Spring 2023

Implementation of a Revised Intubation Checklist For a Critical Care Transport Team

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Submitted as Partial Fulfillment for the Doctor of Nursing Practice Degree

Regis University

April 24, 2023

Abstract

Critical care transport teams are often tasked with performing endotracheal intubation (ETI) during transport while adhering "to the same standards as in-hospital emergency anesthesia" (Lockey et al., 2017). One transport team adopted a checklist in 2014 to meet this high standard, but because of changes in equipment and practice expectation, an updated version was needed. The purpose of this quality improvement (QI) project was to design an updated checklist and measure the following primary outcomes: first pass success and steps taken to mitigate hypoxia and hypotension (and/or elevated shock index) prior to intubation. Additionally, a survey was administered to the clinicians after the project to determine their opinion on the usefulness of the checklist toward meeting these objectives. A total of twelve prospective and twelve retrospective charts were reviewed, and data analysis demonstrated: an improvement of first pass success from 75% with the original checklist and 92% with the updated checklist; an increase in taking steps to avoid hypoxia (67% to 75%) and hypotension (58% to 67%). Survey results were mixed and showed most clinicians felt the resource was useful but may have contained too much information to use in this situation. Overall, the revised checklist resulted in clinically significant improvements in achieving the primary objectives of improved first pass success rates and increasing steps to avoid hypoxia and hypotension.

Keywords: DNP Project, critical care transport, intubation checklist, first pass success, adverse events during intubation, shock index and intubation, avoiding hypotension and hypoxia during intubation.

Executive Summary

Problem

Endotracheal intubation (ETI) is a high-risk, low-frequency procedure required in the process of transporting critically ill and injured patients. To optimize safety, it is necessary for clinicians to be well prepared with a resource such as a checklist ready to execute to assure all necessary equipment is available and steps are taken to avoid complications. One critical care transport team needed a revised intubation checklist which reflected current practice expectations for this procedure. The study question was: Does the implementation of an updated, comprehensive checklist lead to improved first pass success and avoidance of hypoxia and hypotension in the peri-intubation period by clinicians on a critical care transport team?

Purpose

The purpose of this quality improvement (QI) study was to evaluate if the implementation of an updated comprehensive intubation checklist in the critical care transport environment optimized safety, thereby decreasing adverse events and improving patient outcomes. The addition of clinical references such as medication dosing, an ideal body weight chart, and patient specific equipment sizes to the checklist trifold were included, to assure the clinician had this necessary information on hand to successfully prepare for and execute this procedure.

Goals

The project's main goal was to design an updated intubation checklist reflecting the transport team's process and expectations for intubation.

Objectives

The major objectives of this project were to increase first pass intubation success, increase interventions to avoid hypoxia, and to increase recognition of actual and potential shock states and the steps taken to mitigate them. Additional objectives included increasing use of the appropriate intubating equipment (blade/stylet) and improving documentation of verification methods of correct endotracheal tube placement. Lastly, participants were given a chance to provide feedback on the checklist's utility and to offer suggestions for improvement.

Plan

This QI project used a retrospective/prospective chart review design and closed- and open-ended survey questions. After receiving approval from the practice site, a training video and demonstration video along with the new checklist was shared with the team. Chart reviews were conducted for three months after training and compared to an equal number of 12 intubation events preceding the checklist's implementation. Quantitative data were analyzed using SPSS software to determine correlation and statistical significance of data collected from chart reviews. Agreement was reached regarding survey themes by faculty and the DNP student.

Outcomes and Results

Improvement in first pass success from 75%-92% was noted, and the frequency of steps taken to avoid hypoxia and hypotension also improved from the pre-to post-revised checklist period. There were inadequate data to determine improvements in the appropriate equipment use due to insufficient documentation in the retrospective group. The rate of verification by waveform capnography and at least one other method was 100% in both study groups. The survey results were mixed as to which elements of the checklist were most useful; however, most comments support the reference was useful, but a simpler format for delivery may be preferred

Acknowledgements

I am most grateful to God for allowing me this opportunity to learn and grow. He is the source of all good things. My husband Jody who has been my champion encouraging me to pursue my dreams. My children Christopher and Joseph who have inspired me to be the best version of myself. My appreciation to all of them for their sacrifice of our time together while I pursued my educational and career goals is immeasurable.

I am grateful for Regis University and all of the faculty could not have been more knowledgeable and supportive. Dr. Kathleen Whalen provided her expertise and guidance throughout, and was instrumental in helping me see this project to completion. Dr. Cheryl Kruschke was integral in the data analysis and interpretation. Both were always available and provided a never-ending source of encouragement.

The help and guidance from my clinical mentor, individuals on the transport team, and the hospital organization were instrumental in helping me see this project through to fruition. Thank you to everyone who invested time and energy into this effort which has added to our understanding of the utility of checklists and improved care to our patients.

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Implementation of a Revised Intubation Checklist

For a Critical Care Transport Team

Endotracheal intubation (ETI) is an infrequent, yet high-risk, procedure performed by critical care transport nurses and paramedics on acutely ill and injured patients. It is imperative to have measures and guidelines in place to keep the intervention as safe as possible for these already fragile patients. Lockey et al. (2017) assert that out of hospital ETI should be performed "to the same standards as in-hospital emergency anesthesia." They describe several factors which can increase the safety of out-of-hospital ETI for all age groups and assert many of these can be incorporated into a checklist. Furthermore, when a bundle of interventions which standardize practice is available *and* utilized, complications such as severe hypoxemia and cardiovascular collapse can be reduced significantly (Russotto, et al., 2022).

According to Moran et al. (2020 p.40), the Doctor of Nursing Practice (DNP) student and graduate has a primary responsibility to clinical scholarship which is the "mechanism that provides knowledge development within a discipline" and "knowledge production is measured according to its contributions to improved outcomes." Safety and efficacy of endotracheal intubation can improve patient outcomes, thus it is a high priority for this transport team and its clinical leaders, as well as an ideal project for the DNP student. Optimization of the intubation strategy and procedure not only improves patient outcomes, but it also benefits the clinician performing the procedure by alleviating some of the responsibility of recall during a high-stress procedure. Furthermore, critical care transport has become a highly competitive industry (Garcia & Cohen, 2020) and it is beneficial to the organization to have a tangible means of demonstrating outstanding performance in industry benchmarks such as first pass success during endotracheal intubation and avoidance of hypotension and hypoxia throughout the procedure

(GAMUT, 2021). This QI initiative will discuss the practice problem as it pertains to intubations by a critical care transport team, provide extensive evidence from the literature, and present a market/risk analysis which supports the study question and implementation of the Capstone project. A detailed description of the project risk analysis, objectives, methodology, evaluation processes, and study findings are also described.

Problem Recognition and Definition

Statement of Purpose

The purpose of this QI project was to implement a revised checklist based on best practices to better serve clinicians in accomplishing important steps thereby setting the stage for the safest possible procedure and creating an optimal environment which can decrease adverse events and ideally improve the outcome for the patient. Data were analyzed by the DNP student before and after the incorporation of the revised checklist.

Problem Statement

In 2014, a critical care transport team adopted an intubation checklist to remember critical steps needed to perform intubation efficiently and safely while avoiding adverse events throughout the procedure. This team is composed of highly trained critical care nurses and paramedics who transport patients via ground, helicopter, and fixed-wing across a 500-mile and greater region. They care for patients at the scene of an event such as a private residence or on the side of a highway after a motor vehicle accident.

The practice problem for this DNP project addresses the need for an intubation checklist which reflects current practice expectations and updated equipment. Since the inception of the original intubation checklist, the procedure for this team has evolved and improved based on new evidence, recommended procedures, and updated equipment; however, the checklist used by clinicians has not been modified accordingly. Specifically, medical direction for the program has advocated for additional evidence-based measures surrounding intubation which optimize airway protection and oxygenation and improve recognition and prevention of potential/actual hypotension. Updated intubation equipment and increased use of the bougie as a stylet has also allowed for a more tailored approach to airway management. All items play a crucial role in avoiding adverse events including cardiopulmonary collapse, during the peri-intubation period. The improved checklist can provide an increased opportunity to alert/remind clinicians to take steps early, which will increase the safety of the procedure for these patients and provide a list of must-have equipment. The updated checklist has also been revised to incorporate elements of planning and execution of procedures which have changed/evolved since the original version. Finally, the checklist now has current, valuable resources for clinicians to reference during a myriad of emergency situations. Specific modifications to the checklist are outlined below.

The importance of recognizing a “physiologic difficult airway,” where actual or likely hypoxia and/or hypotension may occur, is as important as the patient’s anatomy and physical condition (Russotto, et al., 2022). Hypoxia or hypoperfusion not addressed prior to intubation can lead to grave complications including cardiovascular collapse, especially once intubation medications are administered and positive pressure ventilation ensues. Therefore, elements have also been added to the revised checklist to remind the clinician to take appropriate steps to attempt to improve the physiologic state, if possible, prior to the procedure.

PICO

The PICO statement for this project was:

Population (P): Critical Care Transport Team (Helicopter, Fixed Wing, and Ground)

Intervention (I): Revised Comprehensive Checklist

Comparison (C): Retrospective and Prospective Chart Review comparing vital signs, equipment, medications, and procedures before and after implementation of the revised checklist

Outcome (O): Improved first pass success and avoidance of hypoxia and hypotension in the peri-intubation period, selection of laryngoscope blade with appropriate stylet, and confirmation of correct ETT (endotracheal tube) placement with waveform capnography and at least one other method.

The PICO study question was: Does the implementation of an updated comprehensive checklist lead to improved first pass success and avoidance of hypoxia and hypotension in the peri-intubation period by clinicians on a critical care transport team? Secondary objectives include an analysis of equipment used (blade/stylet) and methods used to confirm correct ETT placement.

Project Significance and Scope of Project

The revised intubation checklist captures changes and improvements in airway management which have occurred over the past eight years. It helps assure the important practice of adequate preparation continues and the patient’s condition is optimized before a very risky procedure. It also embraces several DNP Essentials including incorporating scientific underpinnings for practice, leading quality improvement, and establishing interprofessional collaboration in the setting of advanced nursing practice (AACN, 2006). Multiple changes to the checklist are a result of increased scientific knowledge surrounding the importance of early recognition and management of a compromised physiologic state and its role in optimizing a safe intubation for the already ill or injured patient. Recognizing actual hypotension and/or an elevated shock index in a patient with a normal blood pressure allows the clinician to perform measures prior to intubation which may avoid cardiovascular compromise once medications and positive pressure ventilations occur.

Change usually presents some angst and difficulty, especially when it pertains to an already stressful procedure. The DNP trained professional studied theories surrounding change and ways to optimize tough transitions. The implementation of the checklist can best be accomplished by an experienced leader with this knowledge.

The checklist is a means of collaborating with others involved in patient care. It sets the stage for expectations and the plan for execution. It is a concrete way to unite the room during a stressful situation such that the focus is on intubation success and patient safety. The act of performing an intubation, in and of itself, is one which falls on the experienced nurse with advanced practice knowledge and maturity.

The scope of this project is limited to one small critical care transport system; implementation began in 2022, following organizational approval. This project was not meant to develop new knowledge or be generalized outside of the study site.

Theoretical Foundation

Jean Watson's Theory of Human Caring encompasses the structure and essence of this author's nursing practice. The ten clinical caritas have generalizability in most health care situations. Recently Gunawan et al. (2022) described the applicability of Dr. Watson's theory to administrative nursing leaders. The authors convey how embracing, inspiring, trusting, nurturing, forgiving, deepening, balancing, co-creating, ministering, and openness create a culture for staff to provide optimal care to the patients they serve.

To assure the success of this nursing project, three theories were used as the framework. These included the Flight Nurse Expertise theory, Prevention as an Intervention theory, and Kurt Lewin's Change Theory. The description, analysis, evaluation, and application to this intubation checklist project is discussed below using the Synthesized Method of Theory Evaluation described by McEwen and Willis (2019).

Flight Nursing Expertise Theory

Reimer and Moore (2010) developed the middle range theory entitled Flight Nursing Expertise to support the needs of clinicians who serve their critically ill patients in the unique setting of air medical transport as well as to provide a framework in this specialized field of nursing (Reimer & Moore, 2010). The nine concepts, which serve as the basis of this theory include: experience, training, transport environment of care, psychomotor skills, flight nursing knowledge, cue recognition, pattern recognition, decision-making and action (Reimer & Moore, 2010).

