervention plans.
	Endorsement from group to make action plans more reliable.	Lack of action plans proposed from ACA findings.	Support and direction from sponsors and safety consultant of the team to assist in creating appropriate interventions.

Note. Adapted from: *The doctor of nursing practice project: A framework for success* (p. 327), by K. Moran, 2020, Jones & Bartlett Learning.

Budget

The World Health Organization (2023) estimates globally that one in every ten patients is harmed. Common causes of patient harm include medication errors, surgical errors, healthcare-associated infections, sepsis, diagnostic errors, patient falls, misidentification of patients, venous thromboembolism, unsafe transfusion practices, and unsafe injections (World

Health Organization, 2023). The monetary cost of patient harm globally is estimated to amount to trillions of dollars each year (World Health Organization, 2023).

A driving force in the force field analysis for the DNP project is that established weekly meetings with key stakeholders are in place to discuss ACAs. Support resources such as quality improvement and safety consultant personnel are assigned to the site of care to offer expert guidance. Over the course of the intervention, approximately 30 minutes of the scheduled, facilitated ACA meetings will include action plan evaluation and reliability scoring, which is added time to the team and impacts human resources costs. In addition, personnel costs including baseline data evaluation, education delivery, and ongoing data collection require time and human resources for successful implementation of the project. A budget plan was formulated to reflect the personnel costs of the project measured in hours to estimate human resource time of the ACA working team members. Appendix E outlines the budget plan for the DNP project.

Consideration must also be taken of the cost and time required to implement more reliable interventions through quality improvement initiatives. The goal of the project is to increase the level of reliability in ACA action plans. Moving from action items of lower reliability such as training and awareness to more robust action items rooted in human factors and reliability science will require additional personnel time and other resources impacting cost. As each ACA action plan is different and depending on the event, an estimated cost cannot be calculated and is not included in the budget plan.

Final Project Timeline

The DNP project’s timeline comprises four main phases: planning, implementation, evaluation, and dissemination. The high-level timeline includes phases from February 1, 2023, through March 31, 2024. The planning phase incorporates major milestones to begin the preparation for the project, including identification of the problem, PICO question, and evidence search and synthesis. As detailed previously, an evidence-based model and theoretical framework was identified to guide the project and was included in the planning phase. Faculty and project expert approval, IRB training, submission, and approval, and forming the project team with ongoing meetings was also included in this phase. These specific milestones will occur from February through April 2023.

The subsequent phases of the DNP project implementation and evaluation occur between September 2023 and March 2024. This phase involves implementing the interventions outlined, including measuring baseline data, PDSA cycle testing, data collection, evaluation of interventions, and updating the key driver diagram if indicated. The evaluation included reviewing the data to determine if an improvement was made based upon the interventions, general learnings, and feedback. A sustainment plan from the implementation was formulated following the Model for Improvement.

The dissemination phase, mirroring the Iowa Model, includes both internal and external sharing (Iowa Model Collaborative, 2017). The high-level timeline was between March and April 2024. The dissemination phase offers an opportunity to spread findings and interventions to other sites within the organization if indicated. Dissemination is valuable as the organization of the project's setting conducts ACAs and creates action plans. Safety, risk leadership, and macrosystem key stakeholders were presented with findings. In addition, dissemination includes external sharing as the final DNP project paper to be published on the Ohio Link Electronic Thesis and Dissertation website and presented to the University final DNP recorded presentation. See Appendix F for a detailed timeline.

Data Analysis and Results

The Model for Improvement outlines that measurements are needed to determine if a change results from an intervention (Langley et al., 2009). During and after the implementation phase, ongoing measurements were established to understand if the tested interventions resulted in a change. The project aims to increase the proportion of ACA action plans from a level 1 to a level 2 or higher reliability by March 2024.

Outcome Measures

To evaluate the project aim, the process-focused outcome measurement included the level of reliability score of each ACA action plan intervention for emergency services. The reliability scoring was assigned to each action item following the established reliability toolkit (Cincinnati Children's Hospital Medical Center, 2004). This included baseline reliability measurement prior to project implementation and through the intervention and evaluation phase between September 2023 and March 2024. The denominator includes all ACA action items within emergency services during the timeframe.

Data Collection, Tools, Analysis, and Visualization

The safety consultant gathered data through the implementation and evaluation phase of the DNP project. Three data charts, including a proportion chart and two Pareto charts were used to visualize the data gathered, with each data point representing each ACA action item reliability scoring. The collection and organization of the reliability scores were de-identified of any descriptors regarding patient information or event type.

For baseline measurement of ACA action plans, the quality improvement and safety consultant evaluated each past ACA action item from emergency services at a specific start date and scored a level of reliability. The reliability toolkit was used as a reference to score each action item independently among the two members, with a plan to escalate to a third party for determination of scoring if disagreement on the level of reliability occurred. The safety consultant and quality improvement consultant received internal reliability and quality improvement training as part of orientation and before measuring the baseline data. The baseline data was entered into a proportion chart, establishing the numerator as the number of action items that have scored a level 2 or higher and the denominator as the total number of action items in each ACA. The data displayed on the Y axis identifies the percentage to track the data towards the improvement goal, followed by the X axis showing the units of measurement with an arrow in the top right-hand corner to indicate the desired direction of change. A red bar on the chart shows the median point to determine if special cause variation occurred as a result of the interventions. The baseline data was presented to the project team for evaluation and discussion of the project's goals during the beginning of the implementation phase and ongoing throughout the project. Per the organization's guidelines, specific event or action plan dates were not listed on the X axis for external dissemination; however, the total numbers will be visible.

During the implementation and evaluation phase, the safety consultant updated the data charts following each facilitated ACA meeting, where the project team discussed ACAs and assigned reliability scoring for each action item. The two Pareto charts used the same data points gathered by the proportion chart to aid in visualizing the data pre-intervention and post-intervention. The total counted numbers of ACA action items scored level 1, 2, or 3 are displayed on the X axis of the Pareto chart, and the Y axis captures the category percentages of all counted items. It is important to note that one ACA may have multiple action items; thus, the total counted numbers only reflect the cumulative number of action items from all ACAs during the DNP project.