The interrelationships of these concepts also help describe, define, and analyze this theory and are depicted in five propositions. For example, psychomotor skills include those that are "gained through experience and training, and are performed proficiently (Reimer & Moore, 2010, p. 6)." Examples of psychomotor skills are endotracheal intubation and surgical procedures such as surgical airways or thoracostomies. They are related to other concepts in this theory including cue and pattern recognition which influence decision-making. Having a solid expertise in performing necessary psychomotor skills allows for the mental bandwidth to recognize familiar patterns and detect cues, which developed through experience, can influence the detection of a critical diagnosis which then directs the course of treatment. Cues are obtained from a multitude of sources in the transport environment including visual (number of patients on scene and hazards therein), auditory (the sound of the helicopter which precludes listening of breath sounds), and tactile (the ability to evaluate respiratory difficulties through palpation of the chest). The linkages of the concepts are well-defined and contribute to understanding the underpinnings of the Theory of Flight Nursing Experience and culminate in decision making and appropriate action (Reimer & Moore, 2010).

The theory is congruent with nursing standards and encompasses a field where psychomotor skills, cue recognition and pattern recognition, exist at the upper limits of the nursing scope of practice. Flight nurses diagnose and operate under austere environments which preclude formally obtaining physician orders for significant interventions. They must operate under broad guidelines and protocols considered outside the scope of the registered nurse and fit more congruently under the advanced practice nurse (APRN).

This theory describes and defines an important professional field of nursing and is necessary for the growth of this field in the larger area of nursing as a profession. It provides some concrete, though imperfect, framework to serve as a starting point for further education and research. This theory has not been extensively utilized in nursing education, research, or administration, but the authors did perform related qualitative research which has led to further understanding and development of the theory (Reimer, Clochesy, & Moore, 2003).

Prevention as an Intervention Theory

The second theory which provided framework to the intubation checklist DNP project is Prevention as an Intervention based on the Neuman systems model (August-Brady, 2000). This is a middle range theory generalizable to many situations and describes the use of prevention methods to assure the health and stability of the patient and is achieved when the system input exceeds output. The concepts of primary (health promotion), secondary (strengthening resistance), and tertiary prevention (empirical accessibility) are utilized when a stressor is identified. Stressors can be intrapersonal, interpersonal, and extra personal and are assessed to provide appropriate interventions. The linkages of the concepts are linear beginning with identification of the stressor and the application of the various levels of intervention as needed to create stability. Empirical testing of this theory is lacking; however, it may still have some predictive value in nursing when interventions are analyzed in respect to the outcome (stability) of the patient.

Because of the generalizability, it accounts for the complexities of the individual and their circumstances and thus can serve as a basis for the examination of the use of a checklist in transport in the peri-intubation period. A checklist is, in and of itself, a method of preparation and even provides secondary preparation as it can serve as a resource when the patient's condition changes and requires a different intervention. The checklist studied in this project not only involves a list of needed equipment but served as a guide to the clinician to choose primary, secondary, and tertiary interventions which should be applied in various patient conditions. For instance, if a patient has vomitus or an otherwise contaminated airway, the nurse or paramedic is prompted to utilize a particular blade for best visualization and techniques for clearing the airway throughout the procedure. Another example would be if the patient had an elevated shock index, the clinician should take measures prior to intubation, such as administering a small dose of epinephrine and starting a fluid bolus prior to giving a sedative/analgesic as this can help maintain perfusion throughout the procedure and potentially avoid a subsequent cardiac arrest (Althunayyan, 2019). Both examples show primary prevention (gathering necessary supplies needed for any intubation) and secondary prevention (further medication administration based on the patient's hemodynamic status).

Kurt Lewin's Change Theory

Kurt Lewin's change theory was applied to this project to ensure the overall success of an intervention/change into the organization (Schein, 1996). This theory was developed for the social sciences and includes the major concepts of unfreezing, changing, and refreezing, but has applications in nursing and almost any setting whereby changes are desired and need to be sustained. Unfreezing is described as priming the organization for change by soliciting buy in for the change and opening the door for it to occur. Once the organization is primed, the change can be implemented and should include education and training.

Kurt Lewin's change theory was applied in a hospital seeking to decrease medication errors with a checklist (Stevens et al., 2011). They recruited champions to share the need for improvement, educators to drive the change, and refreezing the initiative with the checklist. Similarly, this methodology was used for the intubation checklist project as they are all interested in keeping their patients safe, avoiding errors, and will work hard to embrace a change that will make that happen. Change, however, is difficult, but by utilizing Lewin's methodology, one can better set the stage to make change successful and meaningful for both patients being intubated as well as their caregivers.

Review of Evidence

Literature Selection/Systematic Process

A literature review was conducted using multiple databases, many of which have overlapped, including Academic Search Premier, CINAHL, Cochrane Database, Embase, Google Scholar, and MEDLINE. Multiple search terms were utilized to capture important categorical aspects of the DNP project. A search was performed to gain a comprehensive understanding of checklists and how they were implemented, trained, and used in transport as well as similar settings such as the emergency department (ED) and intensive care unit (ICU) with terms including “intubation checklist” and “medical checklist” combined with the terms “pre-hospital,” “emergency,” “transport,” “ED,” and “ICU,” “simulation,” “training,” “education,” “quality,” and “development.” Additionally, it was necessary to determine what topics should be included in a checklist to aid the user to avoid/address hypoxia and hypotension (more specifically shock index), and the importance of first pass success of the endotracheal tube. This search added terms to “intubation” including “hypoxia,” “pre-oxygenation,” “hypotension,” “shock-index,” and “first pass success (FPS).” Initially, the search was directed towards those published in 2017 or more recent, but to capture some significant, yet older research, it was extended to include studies from 2010 to present as well as one seminal article regarding first pass success from 2004 by Mort (2004) and the Checklist Manifesto book by Gawande (2009). A total of 39 journal articles written in English were reviewed and two main themes emerged: checklists in healthcare and adverse events surrounding intubation.

Background of Problem and Systematic Review of the Literature

Emergent Themes

Checklists in Healthcare. Checklists have been increasingly used in healthcare to manage complex, high-acuity, and high stress situations to assure needed supplies are in place, proper procedures are followed and important steps and/or equipment are not omitted or found to be non-functional. Atul Gawande (2009) in his book the *Checklist Manifesto: How to Get Things Right*, demonstrated how checklists, a foundation in the aviation industry, can reduce hospital acquired infections in the operating room and throughout hospitals. Checklists in emergency and critical care venues, when designed, trained, and implemented thoughtfully for the environment in which they are utilized, can create a margin of safety for risky procedures such as ETI (Ahmed

& Azim, 2018; Burgess et al., 2018; Burian, 2018; Chen et al, 2016; Kuszajewski, et al., 2016; Lockey et al., 2017; Wijesuriya & Brand, 2014). Furthermore, ETI when performed in the pre-hospital setting has been shown to correlate with favorable outcomes and decreased morbidity and should not be postponed until arrival at the hospital (Denninghoff et al., 2017).

Despite many proponents of checklists, controversy about their utility and benefit remains and there is evidence describing the impact of checklists as negligible, of mixed value, and sometimes even detrimental as they can cause the procedure to take longer than it would without the use of the checklist (Conroy, 2014; Forristal, et al., 2020; Janz, et al., 2018; Turner et al., 2020). There is a definitive lack of repeated studies looking at the same interventions and care must be taken to understand the study components and potential effects of these. For instance, one randomized trial of ETI in adult patients looked at intubations with and without checklists comparing the lowest reported oxygen saturation and lowest systolic blood pressure (SBP) (Janz et al., 2018). They found no difference in complications or outcome in the intensive care setting with a checklist. However, the checklist did not include items such as volume administration, the use of vasopressors, or preoxygenation with non-invasive ventilation and involved less experienced operators such as residents and fellows (Russotto, 2022).

The goal of implementing the revised checklist is to provide an aid which helps a critical care transport team approach various situations and events encountered. Ideally, this checklist helped make the procedure as safe and efficient as possible. This project compared the knowledge and efficiency of both pre and post revised checklist implementation. Literature addressing this niche was limited, so studies from other environments have been included, and lessons learned were applied to the transport environment including endotracheal intubations in and out of the hospital environment. The transport team may be required to treat and transport patients of all ages (Couto, et al., 2019; Davidson, et al., 2017; Johnston, et al., 2018; Landham et al., 2015), but primarily adult studies incorporating checklists are included for analysis (Groombridge et al., 2020; Jarvis et al., 2018; Smith et al., 2015).

Much of the literature describes quality initiatives before and after implementation of a checklist (Conroy, Weingart, & Carlson, 2014; Groombridge et al., 2020; Landham, et al., 2015; & Smith et al., 2015). A few studies detail how the checklists were implemented and describe the training involved (Davidson et al., 2018; Forristal et al., 2021; Johnston et al., 2018) and other studies were examined to simply demonstrate how training, in and of itself with simulation can increase competency with the skill of intubation (Couto et al., 2020). Often the studies demonstrated mixed results. For instance, a multi-center randomized controlled trial comparing intubation with and without a checklist in the emergency department demonstrated checklists decreased the number of important airway tasks omitted, but in doing so, increased the time to the completion of airway management (Forristal et al., 2020).

A time-series analysis by Groombridge et al. (2020) demonstrated the value of a checklist, monthly audits, and ongoing training addressing issues discovered in the audits. They showed improvement in first pass success which continued to increase throughout the study as additional education was provided. Validated checklists can also evaluate the effects of training and proficiency (Johnston et al., 2018).

Adverse Events in the Peri-Intubation Period. Decreasing adverse events during intubation was an important goal when revising the checklist for this transport team. Hypotension and hypoxia in the peri-intubation period can lead to a physiologically difficult airway and multiple intubations attempts in the anatomically difficult airway have been correlated with negative outcomes (Krebs et al., 2021; Mort, 2004; Mosier et al., 2020; Park et al., 2017; Russotto et al., 2022; Sackles et al., 2013). Multiple authors have demonstrated how shock index (SI), which equals heart rate divided by systolic blood pressure, can serve as a marker of a tenuous physiologic state which can and should be addressed prior to intubation (Acker et al., 2016, Althunayyan, 2019; Miller et al., 2016; Trivedi et al, 2015). Jarvis et al, (2018), Nakstad et al. (2011), and Sunde et al. (2017), all studied hypoxia in the pre-hospital patient needing intubation and Guitton et al. (2019) described in a RCT (randomized control trial) the value of high flow nasal cannula for pre-oxygenation to lessen peri-intubation hypoxia. In a large systematic review and meta-analysis, Park et al. (2017, determined first pass success rates were only 84.1%. This demonstrates there is progress to be made and checklists have contributed to this (Dalrymple & Carmo, 2020; Klingberg et al, 2019).

A focus on achieving first pass success is important when avoiding complications for a patient post-intubation. First pass success was shown to decrease adverse events in a large study involving 1,828 intubations in a large emergency department over four years (Sakles et al., 2013). They found the rate of adverse events including aspiration, hypoxia, hypotension, dysrhythmias, and cardiac arrest occurred at a rate of 14.2% when first pass success was achieved; 47.2% when two attempts were needed; 63.6% with three attempts and 70.6% with four or more attempts.

Scope and Quality of Evidence

Using the Melnyk and Fineout-Overholt (2011) Level of Evidence Table, the DNP student categorized the 39 references into seven distinct levels of evidence. Each level of evidence was represented with most articles at Level IV: Evidence from well-designed case-control and cohort studies. Refer to Appendix A to see a complete evaluation of the level of evidence for all articles.

The evidence surrounding the effectiveness of the use of checklists in healthcare is solid and continues to grow. There are too many factors to consider and commit to memory when the task at hand is time-sensitive and involves multiple complex individual patient factors. The importance of first pass success, avoidance of hypotension and hypoxia, and verification of correct ETT placement are reflected in industry standards (GAMUT, 2021). Assuring equipment is present and functioning prior to intubation helps facilitate successful intubation on the first try. The evidence supports the use of a checklist to help achieve first pass success and recognize and mitigate physiologic warning signs which require intervention (Ahmed & Azim, 2018; Burgess et al., 2018; Burian, 2018; Chen et al, 2016; Gawande, 2009; Kuszajewski, et al., 2016; Lockey et al., 2017; Wijesuriya & Brand, 2014). Patients cared for in transport often have tenuous physiology which puts them at risk for cardiovascular collapse and death. The critical care transport clinician is trained to recognize and intervene in these situations but can be more efficient and effective when a checklist is used.

Project Plan and Evaluation

Market/Risk Analysis

Proper planning and execution of any project involves the analysis of the strengths, weaknesses, opportunities, and threats (SWOT) (Parsons, 2021). One **strength** inherent in the implementation of this checklist involved the abundance of evidence supporting the use of checklists in the healthcare setting, especially as they pertain to critical procedures and the need to minimize complications with ETI (Ahmed & Azim, 2018; Burgess et al., 2018; Burian, 2018; Chen et al, 2016; Gawande, 2009; Kuszajewski, et al., 2016; Lockey et al., 2017; Wijesuriya & Brand, 2014). Additionally, this transport team has adopted and embraced this concept with the original checklist, thus the updated version was only a minor change in clinical practice.

Leadership and team members wanted a resource which supports current expectations and practice. Furthermore, the revised checklist trifold also contains references which contain easy to find information for equipment items, calculation of ideal body weight, and medication choices and dosages needed to properly prepare for the procedure, most of which were not included in the original checklist card.