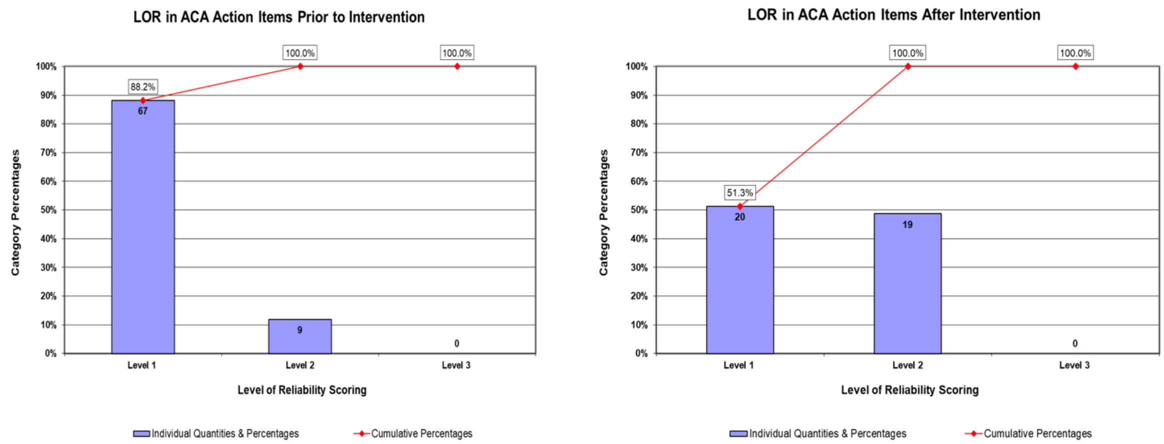
Results

The DNP project aimed to improve the reliability of ACA action plans within emergency services at the DNP project site. The outcome measure was to increase the proportion of ACA action items from a level 1 to a level 2 or higher reliability to 50% by March 2024. During the implementation phase, a bundled approach of interventions were implemented, including facilitated multidisciplinary meetings, a reliability toolkit, and reliability scoring of each action item with the overall aim to improve patient safety.

A total of 115 action items were scored levels of reliability during the DNP project. Baseline data compiled before implementation of interventions totaled 76 action items, with 67 action items scored at level 1 reliability and nine scored at level 2 reliability. This resulted in a baseline measurement of 11% of ACA action plans pre-intervention, scoring a level 2 reliability. A total of 39 ACA action items were evaluated during the implementation phase as the project team started the bundled interventions. Twenty ACA action items evaluated were scored at a level 1 reliability and 19 action items scored a level 2 reliability. After implementing the interventions, the proportion of action items scored level 2 reliability increased from 11% to 46%. See Figures 4 and 5 for the ACA action item level of reliability (LOR) scoring results.

Figure 4

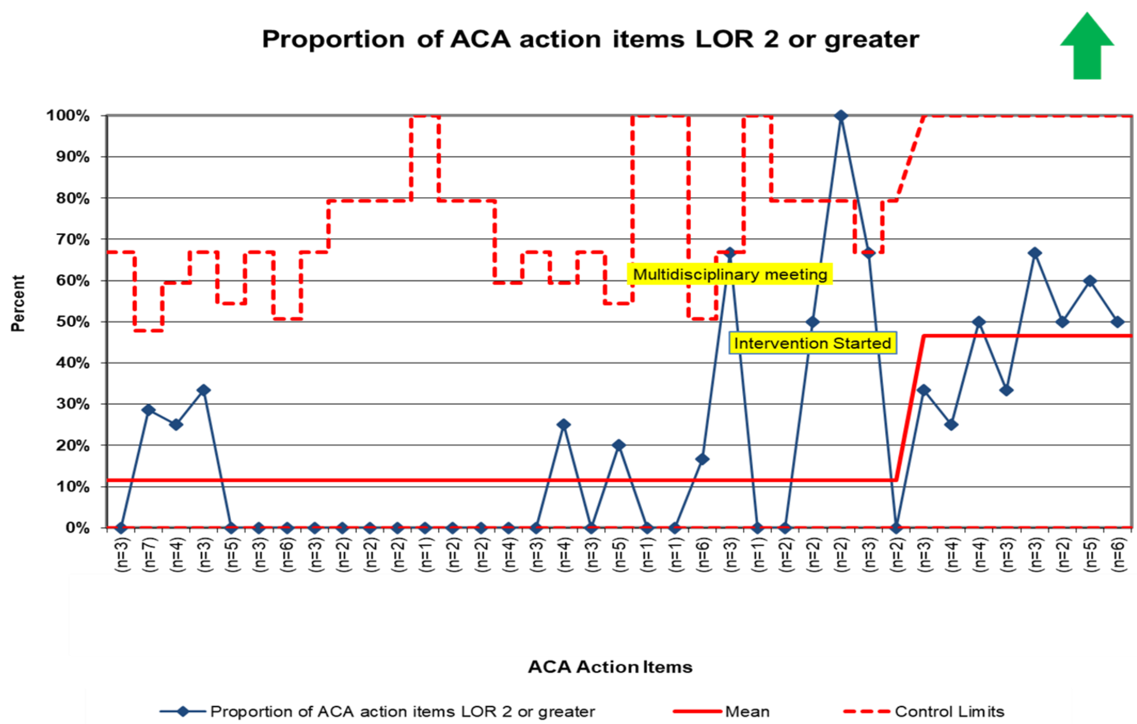
Level of Reliability Scoring in ACA Action Items.



Note. Pareto charts of ACA action item reliability scoring before and after interventions.

Figure 5

Proportion of ACA Action Items LOR 2 or Greater



Note. Proportion chart of ACA action items scored level 2 reliability or higher during the DNP project.

Significance, Implications, and Limitations

The results of the DNP project have significance in improving ACA review processes, patient outcomes, implications for the project site, and limitations to consider. The interventions implemented, data collected, and stakeholder feedback provide an evaluation to assess the project's achievements, opportunities for improvement, and future planning.

Significance

Results from the data collection show an overall improvement in the reliability scoring of ACA action items at the DNP project site. The global aim of the DNP project is to prevent the reoccurrence of patient safety events by increasing the level of reliability of interventions in ACA action plans. However, the global measure is outside the DNP project timeline and will be monitored by the DNP project site for ongoing evaluation. As shown in Figure 4, the majority of action items scored at a level 1 reliability prior to the intervention. As the intervention bundle was implemented, there was a marked improvement in the proportion of ACA action items scored a level 2 reliability or higher, from 11% to 46%, as outlined in Figure 5. The SMART aim of the DNP project was to increase the proportion of ACA action items that scored level 2 reliability or higher to 50%. The results show that this measure was not achieved, although significant improvement was made. Continued data monitoring by the project team is essential to ensure ongoing improvements.

The project team improved the overall efficiency of the process throughout the phases of the DNP project. The project team moved from a weekly to a bi-weekly meeting throughout the evaluation phase. Many ACA action items were already completed by the ACA authors prior to the multidisciplinary meeting, allowing for more ACAs to be reviewed by the team and scored levels of reliability. In some cases, the project team would invite ad hoc members internal to the organization to provide clinical expertise dependent upon the case reviewed. This was planned by the safety consultant and project team leaders, resulting in increased collaboration of action items that spanned outside of the emergency services department. During the facilitated, multidisciplinary meetings, the project team reviewed each ACA and revised, if indicated, the action plans in collaboration with the ACA authors. This intervention and reference to the toolkit improved the reliability scoring of ACA action plans overall. The implementation and evaluation phase goals were met within the DNP project timeline and budget plan.

Implications

The DNP project has further implications for healthcare systems in creating reliable interventions from ACA action plans. Veazie et al. (2022) reviewed how organizations adopt high-reliability organization (HRO) principles to improve safety culture and patient safety, finding that leadership development, support of safety culture, training, data systems, and implementation of improvement activities were common strategies. The DNP project integrated the HRO principles of preoccupation with failure, reluctance to simplify, and deference to expertise (Weick & Sutcliffe, 2007). The overall goal of performing causal analysis on patient safety events or near misses is to ensure an action plan is implemented to address system gaps and prevent reoccurrence. Although much of the evidence discusses the strength of action plans in RCAs, ACAs are conducted more frequently within the project site. Crandall et al. (2017) specifically addressed the reliability of ACA action plans using a high-reliability toolkit, reliability scoring of action items by the safety team, and revision, if needed, of action plans by to improve reliability. The evidence synthesized provided inspiration to trial a similar strategy within the DNP project site. There are opportunities within the DNP project site to share the findings for adaption or adoption with other care sites outside of emergency services. This recommendation for internal dissemination to other departments will be shared with the organization's safety officer and safety team.

Stakeholders of the DNP project reported overall satisfaction with the evidence-based interventions to improve the reliability of ACA interventions. Comments included that the multidisciplinary team was valued for achieving the goals of the work, improving teamwork, and visibility of safety trends across the mesosystem. Stakeholders valued the high-reliability tooklit used in the intervention bundle as a guide to create more reliable interventions. Dedicated risk and safety expertise amongst the team was attributed to successful work implementation and data tracking implementation. Stakeholders also stated satisfaction in reviewing the implementation and sustainment of completed action items across emergency services.

Limitations

There are limitations to consider in the review of the DNP project. There was occasional subjectivity to interpreting the internal high-reliability toolkit used during the DNP project. Items within the toolkit are identified separately; however, project team members may have different interpretations of level or reliability scoring. Any different interpretations were resolved during the multidisciplinary meetings. Another limitation is the lower number of action items for data collection post-intervention during the DNP project timeline. Longer-term data monitoring would collect a larger sample to evaluate if the process and outcome goals were achieved. To assess if the increase in reliability of ACA interventions prevented the reoccurrence of patient safety events, ongoing monitoring outside the timeline of the DNP project will need to be completed. The intervention bundle scoped across all care sites within the organization could capture a larger sample size for analysis and outcome measurement.

Project Future

The high-level timeline of the DNP project included project planning, implementation, evaluation, and dissemination phases. Each of these phases outlined in Appendix G included project goals such as evidence-based search and synthesis, project design, baseline data measurement, implementation of the interventions, evaluation and adaptation, and dissemination. The results of the DNP project showed an overall improvement of the interventions to improve the reliability of ACA interventions; therefore future planning of the project must be considered.

Sustainability

The emergency services department has adopted the facilitated, multidisciplinary ACA meetings, toolkit, and scoring levels of reliability for ACA action plans. The project team has added an evaluation process to hold sustain meetings with past ACA authors to receive updates on implementing each action item. This action also provides an opportunity to discuss if any barriers to implementing those actions exist and discuss a mitigation strategy by key leaders within the department. Ongoing data measurements will be collected by the project team, including proportion and Pareto charts to monitor levels of reliability in ACA interventions. To achieve sustainability of improvements, continued stakeholder support and personnel is needed, including safety and risk consultants to continue facilitated, multidisciplinary ACA meetings, high-reliability toolkit reference, scoring levels of reliability, and ongoing data monitoring.

The DNP project focuses on optimizing the reliability of ACA interventions. Causal analysis, such as RCA and ACAs, focuses on learning from incidents in healthcare and is often referred to as a Safety I approach, in that they are reactive and based on a traditional safety paradigm (Sujan et al., 2017). The DNP project site has focused on moving towards a proactive safety approach in addition to the traditional case review. ACA analysis is a retrospective case review with action plans crafted to prevent reoccurrence. Sujan et al. (2017) promote that healthcare organizations must consider that processes put in place can be variable to understand the difference between work as designed versus work-as-done shifting towards a Safety II perspective. Future considerations for ACA action plans can include evaluation to understand how processes are executed in the environment of care, learning from staff on best practices to that process, and creating action to reflect improvements.

Dissemination

Following the Iowa Model, dissemination of results is the last phase of the framework to implement evidence-based practice change (Iowa Model Collaborative, 2017). The results of the DNP project have been shared with the sponsors, project team, safety officer, and safety team. The safety team will evaluate for adoption with key stakeholders within the other sites of care of the organization. The final DNP project paper will be published on the Ohio Link Electronic Thesis and Dissertation website and presented in April 2024 in an event hosted by the university. In addition, consideration will be given to submit for publication in the Pediatric Quality & Safety journal as ongoing data is collected and the spread of the intervention bundle is implemented. The *Pediatric Quality & Safety* journal is a peer-reviewed, open-access periodical that focuses on safety and quality improvement activities and publishes various topics for the pediatric population (Wolters Kluwer Health Inc., 2024). The journal's scope and audience is relevant to the DNP project topic and approach to improving patient safety.

Summary and Conclusion

The purpose of the DNP project was to implement an evidence-based quality improvement project to increase the levels of reliability in ACA interventions. The intervention bundle included establishing a facilitated, multidisciplinary team in emergency services to review all ACAs, reference an internal high-reliability toolkit, and score levels of reliability to each ACA action item. The improvement results increased the proportion of ACA action plans scoring a level of reliability 2 or higher from 11% to 46% within the DNP project site. The overall global aim is to create more reliable ACA action plans to prevent the reoccurrence of patient safety events. Ongoing data monitoring from the project site will be needed to monitor the success of reaching the global aim.