The habit of using the original checklist could also be a potential **weakness** as the nurses and paramedics needed to become familiar with a slightly new format, wording, and content. Any change can be challenging; therefore, the benefits of the updated checklist ideally outweighed any discomfort or unease related to the new version.

The team adopted the original checklist and found requests from other services to adopt a similar process and the opportunity to do the same may present itself with the latest revision as well. Additional **opportunities** to share this process may be recognized as a best practice by the Commission on Accreditation of Medical Transport Standards (CAMTS) accrediting body. Finally, **threats** to this project included fewer opportunities for intubation (COVID illnesses less frequent or not as severe and decrease in patient transport requests), delayed approval from the Institutional Review Board (IRB), structural changes to the team including a possible base move, changes in leadership, and limited training opportunities. Refer to Table 1 to visualize the SWOT analysis used to develop a strategy for implementing this QI project.

Table 1

SWOT Analysis

Strengths (internal)	**Weaknesses** (internal)
1. Abundance of evidence to use ETI checklist and minimize complications 2. Accustomed to the concept and value using a previous checklist 3. Checklist helps improve current practice 4. Leadership and team are excited for the updated resource	1. Change can be challenging and entails the need to adopt new checklist even though previous version is habit 2. Small sample size 3. Limited time to implement
Opportunities (external)	**Threats** (external)
1. Integration of latest evidence and medical director expectations in ETI into checklist 2. Recognition as a best practice by the CAMTS accrediting body 3. Other services within and external to the organization could see this checklist and consider adopting a similar process	1. Fewer individuals may require intubations as pandemic has lessened 2. IRB approval delay 3. Team structural changes such as base move and new leadership could delay implementation

Driving and Restraining Forces

Petiprin (2020) as she relayed Lewin's Change Theory, described driving forces as those which cause change to occur by encouraging a person towards a desired direction. Conversely, those forces that hinder a person from changing are called restraining forces. Change is stagnant at equilibrium when the driving and restraining forces are equal. The driving force for the updated checklist is that the current checklist is simply outdated and does not reflect current practice. Scientific evidence and the expert opinions of the current medical directors have changed to make intubation safer for the patient. The clinicians desired a resource that incorporated those changes and thereby helped them adhere to expected standards.

Restraining forces are the natural human resistance to change and circumstances which make change more difficult. The team has undergone significant changes in leadership including new educators and, at any time, may face changes inherent to the global pandemic, changes to bases, schedules, and training opportunities. In this tumultuous time in healthcare, any change can be difficult to embrace.

Need, Resources and Sustainability

An updated intubation checklist was needed for this critical care transport team and the study provided a means to assess if the updated checklist was impactful in improving first pass success and the avoidance of adverse events in the peri-intubation period.

The resources needed to conduct the project were creating and distributing the updated checklist, developing, and implementing a training program for the team to access via their education website, a means to collect data within the constraints of securing protected health information, and a process to collect and analyze data.

Sustaining forces included the already engrained process of utilizing a checklist prior to intubation and clear direction from the medical directors to continue this process. Opportunities for practicing and reinforcing the use of the checklist included mandatory quarterly skills/intubation training, unlimited access to the training video and learning lab for practice, as well as the importance of listening to clinician feedback regarding the checklist and making appropriate changes and updates to reflect changes in practice that may occur in the future.

Feasibility, Risks and Unintended Consequences

Feasibility

The implementation of this checklist was feasible but involved several steps for appropriate implementation. There was involvement and support from the medical director, leadership team and educators throughout the process. In the several-month period preceding the checklist implementation requests were made to the team at large for suggestions, assistance, and feedback on the various revisions. The checklist was designed, printed, and distributed in written and electronic form. Special paper was used, which was waterproof and tearproof for the equipment bags, so it could sustain normal wear and tear. A training program was designed to include a demonstration of an intubation by the medical director and educator, a video with written explanation of each of the components, how each portion of the trifold was intended to be used and opportunities throughout to practice and provide feedback.

Risks

Inherent risks included team members who did not review and study the training material as expected, and thus may not have understood the concepts and execution as intended. There were also the expected challenges which accompany implementing something new in an already high-stress situation, no matter how well-prepared one might be. Thus, additional time to intubate while learning the checklist may be longer than what would be expected until the clinician becomes more familiar with the updated process (Forristal et al., 2020).

Unintended Consequences

The unintended consequences would thus be any adverse outcome involving the patient due to the procedure taking longer than it had previously. Forristal et al. (2020) demonstrated a decrease in the number of important airway tasks omitted, but in doing so, increased the time to successful intubation in a simulated training environment. During this study, the time it took to intubate was not monitored, however, there was reference in the survey results to feeling “rushed” in getting through the updated version. Timing an actual intubation in transport is logistically challenging as often there are only two caregivers to manage an already high workload. There were no reports from the team of known adverse consequences to patient care and another survey comment referenced that it was anticipated that running the checklist would become more efficient with practice.

Stakeholders and Project Team

The stakeholders included the program, the team leaders and front-line clinicians, the patients, and the hospital system. All are invested in safe and effective patient care and can benefit from the successful implementation of the checklist.

The project team consisted of the transport team medical directors, program clinical director, chief flight nurse, operations manager, educators, and the clinicians performing the intubations. Additionally, the Vice President of Ethics and Compliance, the Associate Vice President of Clinical Research and the Ethics and Compliance Officer with the hospital had the ultimate authority to approve this project. The Regis DNP Chair and associated faculty have been integral in assisting with direction, navigation, feedback and have a profound investment in this project as well.

Cost-Benefit Analysis

The cost related to this project was minimal. The largest additional cost was the cost of printing checklists on water-resistant and tearproof paper. This paper was purchased, and the checklist printed using the program’s color copier at an expense of $40. The DNP student created, printed, and manually folded the cards, so they could be placed in the uniform pocket. Additional labor costs incurred were associated with creating the training video as it involved the medical director who was compensated at an hourly rate; other labor involved those who were already on duty or who were not hourly employees functioning during their normal schedule. The video was uploaded to the education site by the DNP student at no additional cost to the organization. The clinical team was expected to review the video and practice using mannequins while they are on duty during their regular shifts, thus there were no added labor costs except for the time taken by the medical director as he is a contracted employee billing hourly. Similarly, the time taken to complete the brief survey was minimal and occurred during regularly scheduled shifts. Benefits for the project are immeasurable and included promotion of patient safety and quality of care, prevention of adverse effects, potential CAMTS recognition as best practice, lower clinician stress, increased mental bandwidth to manage other aspects of situation, and ease of training with a tool that matches expectations.

Mission and Vision Statement

The DNP project's **mission** was to execute safe intubations through planning and preparation to recognize and mitigate circumstances which could adversely affect the patient during the procedure. The **vision** of the DNP project was to revise a checklist to be used by clinicians during a critical and potentially life- threatening procedure to enhance safety and improve patient outcomes. These values were consistent with those of the team and larger organization.

Processes/Outcome Objectives

The goal of this project was to develop and implement a resource which assisted the clinician during the emergent intubation and served as a timely and accurate resource to aid in remembering key items which maximized patient safety during this risky procedure. By assisting the intubator to mitigate tenuous physiologic compromise, properly confirming ETT placement, and assuring they have the necessary equipment and use it appropriately, patients should sustain less adverse events leading to more optimal outcomes. Additionally, it was hoped clinicians would report the checklist as being helpful during the practice and live intubations they perform.

The outcome objectives for this project were to increase first pass success; document and perform interventions needed to avoid hypoxia and hypotension; and to confirm ETT placement with capnography and one other method; all of which are established industry benchmarks and tracked via Ground and Air Medical Quality in Transport (GAMUT) (2021). GAMUT was developed to gather quality data and help establish industry benchmarks pertaining to medical transport programs. There are over forty metrics tracked by this organization and participation in data submission is voluntary, but highly encouraged by the CAMTS accrediting body. This study tracked specific data pertinent to at least three metrics involving intubation (first pass success, avoidance of hypoxia and hypotension, and confirmation of ETT placement). See Appendix B for a summary of the pertinent GAMUT metrics. Additional metrics involve more industry/program-specific indices such as the early recognition and management of hypotension/elevated shock index and choice of laryngoscope blade with the appropriate stylet. Steps taken to choose appropriate equipment and avoid/improve hypoxia as well as those taken to avoid/improve an elevated shock index will be noted and analyzed in the setting of vital signs immediately before and after intubation. This transport team has traditionally met or exceeded these standards. With the implementation of the intubation checklist and improvements in first pass success, the team can further defend their status as leaders in the industry. Specifically, the objectives are as follows:

1. Improvement in first pass intubation success.
2. Clinicians will avoid hypoxia during intubation.
3. Clinicians will recognize hypotension/elevated shock index and take appropriate steps to mitigate/avoid hypotension in the peri-intubation period.

4. Clinicians will verify ETT placement using waveform capnography and one other method (CXR, visualization, symmetric breath sounds).
5. Clinicians will choose the appropriate intubation blade and corresponding stylet.
6. Clinicians will provide subjective feedback indicating if the checklist is helpful in achieving the above measures as well recommendations for improvement in the form of an anonymous survey

Logic Model

The Logic Model in Appendix C outlines necessary resources, activities, outputs, and short and long-term outcomes applicable to this goal (W.K. Kellogg Foundation, 2004). Specifically, short-term outcomes involved designing a checklist which reflected current medical direction guidance for intubation and included steps which are easy to follow and execute. Additionally, team familiarity of the checklist, meaningful practice scenarios, and full integration of its use during actual intubation scenarios during transport was expected if any medications are used to facilitate intubation (if medications are not needed for intubation, such as in a patient in cardiopulmonary arrest, the checklist is not required). To achieve and maintain this performance level, the checklist was intended to be practiced upon its introduction, and during quarterly simulation lab practice. Increased patient safety occurred as team members recognize situations prior to intubation which need to be addressed, and subsequent action taken. For example, choosing the appropriate blade and stylet, providing optimal pre-oxygenation, and recognizing an elevated shock index early to mitigate actual or potential hypotension with administration of fluids or medications, and confirming ETT placement. See timeline for execution of various stages of this initiative (Appendix D).

Population and Sampling Parameters

The population for this study was a critical care transport team which completes approximately 2700 transports annually for patients across a multi-state region. This team of approximately 45 clinicians (population) performed an average of 15 intubations/month in the latter half of 2021. The number of intubations during this period was higher than historical averages, due to COVID-19 patients needing intubation. Each clinician had averaged about two intubations in the six-month period. The power of this study was adversely affected as the number of intubations decreased from previous years, due to increased use and success with non-invasive ventilation methods. The study examined three months of data after the introduction of the checklist and subsequent training, then matched the number of intubations pre-intervention, regardless of timing. The team was composed of the same number of clinicians, but a decrease in the number of intubations was experienced during the study period.

Power Analysis

Descriptive and inferential statistics were utilized to analyze data. Completing a power analysis for this project can be done by solving for one of four components if the other three are known (Polit, 2018). The four components include: the significance criterion (typically .05), power (at least .80), population size and effect (can be obtained from pilot study, and sample size). ClinCalc (2022), an online tool for power analysis, was used by entering the study group design (one study group vs. population) and a selecting “yes” to “dichotomous endpoint.” Additionally, fields for estimated results in known population (ex: 80% first pass success rate pre-checklist and 93% post-checklist were entered with a Type I/II Error rate of .05 and Power of 80%), the calculated sample size was 59. Over the three-month period, only 12 medication-facilitated intubations occurred, thus the power of the study decreased. However, clinical benefit was anticipated and valued, if only to this team and the patients they will serve in the future.

Setting

The setting for this project involved the diverse environment of critical care transport. Intubations may vary between the bedside in a hospital (remote or tertiary facility) with adequate physical space, lighting, and personnel to assist; the inside of a moving ambulance, or the small confined space of a helicopter or fixed wing aircraft with only two critical care providers; or it may occur “on-scene” which could be in the patient’s house, car, or on the side of the road. For these reasons, having a checklist becomes more important in gathering and preparing the appropriate equipment.

QI Project Study Design

This study used both quantitative and qualitative methods to ascertain the value of the updated intubation checklist in obtaining definitive airway access on the first attempt while avoiding adverse events. Quantitative data were collected using a retrospective and prospective chart review study design to collect pertinent data to ascertain the value of the checklist towards these goals. Retrospective chart reviews can be beneficial in identifying trends (Terry, 2018). Talari and Goyal (2020) further identify utility in using retrospective analysis when studying a rare situation or event that may be difficult, if not impossible, to study using randomization. Intubations by a critical care transport team certainly fall into that category. However, one must also acknowledge the limitations of this design and recognize data was not entered for the purposes of research and there may be principal elements which were never recorded (Talari & Goyal, 2020). Qualitative analysis is the ideal way to gain insight into the subjective nature of the intubation checklist experience. It can capture the value of each clinician's experience to make improvements and build upon the concepts enforced by the checklist (Doyle et al., 2020).

Multiple variables (all included as steps in the checklist) have demonstrated benefit during intubation, were examined to understand the impact of the checklist on these items including use of airway adjuncts, various methods of oxygenation, administration of a fluid bolus, vasopressors, modification of induction medications, choice/use of blade and stylet as well as confirmation of ETT placement in the trachea (Ahmed & Azim, 2018; Burgess et al., 2018, Burian, 2018; Chen et al., 2016, Conroy et al., 2014; Lockey et al., 2017). After the study period for intubation data was completed, each team member was asked to answer yes/no questions regarding the utility of the checklist as it relates to the primary outcomes in addition to open-ended questions regarding which elements of the checklist were most beneficial as well as suggestions for improvement.

Variables

The intervention, or **independent variable**, was the introduction of an updated intubation checklist and the subsequent training on its intended use. Every intubation is unique, and unfortunately, there is not a "one-size-fits-all" method which will be the safest and most beneficial for every patient and their clinical situation. This checklist was designed to prompt clinicians to consider individual patient circumstances and address potential or actual problems before the procedure to make it as safe and efficient as possible. There are specific dependent variables which were studied as well as several extraneous variables which were also considered. The five main dependent variables are described below in addition to the unique respective outcome measures for each.

The **first dependent variable** was completion of the intubation on the first attempt, described as first pass success. An intubation attempt is defined using GAMUT criteria which is “the insertion of a laryngoscope or the insertion of any bougie or airway device past the lips (GAMUT, 2021). The outcome measure is ordinal data based on this definition and is resulted as simply yes or no.

The **second dependent variable** was based on determining whether steps were taken to avoid or mitigate the presence of hypoxia (defined as an oxygen saturation < 90%) during the procedure (GAMUT, 2021). If any steps were taken the data were recorded as “yes” and if no steps were taken the data were recorded as “no” and would fall into the ordinal category. Additionally, the number of steps taken to avoid hypoxia were recorded as interval-level data. There are multiple ways to avoid hypoxia prior to placement of an endotracheal tube including: positioning, suctioning, oral airway and/or laryngeal mask airway placement. Additionally, application of supplemental oxygen in various forms (nasal cannula at high flow, non-rebreather mask, bag-valve mask, continuous positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP)) can contribute to the avoidance of hypoxia in the peri-intubation period.

The **third dependent variable** was the recognition and mitigation of a shock state measured by actual hypotension or the shock index. Shock index (SI) was defined in 1967 as the ratio of heart rate over systolic blood pressure (Allgower & Burri, 1967). An elevated SI can be an early indicator of shock. The medical directors at this program teach clinicians to consider any SI greater than or equal to one as being elevated. If hypotension or an elevated SI was present prior to intubation, this study examined if the clinicians took steps to address this prior to intubation and if so, how many steps were taken. Interventions to address this included the administration of a fluid bolus or vasopressors or appropriate adjustments to induction and paralytic medications. In shock states, decreased doses of ketamine (Kreb's et al., 2021) and increased doses of rocuronium are recommended (Rezale, 2018). There was a change in the maximum dose of the paralytic rocuronium made one week into the study. This change was quickly made in the checklist and occurred before the team had completed any live intubations. The blood pressure and heart rate values most proximal to the procedure (ideally 5 minutes prior to the intubation and 5 minutes post intubation) were utilized to determine shock index. The timing of these vital signs did vary with each encounter as it is not practical or possible for clinician to record these values at exact time intervals. If any steps were taken to avoid hypotension, the data was recorded as "yes" and if not, "no." These data points were also categorized as ordinal while the data on number of steps taken were also collected and classified as interval level data.

The **fourth dependent variable** was the choice of choosing the correct stylet for the chosen laryngoscope blade. The data collected can also be defined nominal and measured as "yes," the clinician chose the appropriate equipment (laryngoscope blade and stylet) or "no," if they did not. Clinicians on this transport team have the permission and encouragement from the medical directors to use their judgement, experience, and personal preference to choose the most appropriate blade for the situation, however, the stylet chosen must be appropriate for the specific blade. The main objective as it pertains to this variable helps understand if the stylet chosen is appropriate for the laryngoscope blade (hyper-angulated blade used with rigid stylet and bougie or malleable stylet used with curved (also known as a Macintosh) blade.

Academically speaking, for patients with emesis/blood/secretions in their airway the curved blade with the malleable stylet is ideal as it allows the ability to use direct visualization of the airway if the camera on the video laryngoscope becomes obstructed. Alternatively, a patient with possible cervical spine injury or limited neck mobility due to habitus may be better served when the hyper-angulated blade with a conforming rigid stylet is utilized. The hyper-angulated blade allows the intubator to see anatomy and pass an endotracheal tube without much movement of the head and neck. Data was collected as “yes” the choice was appropriate, or “no,” the choice was not appropriate for this situation (coded as ordinal) as determined by the medical director/s opinion of the individual scenario.

The **fifth dependent variable** helped ascertain if the checklist was helpful in confirming the correct placement of the ETT with capnography and at least one other method (chest x-ray, direct visualization, symmetric breath sounds, chest rise, and condensation in the ETT). This is in direct correlation to the metric defined by GAMUT (2021). Waveform capnography should be utilized after every intubation as it is highly sensitive and specific in confirming placement into the trachea and is considered the gold standard (Silvestri et al., 2017). This data was collected as a “yes” if the clinicians utilized more than one method of confirmation or “no,” if they did not and categorized as ordinal.

Finally, the **sixth dependent variable** was assessed with respect to both **quantitative and qualitative** data. It is measured in terms of a simple survey which was requested of each clinician performing an intubation during the study period. The questions were written in a “yes or no” format regarding their opinion of the usefulness of the checklist in contributing to first pass success, avoidance of hypoxia, avoidance of hypotension, choosing the correct intubation equipment, and remembering to verify placement with capnography and one other method. Responses were coded as nominal data. Qualitative data was obtained by using a final open-ended question requesting suggestions on what clinicians found valuable about the checklist and recommendations regarding how the checklist could be improved.

One of the extraneous variables for this project was the time taken to intubate. Typically, it is optimal to complete this procedure in a short amount of time, and to attempt to take too much time mitigating possible adverse events could be detrimental in and of itself. This study did not measure the time taken to intubate due to limited personnel and transport environment limitations. Other extraneous variables are numerous but include the number of people present to assist with gathering equipment and preparing the patient, the equipment used, the experience of the clinician, the space where the intubation takes place (hospital, helicopter, on-scene outside), and if the intubation checklist was omitted due to circumstances such as cardiac arrest. Medical directors for the program allow the omission of the checklist in these situations where induction medications will not be necessary. These cases were excluded from the data. Additionally, if a provider, who is not a member of the transport team performed the intubation, the procedure was not included in the study.

Description of Intervention and Treatment Protocol and Data Collection

Intervention

The checklist's introduction involved presentation of a brief demonstration video developed by the DNP student with the medical director illustrating the intended execution during a simulated intubation on a mannequin. One of the educators played the part of the second team member in the video demonstration. The video program and accompanying detailed explanation of all aspects of the trifold was less than 10 minutes in length and was uploaded to the team’s educational website. Completion status for each individual team member was recorded on the educational platform. This method allowed team members to view the training while on duty and was expected to be completed within a two-week period, but was available for review throughout the study. During routine quarterly skills practice (after implementation of the new checklist) in the program's simulation lab, the clinicians were expected to practice with the updated checklist in place of the original checklist. They had use of a mannequin head with the necessary airway equipment including the video laryngoscope with both the curved blade and the hyper-angulated blade and appropriate stylets. They were expected to simulate medication administration and verbalize thought processes regarding the airway situation.

Increased patient safety was ideally achieved as team members recognized situations prior to intubation which needed to be addressed, and ideally, took subsequent action to address those needs. For example, choosing appropriate equipment for the airway situation at hand, providing optimal pre-oxygenation, and recognizing an elevated shock index early to mitigate actual or potential hypotension with administration of fluids, epinephrine, were all goals for which the checklist was designed to bring into consideration to optimize patient safety. At the end of the two-week period, the checklist replaced the older version in the equipment sets used by the team and a copy given to each clinician. An electronic version of the revised checklist was also available for download to personal devices.

The Checklist in Appendix E was revised by the DNP student and underwent multiple revisions based on feedback from the program's medical directors, current leadership, educators, and front-line clinicians. The final design was based on the above input and current literature pertaining to intubation checklists and checklists used in other healthcare settings. An update to the medication dosage was required shortly after implementation and before any actual intubations occurred. New cards were created and distributed accordingly. The development of checklists, how they should be executed, and actual intubation checklists currently utilized in the industry were reviewed (Burian et al., 2018; Kulp, et al., 2019; Papali et al., 2021; Sevilla-Berrios et al., 2018; Stevens et al., 2011; Weingart & Hua, 2014). The physical version consisted of a trifold, laminated card which fit into the flight suit worn by clinicians and the airway equipment bag. The previous checklist was also a laminated card which had the equipment checklist on the front and some pertinent resources on the back. Many of the elements from the previous checklist were incorporated into the latest version. Additions/changes were primarily related to specifically considering personal protective equipment (PPE), planning for an emergent airway, leading with suction, blade variations, and increased detail on recognizing and treating an elevated shock index.

Specifically, changes to the checklist included planning for the emergent airway (Stage I), an updated checklist to be read aloud just prior to the procedure (Stage II), and a list necessary steps to take post-intubation (Stage III). Stage II was the crux of the project and procedure and is the *new checklist.* The back of the card included emergency resources including endotracheal tube (ETT) and laryngoscope blade sizes, ventilator settings to use if active CPR is needed, an ideal body weight table which is necessary to obtain appropriate ventilator settings, and a medication list which depicts doses of medications used for intubation in patients with either stable or unstable hemodynamics and dosing for commonly used vasopressors. McConnell et al. (2016) looked at post intubation checklists specifically and found improvement in obtaining arterial blood gases within 60 minutes. Tools to assist the clinician in placing patients on a ventilator early was considered an important aspect to include in the references for this tool. The new checklist also included reminders to lead with suction prior to inserting the video laryngoscope blade. In addition to clearing the airway and lessening the possibility of contaminating the camera lens on the blade, thorough suctioning can better facilitate first pass success and lessen the chance of aspiration.

The choice of laryngoscope blade has also evolved over time. The transition in training to utilize more frequently the curved laryngoscope blade, provided an added benefit whereby the clinician can use this blade to look directly at the airway (the more traditional method of intubating) should the camera lens become obscured. Having both the curved blade and the hyper-angulated video laryngoscope blade available for initial airway attempts allows the clinician to choose the optimal equipment for the patient’s condition and situation. Each blade should be used with particular stylets, however. When using the hyper-angulated blade, a specific rigid stylet is optimal as it follows the curve of the blade and leads to the most optimal view. If the curved blade is selected, the malleable stylet or a bougie is preferred.

When a contaminated airway is recognized, the choice of laryngoscope blade should be the curved blade in most cases as it can be used as a standard blade if the camera lens becomes obscured as stated above. In the setting of a patient with known or suspected cervical spine trauma, a more ideal tool may be the hyper-angulated blade which allows for intubation while avoiding unnecessary movement of the cervical spine. The hyper-angulated blade also makes it easier to see landmarks when head movement may be limited due to size/anatomy, however it should not be utilized without camera functionality. Each patient is unique and may have different considerations, or a combination of the above scenarios, in which case it is up to the clinician to choose the blade they are most confident in will enable them to achieve first pass success. The new checklist provides a section which prompts the clinician to consider these situations and choose the most appropriate blade. Leading with suction and choosing the ideal blade for the situation should improve the ability to successfully obtain intubation on the first attempt.

There are potential threats to the validity and reliability. Validity (external and internal) is the “degree to which an instrument measures what it is intended to measure (Moran et al., 2020 & Polit, 2010).” For this checklist project, there is a significant threat to internal validity. As the transport clinicians have more experience intubating and learning the proper ways to avoid adverse events, they should naturally become more proficient with things such as first pass success, avoidance of hypoxia and hypotension. These things could occur irrespective of the checklist and would not likely be solely because of the new checklist.

Since there was a small sample size, and the training and education received by the team is unique, the external validity, or ability to extrapolate findings to other populations, is limited. Additionally, this transport team has been utilizing an intubation checklist for several years and teams new to adopting a checklist of this nature may not see the same results. The reliability, which is the reproducibility of the results, would depend on the team's experience and the type of checklist used. Furthermore, analysis of this data may also be negatively impacted as it is not ideal if the sample size is small (Terry 2018). Despite these threats and limitations, the updated checklist provided a valuable tool which is reflective of current practice and can assist clinicians in this high risk, low volume procedure.

As mentioned, due to new state regulations which mandated a change in the dosing of rocuronium for paramedics, the checklist needed to be updated shortly after the study commenced. Necessary changes were made to the dosing and new checklists distributed and explained to the team. This change also affected what was a potential intervention in addressing an elevated shock index or actual hypotension as the changes no longer allowed rocuronium to be dosed at 2mg/kg. It is difficult to discern how this change may have affected the shock state of the patients intubated by the team.