The DNP project improved ACA action plans to improve patient safety. Stakeholder feedback showed strong support for the facilitation of multidisciplinary meetings and the availability of the internal high-reliability toolkit to create more reliable action items to prevent the reoccurrence of events. The bundled interventions of the DNP project are applicable to consider spread within the project site to improve patient safety. The future project includes spreading considerations across the organization and disseminating them to stakeholders within other care sites. In addition, key sustainment meetings to ensure the implemented action plans are essential to the ongoing foundational priority of safe patient care delivery.

References

Auschra, C., Asaad, E., Sydow, J., & Hinkelmann, J. (2022). Interventions into reliability-seeking health care organizations: A systematic review of their goals and measuring methods. *Journal of Patient Safety*, *18*(8), e1211–e1218. https://doi.org/10.1097/PTS.0000000000001059

Brilli, R. J., McClead, R. E., Jr., Crandall, W. V., Stovecrock, L., Berry, J. C., Wheeler, T. A., & Davis, J. T. (2013). A comprehensive safety program can significantly reduce preventable harm, associated costs, and hospital mortality. *The Journal of Pediatrics*, *163*(6), 1222. https://doi.org/10.1016/j.peds.2013.06.031

Cincinnati Children's Hospital Medical Center. (n.d.). *Becoming a high reliability organization*. James M. Anderson Center for Health Systems Excellence. https://www.cincinnatichildrens.org/research/divisions/j/anderson-center/safety/methodology/high-reliability

Cincinnati Children's Hospital Medical Center. (2004). *Reliability Design Concepts* [Fact sheet]. James M. Anderson Center for Health Systems Excellence.

Crandall, K. M., Sten, M.-B., Almuhanna, A., Fahey, L., & Shah, R. K. (2017). Improving apparent cause analysis reliability: A quality improvement initiative. *Pediatric Quality & Safety*, *2*(3), e025. https://doi.org/10.1097/pq9.0000000000000025

Cropper, D. P., Harb, N. H., Said, P. A., Lemke, J. H., & Shammas, N. W. (2018). Implementation of a patient safety program at a tertiary health system: A longitudinal analysis of interventions and serious safety events. *Journal of Healthcare Risk Management*, *37*(4), 17–24. https://doi.org/10.1002/jhrm.21319

Hettinger, A. Z., Fairbanks, R. J., Hedge, S., Rackoff, A. S., Wreathall, J., Lewis, V. L., Bisantz, A. M., & Wears, R. L. (2013). An evidence-based toolkit for the development of effective and sustainable root cause analysis system safety solutions. *Journal of Healthcare Risk Management*, *33*(2), 11–20. https://doi.org/10.1002/jhrm.21122

Hillard, M. A., Sczudio, R., Scafidi, L., Cady, R., Villard, A., & Shah, R. (2012). Our journey to zero: Reducing serious safety events by over 70% through high-reliability techniques and workforce engagement. *Journal of Healthcare Risk Management*, *32*(2), 4–18. https://doi.org/10.1002/jhrm.2109

Institute for Healthcare Improvement. (2017). *The plan-do-study-act (PDSA) worksheet*. https://www.ihi.org/resources/Pages/Tools/PlanDoStudyActWorksheet.aspx

Institute of Medicine (US) Committee on Quality of Health Care in America. (2000). *To err is human: Building a safer health system* (L. T. Kohn, J. M. Corrigan, & M. S. Donaldson, Eds.). National Academies Press.

Iowa Model Collaborative. (2017). Iowa Model of evidence-based practice: Revisions and validation. *Worldviews on Evidence-Based Nursing*, *14*(3), 175–182. https://doi.org/10.1111/wvn.12223

James M. Anderson Center for Healthcare Excellence. (n.d.). *Key driver diagram* [Fact sheet]. Cincinnati Children's Hospital Medical Center.

Karkhanis, A. J., & Thomson, J. M. (2021). Improving the effectiveness of root cause analysis in hospitals. *Hospital Topics*, *99*(1), 1–14. https://doi.org/10.1080/00186868.2020.1824137

Kellogg, K. M., Hettinger, Z., Shah, M., Wears, R. L., Sellers, C. R., Squires, M., & Fairbanks, R. J. (2017). Our current approach to root cause analysis: Is it contributing to our failure to improve patient safety? *BMJ Quality & Safety*, *26*(5), 381–387. https://doi.org/10.1136/bmjqs-2016-005991

Langley, G. J., Moen, R. D., Nolan, K. M., Nolan, T. W., Norman, C. L., & Provost, L. P. (2009). *The improvement guide* (2nd ed.). Jossey Bass Wiley.

Melnyk, B., & Fineout-Overholt, E. (2019). *Evidence-based practice in nursing and healthcare: A guide to best practice* (4th ed.). Wolters Kluwer.

Moran, K., Burson, R., & Conrad, D. (2020). *The doctor of nursing practice project: A framework for success* (3rd ed.). Jones & Bartlett Learning.

Morse, R. B., & Pollack, M. M. (2012). Root cause analysis performed in a children's hospital: Events, action plan strength, and implementation rates. *Journal for Healthcare Quality: Official Publication of the National Association for Healthcare Quality*, *34*(1), 56–61. https://doi.org/10.1111/j.1945-1474.2011.00140.x

Muething, S. E., Goudie, A., Schoettker, P. J., Donnelly, L. F., Goodfriend, M. A., Bracke, T. M., Brady, P. W., Wheeler, D. S., Anderson, J. M., & Kotagal, U. R. (2012). Quality improvement initiative to reduce serious safety events and improve patient safety culture. *Pediatrics*, *130*(2), e423–e431. https://doi.org/10.1542/peds.2011-3566

Nolan, T., Resar, R., Haraden, C., & Griffin, F. A. (2004). *Improving the reliability of health care. IHI Innovation Series* [White paper]. Boston: Institute for Healthcare Improvement.

Parikh, H., Hochberg, E., Cheng, J. J., Lavette, L. B., Merkeley, K., Fahey, L., & Shah, R. (2020). Apparent cause analysis: A safety tool. *Pediatrics*, *145*(5). https://doi.org/10.1542/peds.2019-1819

Polit, D. F., & Beck, C. T. (2017). *Nursing research: Generating and assessing evidence for nursing practice* (10th ed.). Wolters Kluwer.