Treatment Protocol and Data Collection

The DNP student project lead adhered to the following protocol when carrying out this QI initiative:

Step 1 – Tri-Fold Intubation Checklist and Electronic Medical Record Data Collection Tool created (See Appendix F).

Step 2 – Training videos created demonstrating expected use of the checklist.

Step 3 – Approval as QI project was granted from clinical site QI/QA committee; Regis University IRB also determined the study was not classified as human research and was designated as a QI initiative.

Step 4 – The project was introduced, and the information sheet distributed (See Appendix G).

Step 5 – Training video was posted on an online education website. Clinicians were expected to view within two.

Step 6 – Checklist distributed and go-live for use in clinical practice announced (3 months).

Step 7 – Prospective chart review commenced two weeks post implementation, occurring weekly for study period of 3 months. Note: Clinical Director for the program sent reports containing necessary data from charts in redacted form (no patient or employee identifiers were recorded).

Step 8 –Retrospective chart review/data collection was performed until the number of intubations pre-intervention matched the number of post-intervention intubations. Note: Clinical Director sent report which contained necessary data from charts in redacted form (no patient name or date of birth).

Step 9 – Survey distributed to clinical team at end of study period and remained open for responses for a three-week period. Reminders were sent to encourage participation.

Step 10 – Data analysis performed with assistance from Regis University statistics faculty.

Step 11 – Defended Project Defense to LHSON DNP Chairs.

Step 12 – Arrangements to disseminate findings to Leadership and clinicians of critical transport team.

Protection of Human Subjects

This project was undertaken as a Quality Improvement Initiative and was not formally supervised by the clinical site Institutional Review Board. Upon purview of DNP project documents submitted through IRB Net, Regis University IRB also determined this study as not meeting the definition of human research.

The protection of human subjects is of utmost importance. As stated, an information sheet was provided to the clinicians at the beginning of the study. The DNP student ensured confidentiality and privacy of patient data from electronic medical record (EMR) and clinician identities who participated in training and used the checklist during an actual intubation patient encounter. The EMR for the transport team was separate from the EMR used by the rest of the hospital system. The DNP student had access only to necessary EMR data, specifically intubation data in redacted form reported by the team's clinical director. The Clinical Director shared de-identified data with the DNP student through the hospital's secure email system. All adult/pediatric team clinicians were required by the leadership team and medical directors to complete training on revised EIT checklist and to use the new checklist for each procedure where medication-facilitated intubation occurs as the organization has determined the checklist is standard practice. Training was not completed by all clinicians despite program requirements to do so. Clinician EMR documentation following each intubation event was required (also standard practice). Clinician participation in the post-intervention survey was voluntary. Risks are none or minimal for the clinicians. Use of the new revised tool might initially minimally increase time for intubation; however, clinicians were familiar with utilizing a checklist for intubations, updated evidence-based revisions are minimal, and the literature strongly supports the use of a checklist as it can significantly reduce severe hypoxemia and cardiovascular collapse. It was also possible, the checklist, which aligns with expected practice, decreased time to intubation. Risks to patients from chart reviews were none since documentation occurred after the intubation and patient transport, and patient confidentiality was maintained. EMR review by team leadership is customary practice within the organization. The Collaborative Institutional Training Initiative (CITI) curriculum for Biomedical and Social Behavioral Researchers was successfully completed by the DNP student to ensure appropriate measures were in place to protect the patients, as well as the clinicians, to fullest extent possible during this study. Additionally, approval from the department Medical Directors, Clinical Director, Vice President of Ethics and Compliance as well as the Assistant Vice President for Clinical Research have reviewed the data collected and this project to assure appropriateness.

Instrumentation Description and Validity and Reliability

Electronic Record Data Collection Tool (Appendix F**)**. The electronic record data collection tool was created by the DNP student and reviewed and approved by the mentor, clinical leadership and Vice President of ethics and compliance prior to use. The tool was based on the revised checklist items recorded in the patient's chart for QA/QI evaluation of ETI performed by critical care transport teams.

There are issues concerning the data's validity and reliability given the relatively uncontrolled and variable situations in which these intubations occur. First pass success, mechanisms to assure airway patency and oxygenation, steps taken to mitigate shock index, and blade/stylet are reported by the operator in the EMR, and the thought process often reflected in the narrative involve some level of subjectivity and could be inadvertently omitted. The other main concern with reliability is the estimation of time that must occur if vital signs are not captured on the program's equipment versus using monitoring that occurs via hospital or other emergency medical services devices. This could affect the reliability of determination of shock index and levels of hypoxia as the clinician may be relying on memory or other notes taken in real time. All data will be considered to assure the variables are measured as accurately as possible.

Qualitative data was collected in the form of a survey which was distributed to the clinicians immediately following the study period (Appendix H). It consisted of questions regarding the subjective opinion of the user on the utility of the checklist in the practice setting as well as in transport. Clinicians were asked to elaborate on what was most useful and to describe any opportunities for improvement. The survey was developed by the DNP student and reviewed by the clinical mentor.

Data Analysis

The EMR for each transport in which an intubation was performed by the critical care transport team was examined to elicit variable data. The type of data collected was ordinal or interval (yes or no and number of steps taken) for the main variables in both the quantitative and qualitative arms of this mixed-methods study. Pearson Correlation and Wilcoxon Tests were conducted on the three main outcomes described above (first pass success and avoidance of hypotension and hypoxia) as well as on secondary outcomes including correct ETI blade and stylet used and methods to confirm successful intubation. This depicts if the results of each category had a statistically significant relationship and if it differed from what occurred before intervention (Polit, 2010 &Terry, 2018). Multiple datapoints collected aided in informing which steps taken may have been most influential in the results of the primary and secondary outcomes as well as incidental findings. The magnitude of the relationships is derived by using the correlation coefficient “R.” (Polit, 2010).

Quantitative data was analyzed using SPSS software to determine correlation and statistical significance of data collected from chart review. Qualitative data collected from the clinicians via an anonymous survey was also analyzed independently by a member of the Regis faculty and the DNP student. Agreement was reached regarding the survey result and themes and trends were subsequently analyzed.

Project Findings and Results

Statistical tests were performed for the parametric and non-parametric data collected and organized by the study primary and secondary objectives. Refer to Appendix I to view a Summary of the Pearson Correlation Data which shows measurements of statistical relationships between study variables collected in both the original checklist and revised checklist. As shown in Appendix J, the Wilcoxon Test was also performed for all data points for comparison of original checklist group data to revised checklist group data. Statistically significant findings are summarized in the following paragraphs. Specific metrics were also compared within both the original group and revised checklist group to determine if interventions taken to avoid hypoxia and hypotension had significant effects on oxygen saturations, shock index, and systolic blood pressure (pre and post intubation). As visualized in Appendix K, survey data were compiled and reported as frequencies and percentages to the “yes” or “no” questions. Themes and trends from the open-ended responses (identified by two reviewers) are discussed later in this section. All study findings are summarized as they relate to each objective.

First Pass Success (FPS)

Improvement in FPS increased from 75% in the original checklist group to 92% in the new checklist group. Although not statistically significant by either the Pearson Correlation or Wilcoxon Test, this equates to a 22% (.75-.92/.75) improvement from the original to new checklist group. In the original checklist group both SBP <=90 mmHg (pre and post intubation) correlated negatively to FPS (Z= -2.33, p .020; Z=-.245 p = .014), thereby if the SBP was not <=90 mmHg, this was associated with FPS. Similarly, an SpO2 <90% negatively correlated to FPS both pre and post intubation (Z=-2.33, p.020; Z= -2.33, p = .020), thereby if the SpO2 was not <90%, this also correlated with FPS. FPS in the new checklist group negatively correlated to both a SI >=1 (Z = -2.65, p = .008) and SpO2 <90% prior to intubation (Z = -2.83, p = .005). For a summary of these correlations, refer to Table 2 below. Although not primary objectives, the above data suggests that when SI, SBP, and SpO2 were not abnormal, the chance of first pass success was greater. One may infer from this, that patients who have more stable physiology as it pertains to oxygenation and hemodynamics, may more likely be intubated on the first attempt. It was also discovered, leading with suction in the revised checklist group also had a significant correlation to first pass success (p = .003).

Table 2

Correlations to First Pass Success

Original Checklist Group		
Correlations	**Pre-Intubation**	**Post-Intubation**
SpO2 < 90%	Z = -2.33, p = .020	Z = -2.33, p = .020
SBP < 90 mmHg	Z = -2.33, p = .020	Z = -2.45, p = .014
New Checklist Group		
Correlations	**Pre-Intubation**	
Shock Index >1	Z = -2.65, p = .008	No statistically significant correlation found
SpO2 <90%	Z = -2.83, p = .005	No statistically significant correlation found

There were complications noted in those cases where first pass success was not achieved. In the control group, two of the three cases requiring multiple intubation attempts, had complications of a SI equal to or greater than one post intubation (one of the two also had an elevated SI prior to intubation). In the revised checklist group, the only patient who was not successfully intubated on the first attempt, was hypoxic (SpO2 < 90%) prior to intubation, but oxygen saturation did improve to greater than 90% post intubation. Although there was improvement in the first pass success rate, survey results indicated 44% (7/16) of respondents did not think revised checklist contributed to this.

Avoidance of Hypoxia

The number of cases where any steps were taken to avoid hypoxia increased from 67% (8/12) in the original checklist group to 75% (9/12) in the revised checklist group and 75% of survey respondents found the new checklist helpful in achieving this. Only one patient in each group was hypoxic (SpO2 <90%) post-intubation. This is a 12% improvement [(.67-.75)/.67]. As shown in Table 3 below, other statistics show SpO2 <90% before and after intubation in the original checklist group were negatively correlated to any steps taken prior to intubation to avoid hypoxia (Z= -2.45, p= .014; Z= -2.45, p= .014). The same correlations were found in the new checklist group both before and after intubation: SpO2 <90% correlated negatively to any steps taken to avoid hypoxia (Z= -2.45, p = .014; Z = -,2.646, = .008). This data suggests that if steps were taken to avoid hypoxia, it did contribute to SpO2 values not being below 90% throughout the procedure. In the original checklist group, hypotension (SBP <= 90 mmHg) post intubation positively correlated to an elevated SI (R = .81, P = .003) which supports an elevated shock index can be a surrogate to SBP.

Table 3

Correlations to Avoidance of Hypoxia

SpO2 < 90%	Pre-Intubation	Post-Intubation
Original Checklist	Z = -2.45, p = .014	Z = -2.45, p = .014
New Checklist	Z = -2.45, p = .014	Z = -2.65, p = .008

Avoidance of Hypotension

In the original checklist group, 58% (7/12) took steps to avoid hypotension which increased to 67% (8/12) in revised checklist group or a 13.4% increase (.58 - .67/.67). Prior to intubation 33% (4/12) of these patients had an elevated SI, and in each case, measures were taken to mitigate this (three cases took more than one step and one took one step), but all four cases still had a SI greater than or equal to one post intubation. Two additional patients, in this original group, who did not show signs of hypotension pre-intubation, did have an elevated SI after the ETT was placed. In the end, half of these patients (6/12) had an elevated SI and 25% (4/12) had a systolic blood pressure less than or equal to 90 mmHg post intubation. An elevated SI pre-intubation correlated with an elevated SI post intubation (R=.828, p =.002) but this was not the case in the revised checklist group.

As noted in Table 4 below, in the original checklist group an SBP<=90 mmHg post intubation had a negative correlation to any steps taken to avoid hypotension and the number of steps taken to avoid hypotension (Z= -2.00, p = .046; Z= - 2.12, p = .034). In the new checklist group, findings were similar as SBP < =90 mmHg prior to intubation correlated negatively to steps taken to avoid hypotension (Z = -2.24, p = .025). Thereby, steps taken to avoid hypotension correlated to an SBP not being less than or equal to 90 mmHg.

Table 4

Correlations to Avoidance of Hypotension

Original Checklist Group		
	If steps taken to avoid hypotension	**Number of steps taken to avoid hypotension**
SBP < 90 mmHg Post Intubation	Z = -2.00, p = .046	Z = -2.12, p = .003
New Checklist Group		
	If steps taken to avoid hypotension	No statistically significant correlation found
SBP < 90 mmHg Post Intubation	Z = -2.24, p = .025	No statistically significant correlation found

Shock index did correlate positively with hypotension (SBP <=90 mmHg) in the post intubation groups for both the original and revised checklist groups supporting the concept that SI may be a reliable marker for hypoperfusion.

In the revised checklist group, 33% (4/12) had either an elevated SI or SBP less than or equal 90 mmHg prior to intubation. Steps were taken to mitigate this only 50% of the time. The number of patients post intubation who had an elevated shock index doubled to 67% (8/12) and seven of these 8 patients also had an SBP less than 90 mmHg. Over half (56%, 9/16) of survey respondents felt the checklist was helpful in avoiding hypotension.

This data is concerning as some patients who did not have objective signs of poor perfusion (elevated SI or hypotension), did have these indicators post intubation. This conveys that any patient undergoing ETI has a risk of developing signs of poor perfusion post procedure.

Clinicians should be diligent, not only in recognition of hypo-perfused states, but should make further efforts to optimize hemodynamics prior to administering medications to facilitate ETI.

Appropriate Blade and Stylet Utilized

Use of the correct blade/stylet combination in the revised had a strong negative correlation to post SpO_2 less than 90% ($R = -.667$, $p = .035$), meaning if the correct equipment was used, the post intubation saturations were not less than or equal to 90%.

The data in the original checklist group was limited as only 25% (3/12) documented the type of stylet used. However, each of the three cases documented the correct blade/stylet combination and achieved successful intubation on the first attempt, and the medical director agreed with their equipment choice. In the new checklist group, 83% (10/12) used the correct blade and stylet combination. In the two cases where the optimal blade/stylet combination was not used, first pass success was still achieved. The medical director determined the clinicians made the correct blade choice in all twelve cases. The data in this study does not appear to support choice of equipment in these cases affected first pass success. Over half (56%, 9/16) of survey respondents indicated the revised checklist was helpful in choosing the correct blade/stylet combination for their patients.

Confirmation of Correct ETT Placement

In the original checklist group 100% of clinicians verified correct tube placement with waveform capnography and one other method and 83% (10/12) verified with two additional methods. Those using the new checklist had 100% verification of ETT placement with waveform capnography and at least two other methods. Updated documentation requirements to record methods of confirmation, initiated prior to the study period, seems to have had a positive effect on this metric. Exactly 50% (8/16) survey respondents thought the revised checklist helped with this aspect of care and documentation.

Survey Feedback

The survey was completed by 16 out of 45 clinicians (36%), eight of whom reported utilizing the new checklist in a live intubation. For the survey questions that asked for feedback on the usefulness of the revised checklist and suggestions for improvement, two themes emerged. Although the survey results were mixed as to which elements of the checklist were most useful, many of the comments supported the first theme that the **reference was useful**. Specific comments included “the order of the checklist represented the order of the actions I take when preparing to intubate a patient” and “having the resources, i.e., sizes for various ages available on the checklist was helpful.” The second theme identified was the checklist being perceived as being busy with a preference for a **simpler format for delivery**. Comments related to this theme included, “The checklist can be pared down quite a bit” and it was “too busy for real life application.” This feedback supports the possible need to reformat and make the checklist more concise. Additionally, practice may also be warranted as one clinician summarized “My first use of the checklist felt slow even though I had reviewed it several times. I think with more use it will become more comfortable.”

Survey nominal data results were discussed in the previous section as related to each outcome measurement, and as noted in Appendix K there was a 50% or greater favorable response for most items.

This project’s intent was to investigate whether the implementation of an updated comprehensive checklist would lead to improved first pass success and avoidance of hypoxia and hypotension in the peri-intubation period by clinicians on a critical care transport team. Even though statistical significance was not established with all measures, there was positive clinical significance in the findings. Responses in the post-survey (open-ended and closed-ended questions), even though many were positive, may indicate that nurses still have concerns about their confidence level in using the revised checklist.

Limitations, Recommendations, Implication for Change

Limitations with this QI study was a small sample size. The program had reported its smallest number of intubations in the past several years. The number of intubations during the peaks of the COVID-19 pandemic had increased, but concurrently it was noted by the transport team, treatment with non-invasive means such as high-flow nasal cannula, CPAP, and BiPAP had also increased. A study by Menzella, et al. (2020) of 79 patients with COVID-19 pneumonia demonstrated over half of the patients avoided intubation with the use of non-invasive strategies which supports the trends noted by the transport team. An additional limitation was the overall training completion rate of 82%. Although the training was mandatory, per the leadership, 37 out of 45 clinicians completed this. The number of adult/pediatric team members (those much more likely to complete an intubation in transport; however, did have a completion rate of 85% (35/41). Finally, documentation of some items was limited in the pre-intervention group as elements studied were not required to be recorded in the EMR before the study. These included the type of stylet used and if the clinician led with suction in the process of intubating. In turn, the study could be credited for an improvement in practice as these elements are now part of required documentation which can provide relevant practice information going forward.

Recommendations from this project include continual data collection for this transport team relating to the objectives above. It was encouraging to see an increase in first pass success, but the relative number of intubations studied was low, so continued data collection will help establish what steps most significantly contribute to this goal. Charting requirements which aid in data collection should continue to evolve as these changes were instrumental for the analysis in this study. Completion of training materials and confirmed understanding of the intended use of the checklist should be verified for 100% of the clinicians using the tool to understand what works and what elements of the tool should be modified. Finally, the team's continued diligence to practice the intubation procedure, including increased familiarization and training on the use of the checklist as designed, will be important to maintain competency and optimize efficiency.

Recommendations for nursing and advanced practice include the adoption of checklists for high-risk procedures. Checklists provide a natural time-out and eliminate the need for strict memorization. When new workflow measures are implemented, it is vitally important to train, simulate and practice to assure the tool can be utilized seamlessly in a stressful situation. Finally, it is impossible to understand the need for and effects of change without data collection. Assure measures are in place to review and collect information to help support evidence-based changes and improvements.

The individual patient's needs vary with every intubation, and tailoring the preparation and execution to meet those needs is crucial to optimizing a safe procedure. These elements are difficult to study in the dynamic transport environment. Medical directors and clinicians should continue to adapt larger scale data to their practice as it relates to the avoidance of complications such as hypoxia and hypotension. In the patients studied for this project, few had issues with hypoxia either pre- or post-intubation, but steps to avoid it made a positive impact. Poor perfusion states, recognized by either an elevated shock index or SBP less than or equal 90 mmHg, were prevalent. As stated previously, hypotension in the peri-intubation period is correlated to negative outcomes (Krebs et al., 2021; Mort, 2004; Mosier et al., 2020; Park et al., 2017; Russotto et al., 2022; Sackles et al., 2013). This should be mitigated as much as possible prior to intubation. This should be mitigated as much as possible prior to intubation. This review supports previous studies showing hypotension is common after medications to facilitate intubation are administered. More aggressively recognizing signs of hypotension and optimally and efficiently managing them may be the most significant implication for change.

There are opportunities for improvement of the checklist resource to make it more appealing as suggested by survey respondents. Outside of the checklist portion of the trifold, several resources were included which were noted as valuable by survey respondents. Suggested changes to the checklist itself could include simplifying the steps, without removing items which may be detrimental to patients if omitted. No matter if changes are made to the checklist or not, it is vitally important that clinicians complete necessary training to fully understand how any checklist is intended to be used, to practice with physical and mental models, and to advocate for improvements which will help them be successful.

It is hopeful, that not only this team, but other critical care transport teams will continue to use checklists for high-risk procedures and make changes to incorporate those items which contribute to first pass success, avoidance of complications, and verification of appropriate ETT placement.

Conclusion

ETI is a risky, but often necessary procedure during the care of a critically ill patient during transport. Care must be taken to assure optimal conditions are established to perform this procedure successfully on the first attempt and to mitigate deleterious associated risk factors such as hypotension and hypoxia. Checklists are often utilized by transport providers and those in the hospital setting to cognitively offload the clinician during this stressful time and to assure all appropriate measures are in place to optimize patient outcomes. The checklist must reflect expected performance measures during the procedures to be most efficacious in these time-sensitive scenarios.

The revised checklist for this team seemed to have a clinically significant effect in improved first pass success and an increase in steps taken to avoid hypoxia and hypotension. Continued use and development of this checklist for intubation is encouraged and the adoption of checklists for other low volume, high-risk procedures is recommended.

References

Acker, S. N., Bredbeck, B., Partrick, D. A., Kulungowski, A. M., Barnett, C. C., & Bensard, D. D. (2017). Shock index, pediatric age-adjusted (SIPA) is more accurate than age-adjusted hypotension for trauma team activation. *Surgery*, *161*(3), 803–807. https://doi.org/10.1016/j.surg.2016.08.050

Ahmed, A., & Azim, A. (2018). Difficult tracheal intubation in critically ill. *Journal of Intensive Care*, *6*(1), 49. https://doi.org/10.1186/s40560-018-0318-4

Allgower, M. & Burri, (1967). Shock index. *Dtsch Med Worchenschr*. 92(43), 1947-1950. DOI: 10.1055/s-0028-1106070.

Althunayyan S. M. (2019). Shock index as a predictor of post-intubation hypotension and cardiac arrest: A review of the current evidence. *Bulletin of emergency and trauma*, *7*(1), 21–27. https://www-ncbi-nlm-nih-gov.dml.regis.edu/pmc/articles/PMC6360014/pdf/bet-7-021.pdf.

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

Burgess, M. R., Crewdson, K., Lockey, D. J., & Perkins, Z. B. (2018). Prehospital emergency anaesthesia: An updated survey of UK practice with emphasis on the role of standardisation and checklists. *Emergency Medicine Journal*, *35*(9), 532–537. CINAHL Complete. https://doi.org/10.1136/emermed-2017-206592

Burian, B. K., Clebone, A., Dismukes, K., & Ruskin, K. J. (2018). More than a tick box: Medical checklist development, design, and use. *Anesthesia & Analgesia*, *126*(1), 223–232. https://doi.org/10.1213/ANE.0000000000002286

Chen, C., Kan, T., Li, S., Qiu, C., & Gui, L. (2016). Use and implementation of standard operating procedures and checklists in prehospital emergency medicine: A literature review. *The American Journal of Emergency Medicine*, *34*(12), 2432–2439. https://doi.org/10.1016/j.ajem.2016.09.057

ClinCalc LLC. (2022). Sample Size Calculator. Retrieved from clincalc.com

Conroy, M. J., Weingart, G. S., & Carlson, J. N. (2014). Impact of checklists on peri-intubation care in ED trauma patients. *The American Journal of Emergency Medicine*, *32*(6), 541–544. https://doi.org/10.1016/j.ajem.2014.02.006

Couto, T. B., Reis, A. G., Farhat, S. C. L., Carvalho, V. E. L., & Schvartsman, C. (2021). Changing the view: Impact of simulation-based mastery learning in pediatric tracheal intubation with videolaryngoscopy. *Jornal de Pediatria*, *97*(1), 30–36. https://doi.org/10.1016/j.jped.2019.12.007

Dalrymple, H. M., & Browning Carmo, K. (2020). Improving intubation success in pediatric and neonatal transport using simulation. *Pediatric Emergency Care*, *Publish Ahead of Print*. https://doi.org/10.1097/PEC.0000000000002315

Davidson, L. A., Utarnachitt, R. B., Mason, A., & Sawyer, T. (2018). Development and testing of a neonatal intubation checklist for an air medical transport team. *Air Medical Journal*, *37*(1), 41–45. https://doi.org/10.1016/j.amj.2017.09.010

Denninghoff, K. R., Nuño, T., Pauls, Q., Yeatts, S. D., Silbergleit, R., Palesch, Y. Y., Merck, L. H., Manley, G. T., & Wright, D. W. (2017). Prehospital intubation is associated with favorable outcomes and lower mortality in ProTECT III. *Prehospital Emergency Care*, *21*(5), 539–544. https://doi.org/10.1080/10903127.2017.1315201

Doyle, L., McCabe, C., Keogh, B., Brady, A., & McCann, M. (2020). An overview of the qualitative descriptive design within nursing research. *Journal of Research in Nursing*, *25*(5), 443–455. https://doi.org/10.1177/1744987119880234

Forristal, C., Hayman, K., Smith, N., Mal, S., Columbus, M., Farooki, N., Van Aarsen, K., McLeod, S., & Ouellette, D. (2021). Does utilization of an intubation safety checklist reduce omissions during simulated resuscitation scenarios: A multi-center randomized controlled trial. *Canadian Journal of Emergency Medicine*, *23*(1), 45–53. https://doi.org/10.1007/s43678-020-00010-w

Garcia, C. & Cohen, R. (2020). Why the cost of air ambulances is rising. *National Public Radio*. Retrieved from https://www.npr.org/2020/01/29/800725875/why-the-cost-of-air-ambulances-is-rising.

Gawande, A. (2010). The checklist manifesto: How to get things right. New York: Picador.

Ground and Air Medical Quality in Tranport (GAMUT) (2021). Metrics. Retrieved from https://www.gamutqi.org/GAMUT-Metrics-full.pdf.