Schaffer, M. A., Sandau, K. E., & Diedrick, L. (2012). Evidence-based models for organizational change: Overview and practical applications. *Journal of Advanced Nursing*, *69*(5), 1197–1209. https://doi.org/10.1111/j.136502648.2012.06122.x

Sujan, M. A., Huang, H., Braithwaite, J. (2017). Learning from incidents in healthcare: Critique from a Safety-II perspective. *Safety Science, 99*, 115-121. https://doi.org/10.1016/j.ssci.2016.08.005

Veazie, S., Peterson, K., Bourne, D., Anderson, J., Damschroder, L., & Gunnar, W. (2022). Implementing high-reliability organization principles into practice: A rapid evidence review. *Journal of Patient Safety*, *18*(1), e320–e328. https://doi.org/10.1097/PTS.0000000000000768

Weick, K., & Sutcliffe, K. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty*. Jossey Bass.

Wolters Kluwer Health Inc. (2024). *Aim and scope.* https://journals.lww.com/pqs/Pages/aboutthejournal.aspx

World Health Organization. (2023, September 11). *Patient safety*. http://www.who.int/news-room/fact-sheets/detail/patient-safety#

Appendix A

Search Strategy

Search Terms	PUB Med	CINAHL	Medline with full text
“Patient safety event analysis“ AND ”high reliability“ AND ”prevention OR reduction OR minimize“	40 2 relevant	24 Relevant 6	2 Relevant 0
“Apparent Cause Analysis” AND “reliability”	5 (2 duplicate) Relevant 3	1 (removed for duplication)	2 Relevant 2
“Apparent cause analysis” reliability interventions	0	1 duplication	
“Root cause analysis” AND “reliability of interventions or solutions” AND “prevention or reduction or minimize”		27 Relevant 2	39

Note. Total number of hits = 141. Total number of relevant hits = 15. Four removed after rapid critical appraisal.

Appendix B

Evidence Synthesis Table

Citation: Author, Date of Publication, & Title	Purpose of Study	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables Studied and Their Definitions	Measurement of Major Variables	Data Analysis	Study Findings	Worth to Practice: LOE Strengths/Weaknesses Feasibility Conclusion RECOMMENDATION
Auschra, C., 2022, Interventions into reliability-seeking health care organizations: A systematic review of their goals and measuring methods.	Explore goals on which interventi ons focus to increase reliability. 2. Explore measurem ent of goals and reliability	Atheorectical	Systematic Review	8896 articles, 75 met inclusion criteria	DV1= Studies that have goals to increase reliability within healthcare DV2=Studies including measurement of high reliability	DV1=n of studies reviewed DV2= n of studies reviewed	Thematic analysis of overarching themes from studies	DV1= 65 studies focus on safety goals, 23 effectiveness DV2= 58 studies use quantitative measurement, 7 qualitative	• **Level of evidence** (LOE) Systematic Review LOE 1 • **Strengths and limitations** Reviewed articles over two decades in inclusion criteria, identified patient safety goals and quantitative measurements as primary functions to address reliability. Limitations include definitions or words- “effectiveness” “reliability” “quality”. • **Risk or harm** Low Risk • **Feasibility** Moderate • **Conclusion**: Review found multifaceted approach in how healthcare addressed reliability, even when following the same theory. Many studies do not have a consensus of levels of

Citation: Author, Date of Publication, & Title	**Purpose of Study**	**Conceptual Framework**	**Design/ Method**	**Sample/ Setting**	**Major Variables Studied and Their Definitions**	**Measurement of Major Variables**	**Data Analysis**	**Study Findings**	**Worth to Practice: LOE Strengths/Weaknesses Feasibility Conclusion RECOMMENDATION**
									reliability tied to interventions or definitions. • **Recommendation**: Study recommends clear levels of reliability with interventions, operationalization, and definition of reliability • **Notes:** Findings of lack of consensus in approach when same reliability theory used.
Brilli, R. J., 2013, A comprehensive patient safety program can significantly reduce preventable harm, associated costs, and hospital mortality.	To reduce hospital acquired harm.	Quasi-experimental, time series, no control group.	Quality Improvement IHI Model for Improvement	Nationwide Childrens Hospital	IV= HRO Principles in a bundle of safety processes including training, root cause analysis process, safety coach DV= SSER	IV= Bundle approach DV= SSER between 2010- 2012 per 10,000 adjustable hospital days	Process Control Charts	DV= SSER rate 0.19 event, 83% reduction $p < 0.001$	• **Level of evidence** (LOE) Level III • **Strengths and limitations**: High-reliability concepts as part of implementation bundle, did not speak directly to level of reliability measurements. Used system approach to interventions. • **Risk or harm** Low Risk • **Feasibility** Low • **Conclusion**: Multifaceted approach in how healthcare bundle of recommendations. • **Recommendation**: Study recommends bundled approach to decreasing harm throughout.

Citation: Author, Date of Publication, & Title	Purpose of Study	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables Studied and Their Definitions	Measurement of Major Variables	Data Analysis	Study Findings	Worth to Practice: LOE Strengths/Weaknesses Feasibility Conclusion RECOMMENDATION
Crandall, K. M., 2017, Improving apparent cause analysis reliability: A quality improvement initiative.	To increase ACA action plan reliability and maintain or decrease ACA turnaround time.	Quality Improvement	Model for Improvement	Childrens National Hospital ACA action plans from June 2016 through improvement project.	IV= Bundle of Process Improvements for ACA (implemented simultaneously DV = ACA reliability (as measured through internal toolkit, evidence based) DV2 = average number of days of ACA completion	DV1= High reliability toolkit expanded by authors from (Cincinnati Childrens Hospital Medical Center) percentages for Level 1, 2, or 3 reliability over time. DV2 ACA Turnaround time measured in days	X Bar chart, descriptive statistics, mean percentage. X Bar Chart, descriptive Statistics, average	DV1= 96.1% DV2 = 8.6 days	• **Level of evidence** (LOE) Quality Improvement Project VI • **Strengths and limitations** Applicable interventions to replicate and based on reliability science. Limitations one hospital finding, no outcome data. • **Risk or harm** Low Risk • **Feasibility** High • **Conclusion**: Quality improvement project that speaks directly to PICO question, use of reliability, time for outcome data may not be applicable in scope of DNP project. • **Recommendation** Replication can be used for high reliability interventions in causal analysis inclusive of ACAs. • **Notes:** Article inspired this DNP project and interventions to address the current problem at DNP project site.

Citation: Author, Date of Publication, & Title	Purpose of Study	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables Studied and Their Definitions	Measurement of Major Variables	Data Analysis	Study Findings	Worth to Practice: LOE Strengths/Weaknesses Feasibility Conclusion RECOMMENDATION
Cropper, D. P., 2018, Implementation of a patient safety program at a tertiary health system: A longitudinal analysis of interventions and serious safety events.	To implement safety program based on high reliability principles to reduce SSEs	Atheorectical	Longitudinal analysis	One Hospital, size unknown	IV= Bundle of 7 components: safety rounding, safety oversight, huddles, safety coaches, good catches, safety education, red rule DV= SSER	IV= Process measure on Safety success story, implementation over time of bundle DV= SSER per 100,000 adjusted patient days	IV= n of safety success DV= SSER rolling 12 months per 100, 000 adjusted patient days	IV= above target of n > 440 11 data points DV= SSER to 0	• **Level of evidence** (LOE) Descriptive Study VI • **Strengths and limitations**: Measured bundled approach over time, not one intervention alone can be attributed to success in reducing SSEs. • **Risk or harm** Low risk • **Feasibility**: Low to moderate • **Conclusion**: Organizational change in safety program, bundles approach to address SSEs. • **Recommendation**: Some solutions speak to high reliability, can be replicated when feasible for action planning in ACAs.
Hettinger, A. Z., 2013, An evidence-based toolkit for the development of effective and sustainable root cause	To develop a model to guide RCA teams to develop effective and sustainable	Atheorectical	Qualitative analysis	334 RCA cases and 782 solutions from a multi-institutio	IV= Interviews across 7 hospital-based units/ Multidisciplinary on effectiveness and	DV- Number of solutions categories and ranking in 2-dimensional framework	Means and standard deviations for each category, regression analysis	DV=13 solution categories	• **Level of evidence** (LOE) Descriptive Study VI • **Strengths and limitations**: RCA solutions identified through multiple cases and labeled effective or sustainable through an initial

analysis system safety solutions	solutions to prevent reoccurrence of patient harm events.			nal data set.	sustainability of solution categories, Likert scale. DV= Rank of solution categories from interviews ranked high, moderate, low, and minimal in terms of effectiveness				evaluation with experts and validated through interviews of clinical expertise. Interviews did not include physicians due to limitations, potential for recall bias. • **Risk or harm** Low risk • **Feasibility** Moderate • **Conclusion**: Feasible for DNP project as background validated with other evidence of sustainable and effective solutions, does not speak to levels of reliability. • **Recommendation**: Incorporation solutions scored as moderated to high can be considered as part of DNP project PICO question.
Hilliard, M. A., 2012, Our journey to zero: Reducing serious safety events by over 70% through high reliability techniques and workforce engagement	To put in place a safety transformation initiative based on high reliability principles to decrease SSER in a Children	Atheorectical	Quality Improvement Initiative	Childrens National Hospital	IV: Bundle of high reliability initiatives within the organization. DV1= SSER, monthly number of serious safety events from previous 12	DV1= SSER, monthly number of serious safety events from previous 12 months per 10000 adjusted patient days of the same time period. Rate over time. DV2= total number of voluntary reported	Descriptive Statistics	DV1= 0.5 rate DV2= n=140,600	• **Level of evidence** (LOE) Quality Improvement VI • **Strengths and limitations**: Independent interventions bundled, difficult to attest to which intervention had the highest impact of outcomes. Focusing on high reliability principles shows success across an organization in preventing reoccurrence of safety events classified as SSE. • **Risk or harm** Low risk • **Feasibility** Moderate

	Hospital				months per 10000 adjusted patient days of the same time period. DV2= Overall number of adverse event reporting	incidents / total adjusted patient days			• **Conclusion**: Speaks about reliability principles broadly, just culture specifically to causal analysis, does not have a measurement for reliability from solutions of causal analysis. • **Recommendation**: Useful for bundling safety programs**.** • **Notes:** Balancing metric that safety reporting should not decrease, and safety improvement occur.
Kellogg, K. M., 2017, Our current approach to root cause analysis: Is it contributing to our failure to improve patient safety?	Aim to examine types of solutions of RCA over 8 years at 1 academic medical institution .	Atheorectical	Quantitative and Qualitative analysis, retrospective review	Tertiary care medical center 750 bed.	No interventions Types of solutions proposed from RCAs between 2001 and 2008	Number and frequency of solution categories	Descriptive Statistics	499 solutions out of 302 RCAs • Training 20% • Process Change 19.6% • Policy 15.2%	• **Level of evidence** Descriptive Study • **Strengths and limitations**: In-depth analysis of solution category and frequency of use, article also factor RCA themes over time as a measure. Limitation is the single care facility. • **Risk or harm** Low risk • **Feasibility** Moderate • **Conclusion**: Validates problem of low reliability options used in causal analysis. Speaks to the need for validated tools to be present when proposing solutions. • **Recommendation**: Aligns with DNP project problem and scope.

Morse, R. B., 2011, Root cause analysis performed in a children's hospital: Events, action plan strength, and implementation rates.	To examine types of RCA events, strength of plans and implementation in 1 pediatric hospital	Atheorectical	Quantitative analysis, retrospective review	345 bed tertiary care pediatric medical center	Types of events, action plan strength and implementation rate	Numbers and average percentage	Descriptive statistics	78 action plans classified as: • 46% weak • 44% intermediate • 10% strong classification	• **Level of evidence** Descriptive Study • **Strengths and limitations**: Classification of action plan strength including hierarchy of actions. • **Risk or harm** Low risk • **Feasibility** High • **Conclusion**: Validates consistent use of reliability action items that correlate with other studies although classified and named differently. • **Recommendation**: Speaks change concepts and hierarchy of actions.
Muething, S. M., 2012, Quality improvement initiative to reduce serious safety events and improve patient safety culture.	To implement cultural and system changes to reduce SSE by 80% within 4 years.	Quality Improvement	Model for Improvement	Cincinnati Childrens Hospital Medical Center	IV= Bundled interventions including, error prevention system, improve safety governance, Causal analysis program, lessons learned program, tactical intervention.	DV1= SSE rate per adjusted patient days DV2= Days between SSE	Statistical process control charts DV1= U (unit) Chart DV2= T (time between) Chart	DV1= rate of 0.3 or $p<.0001$ DV2= mean 55.2 or $p<.0001$	• **Level of evidence** (LOE): Quality Improvement Project VI • **Strengths and limitations**: Analysis of outcome date to reduce SSE through comprehensive organizational safety improvements. Bundled approach, difficult to determine which intervention directly impacted outcome measurement. • **Risk or harm** Low risk • **Feasibility** Moderate • **Conclusion**: Discusses effective causal analysis plans,