Groombridge, C., Maini, A., Olaussen, A., Kim, Y., Fitzgerald, M., Mitra, B., & Smit, D. V. (2020). Impact of a targeted bundle of audit with tailored education and an intubation checklist to improve airway management in the emergency department: An integrated time series analysis. *Emergency Medicine Journal*, *37*(9), 576–580. https://doi.org/10.1136/emermed-2019-208935

Guitton, C., Ehrmann, S., Volteau, C., Colin, G., Maamar, A., Jean-Michel, V., Mahe, P.-J., Landais, M., Brule, N., Bretonnière, C., Zambon, O., & Vourc'h, M. (2019). Nasal high-flow preoxygenation for endotracheal intubation in the critically ill patient: A randomized clinical trial. *Intensive Care Medicine*, *45*(4), 447–458. https://doi.org/10.1007/s00134-019-05529-w

Gunawan, J., Aungsuroch, Y., Watson, J., & Marzilli, C. (2022). Nursing administration: Watson's Theory of Human Caring. *Nursing Science Quarterly*, *35*(2), 235–243. https://doi.org/10.1177/08943184211070582

Janz, D. R., Semler, M. W., Joffe, A. M., Casey, J. D., Lentz, R. J., deBoisblanc, B. P., Khan, Y. A., Santanilla, J. I., Bentov, I., Rice, T. W., Creek, G. P., Haddock, J. L., Vonderhaar, D. J., Lapinel, N. C., Samant, S. D., Paccione, R., Dischert, K., Majid-Moosa, A., Crespo, J., … Griffith, M. (2018). A multicenter randomized trial of a checklist for endotracheal intubation of critically ill adults. *Chest*, *153*(4), 816–824. https://doi.org/10.1016/j.chest.2017.08.1163

Jarvis, J. L., Gonzales, J., Johns, D., & Sager, L. (2018). Implementation of a clinical bundle to reduce out-of-hospital peri-intubation hypoxia. *Annals of Emergency Medicine*, *72*(3), 272-279.e1. https://doi.org/10.1016/j.annemergmed.2018.01.044

Johnston, L., Sawyer, T., Nishisaki, A., Whitfill, T., Ades, A., French, H., Glass, K., Dadiz, R., Bruno, C., Levit, O., Gangadharan, S., Scherzer, D., Moussa, A., & Auerbach, M. (2019). Neonatal intubation competency assessment tool: Development and validation. *Academic Pediatrics*, *19*(2), 157–164. https://doi.org/10.1016/j.acap.2018.07.008

Klingberg, C., Kornhall, D., Gryth, D., Krüger, A. J., Lossius, H. M., & Gellerfors, M. (2020). Checklists in pre-hospital advanced airway management. *Acta Anaesthesiologica Scandinavica*, *64*(1), 124–130. https://doi.org/10.1111/aas.13460

Krebs, W., Werman, H., Jackson, J., Swecker, K. A., Hutchison, H., Rodgers, M., Fulton, S., Brenna, C. C., Stausmire, J., Buderer, N., & Paplaskas, A. M. (2021). Prehospital

Ketamine use for rapid sequence intubation: Are higher doses associated with adverse events? *Air Medical Journal*, *40*(1), 36–40. https://doi.org/10.1016/j.amj.2020.11.007

Kuszajewski, M. L., O'Donnell, J. M., Phrampus, P. E., Robey, W. C., & Tuite, P. K. (2016). Airway management: A structured curriculum for critical care transport providers. *Air Medical Journal*, *35*(3), 138–142. https://doi.org/10.1016/j.amj.2015.12.013

Landham, H. T., Wood, T., Hollis, S., & Shepherd, M. (2015). Quality improvement in endotracheal intubation in a paediatric emergency department: Checklist development and implementation using simulation. *Archives of Disease in Childhood*, *100*(Suppl 3), A249. https://doi.org/10.1136/archdischild-2015-308599.505

Lockey, D. J., Crewdson, K., Davies, G., Jenkins, B., Klein, J., Laird, C., Mahoney, P. F., Nolan, J., Pountney, A., Shinde, S., Tighe, S., Russell, M. Q., Price, J., & Wright, C. (2017). AAGBI: Safer pre-hospital anaesthesia 2017: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*, *72*(3), 379–390. https://doi.org/10.1111/anae.13779.

McEwen, M., & Wills, E. M. (2019). *Theoretical basis for nursing* (Fifth edition). Wolters Kluwer.

Menzella, F., Barbieri, C., Fontana, M., Scelfo, C., Castagnetti, C., Ghidoni, G., Ruggiero, P., Livrieri, F., Piro, R., Ghidorsi, L., Montanari, G., Gibellini, G., Casalini, E., Falco, F., Catellani, C., & Facciolongo, N. (2021). Effectiveness of noninvasive ventilation in COVID-19 related-acute respiratory distress syndrome. *The Clinical Respiratory Journal*, *15*(7), 779–787. https://doi.org/10.1111/crj.13361

Melnyk, B.M., & Fineout-Overholt, E. (2015). *Evidence-based practice in nursing and healthcare* (3rd ed.). Wolters Kluwer.

Miller, M., Kruit, N., Heldreich, C., Ware, S., Habig, K., Reid, C., & Burns, B. (2016). Hemodynamic response after rapid sequence induction with Ketamine in out-of-hospital patients at risk of shock as defined by the shock index. *Annals of Emergency Medicine*, *68*(2), 181-188.e2. https://doi.org/10.1016/j.annemergmed.2016.03.041

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

Mort, T. C. (2004). Emergency tracheal intubation: Complications associated with repeated laryngoscopic attempts: *Anesthesia & Analgesia*, 607–613. https://doi.org/10.1213/01.ANE.0000122825.04923.15

Mosier, J. M., Sakles, J. C., Law, J. A., Brown, C. A., & Brindley, P. G. (2020). Tracheal intubation in the critically ill. Where we came from and where we should go. *American Journal of Respiratory and Critical Care Medicine*, *201*(7), 775–788. https://doi.org/10.1164/rccm.201908-1636CI

Nakstad, A. R., Heimdal, H.-J., Strand, T., & Sandberg, M. (2011). Incidence of desaturation during prehospital rapid sequence intubation in a physician-based helicopter emergency service. *The American Journal of Emergency Medicine*, *29*(6), 639–644. https://doi.org/10.1016/j.ajem.2010.01.013

Papali, A., Ingram, A. O., Rosenberger, A. M., D’Arcy, F. R., Singh, J., Ahlberg, L., & Russell, C. D. (2021). Intubation checklist for COVID-19 patients: A practical tool for bedside practitioners. *Respiratory Care*, *66*(1), 138–143. https://doi.org/10.4187/respcare.08063

Park, L., Zeng, I., & Brainard, A. (2017). Systematic review and meta-analysis of first-pass success rates in emergency department intubation: Creating a benchmark for emergency airway care: systematic review and meta-analysis of ED first-pass success. *Emergency Medicine Australasia*, *29*(1), 40–47. https://doi.org/10.1111/1742-6723.12704

Parsons, N. (2021). What is a SWOT analysis and how to do it right (with examples). Retrieved from https://www.liveplan.com/blog/what-is-a-swot-analysis-and-how-to-do-it-right-with-examples/

Petiprin, A. (2020). Kurt Lewin – nursing theorist. *Nursing Theory*. Retrieved from https://nursing-theory.org/nursing-theorists/Kurt-Lewin.php.

Polit, D. (2010). *Statistics and data analysis for nursing research* (2nd ed.). NJ: Prentice Hall.

Reimer, A. P. & Moore, S. M. (2010). Flight nursing expertise: Towards a middle-range theory. *Journal of Advanced Nursing, 66*(5), 1183-1192. DOI: 10.1111/j.1365-2648.2010.05269.x

Rezale, S. (2018). Dosing sedatives low and paralytics high in shock patients requiring RSI. *REBELEM*. Retrieved from https://rebelem.com/dosing-sedatives-low-and-paralytics-high-in-shock-patients-requiring-rsi/

Russotto, V., Rahmani, L. S., Parotto, M., Bellani, G., & Laffey, J. G. (2022). Tracheal intubation in the critically ill patient. *European Journal of Anaesthesiology*, *39*(5), 463–472. https://doi.org/10.1097/EJA.0000000000001627

Sakles, J. C., Chiu, S., Mosier, J., Walker, C., & Stolz, U. (2013). The importance of first pass success when performing orotracheal intubation in the emergency department. *Academic Emergency Medicine*, *20*(1), 71–78. https://doi.org/10.1111/acem.12055

Sevilla-Berrios, R., O’Horo, J. C., Schmickl, C. N., Erdogan, A., Chen, X., Garcia Arguello, L. Y., Dong, Y., Kilickaya, O., Pickering, B., Kashyap, R., & Gajic, O. (2018). Prompting with electronic checklist improves clinician performance in medical emergencies: A high-fidelity simulation study. *International Journal of Emergency Medicine*, *11*(1), 26. https://doi.org/10.1186/s12245-018-0185-8

Smith, K. A., High, K., Collins, S. P., & Self, W. H. (2015). A preprocedural checklist improves the safety of emergency department intubation of trauma patients. *Academic Emergency Medicine*, *22*(8), 989–992. https://doi.org/10.1111/acem.12717

Silvestri, S., Ladde, J. G., Brown, J. F., Roa, J. V., Hunter, C., Ralls, G. A., & Papa, L. (2017). Endotracheal tube placement confirmation: 100% sensitivity and specificity with sustained four-phase capnographic waveforms in a cadaveric experimental model. *Resuscitation*, *115*, 192–198. https://doi.org/10.1016/j.resuscitation.2017.01.002

Stevens, J. D., Bader, M. K., Luna, M. A., & Johnson, L. M. (2011). Cultivating quality: Implementing standardized reporting and safety checklists. *AJN, American Journal of Nursing*, *111*(5), 48–53. https://doi.org/10.1097/01.NAJ.0000398051.07923.69

Sunde, G. A., Sandberg, M., Lyon, R., Fredriksen, K., Burns, B., Hufthammer, K. O., Røislien, J., Soti, A., Jäntti, H., Lockey, D., Heltne, J.-K., & Sollid, S. J. M. (2017). Hypoxia and hypotension in patients intubated by physician staffed helicopter emergency medical services—A prospective observational multi-centre study. *BMC Emergency Medicine*, *17*(1), 22. https://doi.org/10.1186/s12873-017-0134-5

Talari, K., & Goyal, M. (2020). Retrospective studies – Utility and caveats. *Journal of the Royal College of Physicians of Edinburgh*, *50*(4), 398–402. https://doi.org/10.4997/jrcpe.2020.409

Terry, A. J. (2018). *Clinical research for the doctor of nursing practice (3rd ed.).* Jones & Bartlett Learning.

Trivedi, S., Demirci, O., Arteaga, G., Kashyap, R., & Smischney, N. J. (2015). Evaluation of preintubation shock index and modified shock index as predictors of postintubation hypotension and other short-term outcomes. *Journal of Critical Care*, *30*(4), 861.e1-861.e7. https://doi.org/10.1016/j.jcrc.2015.04.013

Turner, J. S., Bucca, A. W., Propst, S. L., Ellender, T. J., Sarmiento, E. J., Menard, L. M., & Hunter, B. R. (2020). Association of checklist use in endotracheal intubation with clinically important outcomes: A systematic review and meta-analysis. *JAMA Network Open*, *3*(7), e209278. https://doi.org/10.1001/jamanetworkopen.2020.9278

Wijesuriya, J., & Brand, J. (2014). Improving the safety of remote site emergency airway management. *BMJ Quality Improvement Reports*, *2*(2), u202785.w1275. https://doi.org/10.1136/bmjquality.u202785.w1275

W.K. Kellog Foundation (2004). Logic model development guide. https://worldclass.regis.edu/content/enforced/281841-DN_NR707-XIN_XH40_22S8W1/Content/pdfs/LogicModel.pdf?_&d2lSessionVal=EXYTkpSWAPgl6lG5rhzNOBOec&ou=281841

Zaccagnini, M. E. & Pechacek, J. M. (Eds.). (2021). *The Doctor of Nursing Practice Essentials: A model for advanced practice nursing* (4th Ed.) Jones & Bartlett Learning.