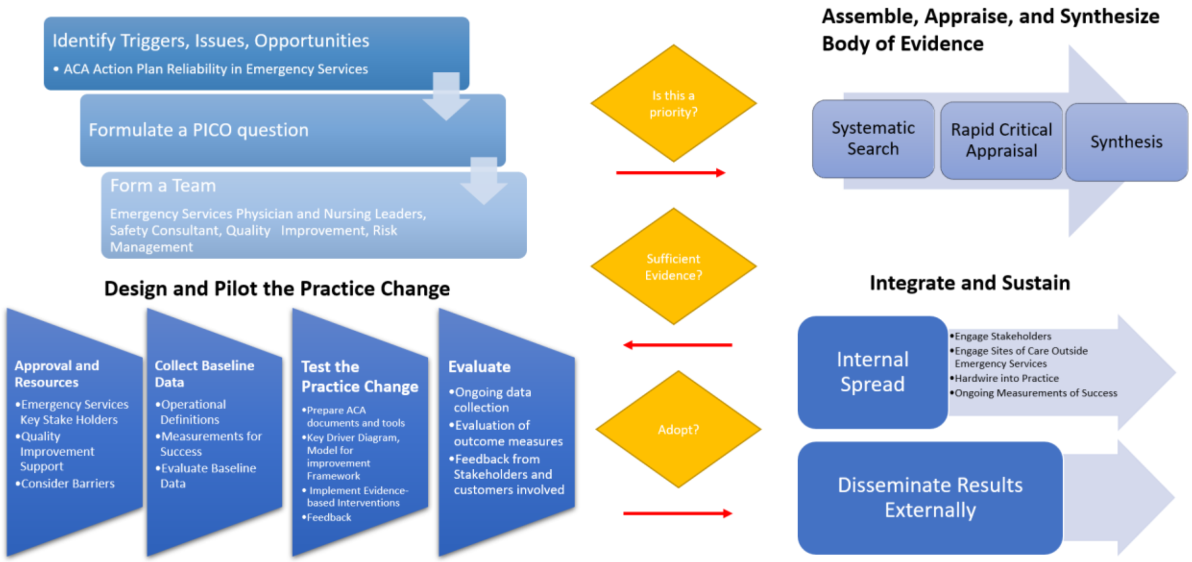
					DV1= SSE per adjusted patient days DV2= Days between SSE				but not descriptions of high reliability solutions. • **Recommendation**: Review for effective outcome data and organizational change.
Parikh, K., 2020, Apparent Cause Analysis: A Safety Tool	Improvement to revise current ACA approach within the hospital for a standard and reliable approach to move beyond human errors to system solutions	Atheorectical	Study used improvement methodology	Childrens National Hospital 323 pediatric bed hospital	IV- 318 Participants overall in facilitated ACA structure in review of ACAs. To mark spread of learnings over 100 participants	No outcome measurement.	Descriptive statistics, number of participants	318 participants	• **Level of evidence**: Expert Opinion VII • **Strengths and limitations**: Limitations of data analysis to determine if interventions were effective, no outcome data listed. • **Risk or harm** Low risk • **Feasibility**: High • **Conclusion**: Single hospital process implementation of facilitated ACAs with limited data on outcomes and improvement methodology. • **Recommendation**: Replication of the facilitated ACAs can be an intervention for further QI initiatives. • **Notes** Background on ACAs and cause history.

Veazie, S., 2022, Implementing high-reliability organization principles into practice: A rapid evidence review	Synthesize literature for implementation effects of HRO principles	Atheorectical	Literature review	569 articles resulted, 23 selected for review.	DV= effects of HRO implementation	Safety measures varied reflected in literature review	Qualitative assessment and synthesis	DV- Process measures match to safety measure outcomes.	• **Level of evidence**: Evidence Review LOE: VI • **Strengths and limitations**: Identified several articles with process measures impacting outcomes safety data. Did not identify directly if level of reliability for interventions. • **Risk or harm** Low risk • **Feasibility** : Moderate • **Conclusion**: Several interventions deployed can impact safety outcome data • **Recommendation**: Feasibility, but not directly with action plan reliability towards safety outcomes for DNP project.

Note. Legend: ACA(s)= Apparent Cause Analysis, DV= Dependent Variable, HRO= High Reliability Organizations, IV= Independent Variable, LOE = level of evidence, SSE= Serious Safety Event, SSER= Serious Safety event rate QI= Quality Improvement. Used with permission, © 2007 Fineout-Overholt; If you use this evaluation template or the synthesis information, please let Dr. EFO know how it worked for you by contacting her at ellen.fineout.overholt@gmail.com

Appendix C

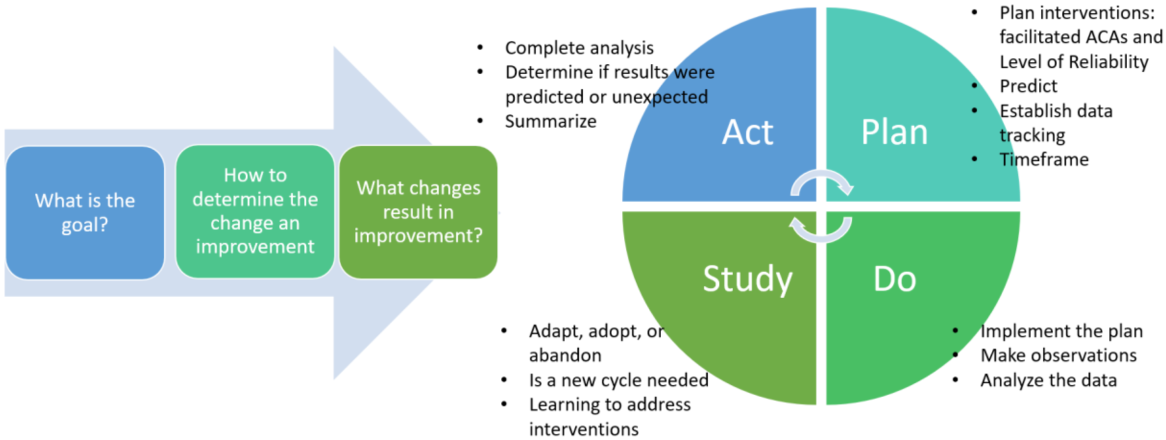
Project Plan and Application of the Iowa Model



Note. Integration of the Iowa Model key phases into the project plan to improve ACA action plan reliability. Adapted from: "Iowa Model of Evidence-Based Practice: Revisions and validation" by Iowa Model Collaborative, 2017, *Worldviews on evidence-based nursing*, *14*(3), 175–182. *https://doi.org/10.1111/wvn.12223*

Appendix D

Project Plan and The Model for Improvement



Note. Application of the Model for Improvement framework into the project plan to improve ACA action plan reliability. Adapted from: *The Improvement Guide* (p. 24), by G. J. Langley, 2009, Jossey Bass Wiley.

Appendix E

Budget Plan for Project

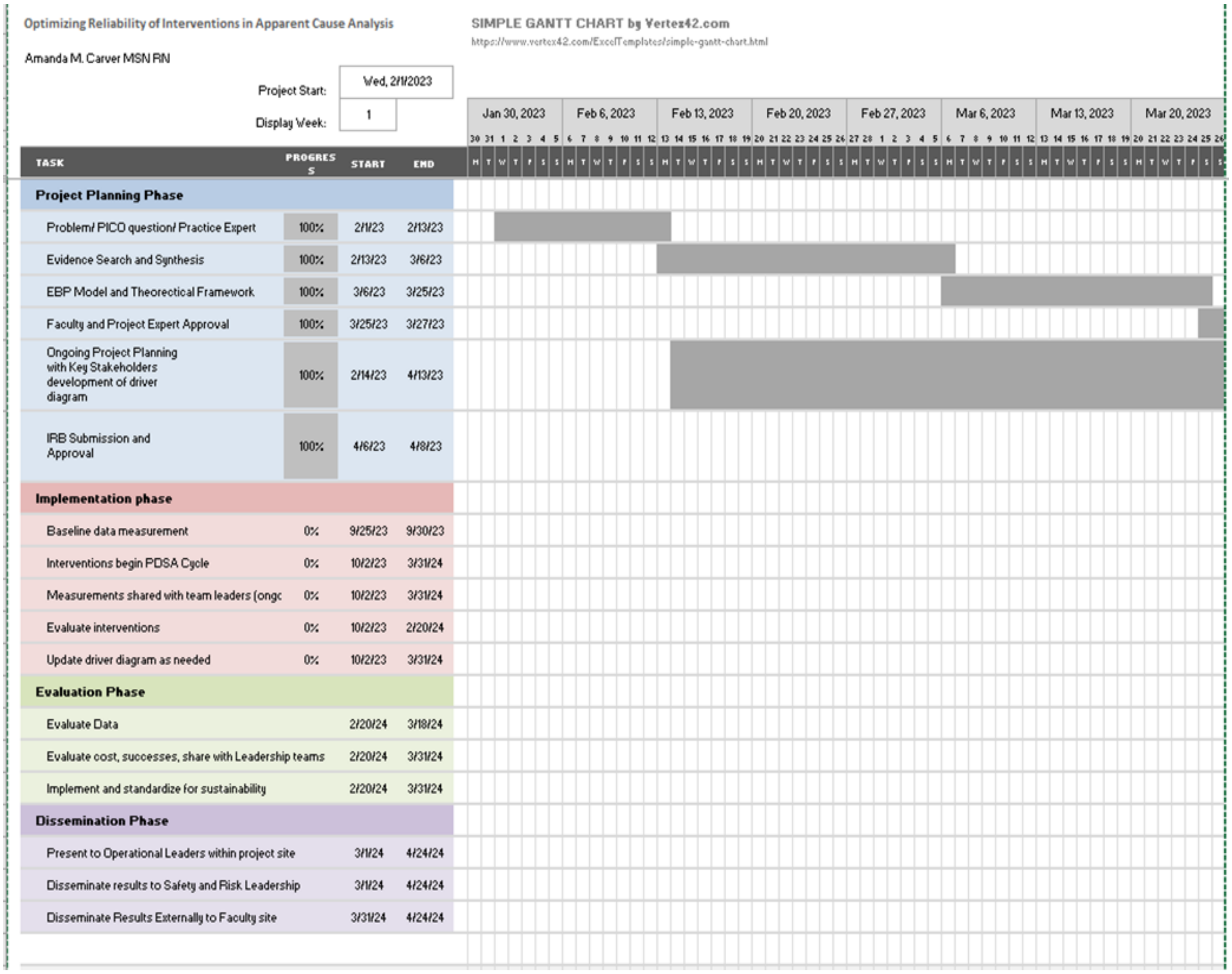
Budget Plan for Project: Optimizing ACA Action Plan Reliability

Item	Time (hours)	Cost		Project Activities	Hours
Personnel Costs					
Baseline Data: Safety Consultant and Quality Improvement	3	$300.00		Baseline Data Collection	3
ACA working Team Personnel	10	$7,250.00		Education Delivery	1
Education Delivery	1	$725.00		Data Analysis	4
Ongoing Data Collection and Analysis	4	$200.00		ACA working Team	10
Total		**$8,475.00**		**Total**	18
Total Non-Personnel Costs		**$0.00**			
Grand Total (Expenses)		**$8,475.00**			

Note. Estimation of personnel costs for the implementation of the project.

Appendix F

Gantt Chart



Optimizing Reliability of Interventions in Apparent Cause Analysis

Amanda M. Carver MSN RN

SIMPLE GANTT CHART by Vertex42.com

https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

Project Start: Wed, 2/1/2023

Display Week: 1

TASK	PROGRESS	START	END
Project Planning Phase			
Problem/ PICO question/ Practice Expert	100%	2/1/23	2/13/23
Evidence Search and Synthesis	100%	2/13/23	3/6/23
EBP Model and Theorectical Framework	100%	3/6/23	3/25/23
Faculty and Project Expert Approval	100%	3/25/23	3/27/23
Ongoing Project Planning with Key Stakeholders development of driver diagram	100%	2/14/23	4/13/23
IRB Submission and Approval	100%	4/6/23	4/8/23
Implementation phase			
Baseline data measurement	0%	9/25/23	9/30/23
Interventions begin PDSA Cycle	0%	10/2/23	3/31/24
Measurements shared with team leaders (ongc	0%	10/2/23	3/31/24
Evaluate interventions	0%	10/2/23	2/20/24
Update driver diagram as needed	0%	10/2/23	3/31/24
Evaluation Phase			
Evaluate Data		2/20/24	3/18/24
Evaluate cost, successes, share with Leadership teams		2/20/24	3/31/24
Implement and standardize for sustainability		2/20/24	3/31/24
Dissemination Phase			
Present to Operational Leaders within project site		3/1/24	4/24/24
Disseminate results to Safety and Risk Leadership		3/1/24	4/24/24
Disseminate Results Externally to Faculty site		3/31/24	4/24/24