Appendix A

Categorization of Literature & Levels of Evidence

Level of Evidence (Melnyk & Fineout-Overholt, 2015)	**Author(s)/Date**	**Number of Articles**
Level I: Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)	Forristal et al. (2021) & Guitton et al. (2019)	2
Level II: Evidence from well-designed RCTs	Denninghoff, et al. (2017) & Janz et al. (2018)	2
Level III: Evidence from well-designed controlled trials without randomization	Althunayyan (2019), Silvestri et al (2017)	2
Level IV: Evidence from well-designed case-control and cohort studies	Acker et al. (2016); Burgess et al. (2018); Conroy et al. (2014); Couto et al. (2019); Dalrymple & Browning Carmo (2020); Davidson et al. (2018); Groombridge et al. (2020); Jarvis et al. (2018); Menzella et al. (2021); Miller et al. (2016); Mort (2004); Sevilla-Berrios et al. (2018); Sheth et al. (2018); Smith et al. (2015); Sunde et al. (2017) & Trivedi et al. (2015)	16
Level V: Evidence from systematic reviews of descriptive and qualitative studies	Chen et al. (2016) & Park et al. (2017)	2
Level VI: Evidence from single descriptive or qualitative studies	Johnston et al. (2018); Klingberg et al. (2020); Krebs et al. (2021); Kuszajewski et al. (2016); McConnell et al. (2016); Papali et al. (2021); & Stevens et al. (2011).	7
Level VII: Evidence from the opinion of authorities and/or reports of expert committees	Ahmed & Azim (2018); Burian et al. (2018); De Jong & Jaber (2021); Mosier et al. (2020); Olvera (2020); Rezaie (2020); Russotto et al. (2022); Weingart (2015)	8
TOTAL		39

Melnyk, B.M., & Fineout-Overholt, E. (2015). Evidence-based practice in nursing and healthcare. (3rd ed.). Philadelphia, PA: Wolters Kluwer

Appendix B

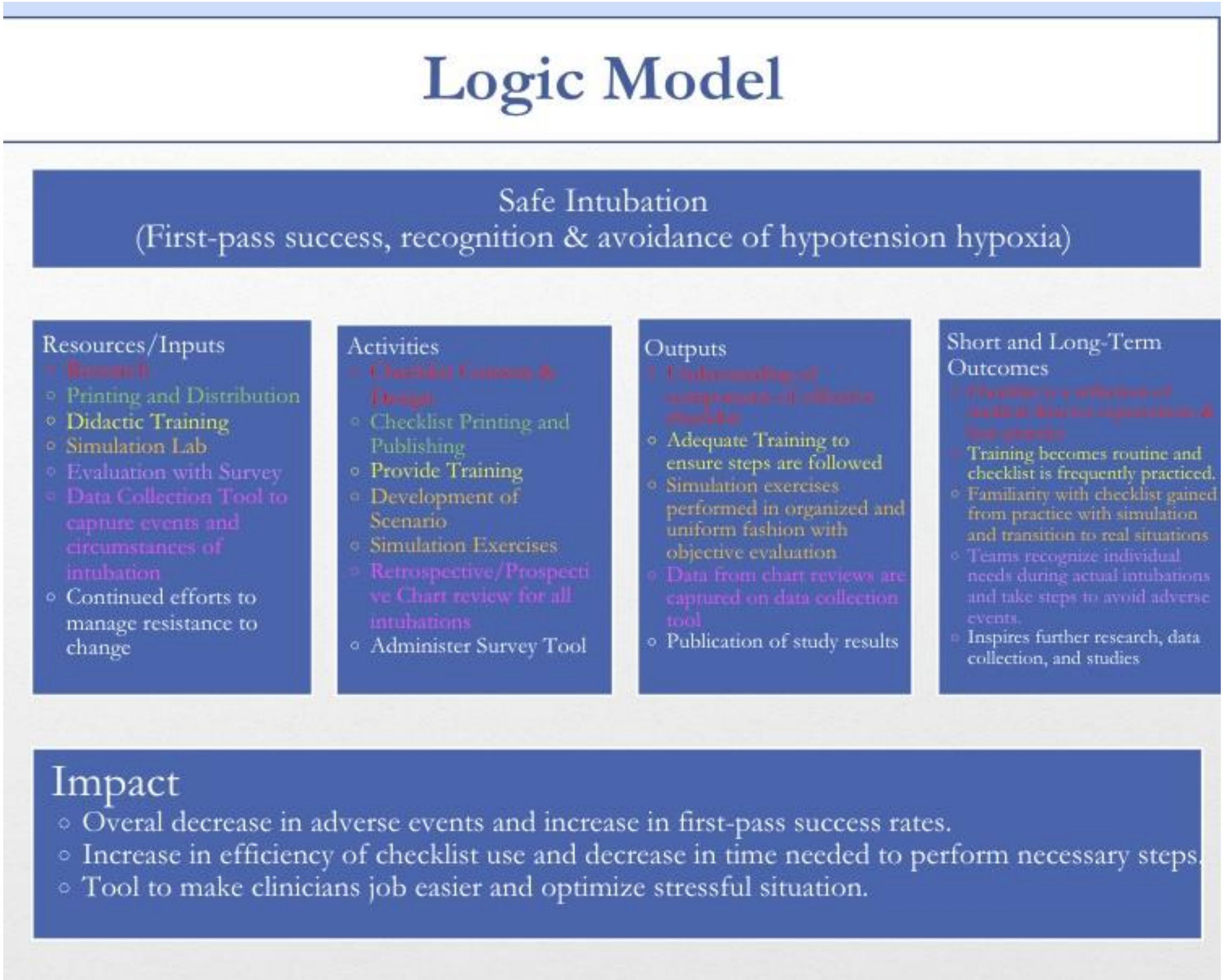
GAMUT Metrics Used in Study

First attempt tracheal tube (TT) success This metric will be categorized by age into the following 3 categories (neonatal defined as infants <29 days, pediatric defined as patients age 29 days to <18 years, and adults defined as age 18 or older)[3]. This metric is reported as "Percent of patient transport contacts successfully intubated on the 1st attempt by the transport team."	**NUMERATOR**: Number of patient transport contacts with successful TT placement during the 1st intubation attempt by the transport team. First-attempt success should not be disqualified by necessary adjustments to the depth of the TT and re-securing it. **DENOMINATOR:** Number of patient transport contacts undergoing intubation by the transport team during the calendar month. *An attempt is defined as the insertion of a laryngoscope or the insertion of any bougie or airway device (e.g. TT or LMA) past the lips.
DASH 1A- Definitive airway "sans" hypoxia/hypotension on first attempt This metric will be categorized by age into the following 3 categories (neonatal defined as infants <29 days, pediatric defined as patients age 29 days to <18 years, and adults defined as age 18 or older)[3]. This metric is reported as "Percent of patients with definitive airway during the 1st attempt by the transport team without suffering hypoxia or hypotension."	**NUMERATOR:** Number of patient transport contacts with successful advanced airway[2] device placement (TT/cricothyrotomy tube/supraglottic airway) during 1st airway attempt by the transport team WITHOUT associated hypoxia or hypotension. An attempt is defined as the insertion of a laryngoscope, the insertion of any bougie or advanced airway[2] device (e.g. TT or LMA) past the lips, or the touching of scalpel or other "cric" instrumentation to the neck. Hypoxia is defined as oxygen saturation newly falling below 90%. Hypotension is defined as systolic blood pressure in adults < 90 mm Hg and SBP <5th percentile in children < 17 years of age. **DENOMINATOR**: Number of patient transport contacts undergoing an airway attempt by the transport team during the calendar month.
Verification of TT placement This metric is reported as the "Percent of intubated patient transport contacts with documentation of confirmed tracheal tube placement."	**NUMERATOR:** The number of patient transport contacts with tracheal tubes, regardless of whether or not the transport team placed them themselves, for which there is documentation confirming placement using capnography plus at least 1 of the following methods for TT confirmation: direct visualization, chest radiograph, or symmetric breath sounds. **DENOMINATOR:** Number of patient transport contacts with tracheal tubes during the calendar month.

Ground and Air Medical Quality in Transport (GAMUT) (2021). Metrics. Retrieved from https://www.gamutqi.org/GAMUT-Metrics-full.pdf.

Appendix C

Logic Model



Project element - Key
Research/Background Development
Training
Simulation
Publishing/Printing Checklist
Evaluation Tool

Appendix D

Timeline

2021

SROL completed

PICO identified

Lit review write-up using themes to support PICO completed

2022-2023

Project proposal written

Site approval letter signed

Project proposal defense

Training videos/material provided to team

Regis IRB/Research Council approval - non-research

Project started. Recruitment with information letter to team sent

Prospective chart review started.

Study period ended

Data collection complete

Analyze data

Final Project Defense

Submit final written proposal

Upload final approved written project to library

Appendix E

New Intubation Checklist Page 1 (Front)

STAGE I – Address Emergent Airway

Considerations for Crash/Emergent Airway (No Medications to Facilitate Intubation)

- Oral/Nasal/Supraglottic Airway(s)
- BVM - Bag/Mask/PEEP/EtCO2/Filter
- Suction – Large Bore
- High Flow NC
- CPAP
- Cric – I.D. Landmarks; Cric Kit
- EZIO for meds

iGEL			
Patient	Weight (Kg)	iGEL Size	NGT (Max)
Neo	2-5	1	None
Infant	5-12	1.5	10 Fr
Small Ped	10-25	2	12 Fr
Large Ped	25-35	2.5	12 Fr

AirQ	
30-50 kg	2.5
50-70 kg	3.5
70-100 kg	4.5

STAGE II - CHECKLIST

PPE – Airborne Precautions

Position
- Elevate HOB and Ramp
- Ear to Sternal Notch/Face Parallel to Ceiling
- Shoulder roll for pediatric patients < 2 yrs
- Stabilize neck– remove collar after meds

Assess
- Assess Head/Airway for Difficulty
- Shock Index Elevated – Treat Early
- Neuro status (MAE?) – Stabilize C-spine

Pre-Oxygenation
- Apneic Oxygen, NRB, CPAP/BiPAP
- Oral/Nasal/Supraglottic Airway(s)
- BVM- Bag/Mask/PEEP/EtCO2
- Cric – ID Landmarks; Cric Kit

Monitor
- SpO2, HR, EKG, EtCO2, & BP every 5

IV - Patent/Start Bolus

Medications
- Ketamine and Rocuronium

Hypotension or Shock Index (HR/SBP) >= 1.0
- Push Dose Epi
- Increase Rocuronium & Decrease Ketamine

Video Laryngoscope
- Attach Blade, Turn On, Verify Recording

Choose Blade/Stylet
- Consider Bougie
- Mac with Flexible Stylet
- Hyper-angulated with Rigid Stylet

ETT
- Correct size & above/below
- Syringe/Check cuff
- ETT holder in position

Lube
- ETT, Stylet, Blade

Suction Operational - Lead with Large Bore Suction

Announce Plan AND Backup Plan

STAGE III - Post Intubation

Verify
- EtCO2 value/waveform
- Depth (3 x size of ETT)
- Secure tube
- Breath sounds
- Check vital signs
- Check ETT Cuff Pressure – 20-30 cm H2O

Vent

Sedation and Analgesia

Chest XR
- Adults ETT between the clavicles
- Peds ETT T2-T3

Consider OGT/NGT

Intubation Checklist Page 2 (Back)

ETT and Blade Sizes

ETT and Blade Sized per Age and Weight						
AGE	Weight	ETT cuffed	ETT uncuffed	ETT Dept (cm)	Glidescope VL Blade	DL Blade
	1kg	N/A	2.5-3.0	7		Straight 0-1
	2kg	N/A	3	8	2	Straight 1
Newborn	3kg	N/A	3-3.5	9	2	Straight 1
6 months	8kg	3.0-3.5	3.5-4.0	9.0-12	2	Straight 1
18 months	13kg	4	4.5	12-13.5	2.5	Str/Curv 2
3 years	16kg	4.5	5	13.5-15	2.5	Str/Curv 2
5 years	20kg	5	5.5	15-16.5	2.5	Str/Curv 2
8 years	30kg	5.5	6	16.5-18	3	Str/Curv 2-3
10-15 years		5.5-7.0	6.5-7.0	16.5-21	3-4	Str/Curv 3
Adult		7.0-8.0	7.0-9.0	21-27	3-4	Str/Curv 3-4
Formulas: Cuffed: (Age in yrs/4) + 3 Uncuffed: (Age in yrs/4) + 4						
Green Denotes ETTs Carried by AirLife						

This Reference Card is for informational purposes only. All information must be verified with your clinical judgement, pharmacy and hospital/agency regulations.

CPR Vent Settings and IBW Chart

1. **Set Gender/Height**
2. **Choose CPR Mode**
3. **Change RR to 10**

TV Goal = 5-6 mL/kg

Female					MALE				
Height	PBW	4 mL	6mL	8mL	Height	PBW	4 mL	6mL	8mL
4'0" (48)	17.9	72	107	143	4'0" (48)	22.4	90	134	179
4'1" (49)	20.2	81	121	162	4'1" (49)	24.7	99	148	198
4'2" (50)	22.5	90	135	180	4'2" (50)	27	108	162	216
4'3" (51)	24.8	99	149	198	4'3" (51)	29.3	117	176	234
4'4" (52)	27.1	108	163	217	4'4" (52)	31.6	126	190	253
4'5" (53)	29.4	118	176	235	4'5" (53)	33.9	136	203	271
4'6" (54)	31.7	127	190	254	4'6" (54)	36.2	145	217	290
4'7" (55)	34	136	204	272	4'7" (55)	38.5	154	231	308
4'8" (56)	36.3	145	218	290	4'8" (56)	40.8	163	245	326
4'9" (57)	38.6	154	232	309	4'9" (57)	43.1	172	259	345
4'10" (58)	40.9	164	245	327	4'10" (58)	45.4	182	272	363
4'11" (59)	43.2	173	259	346	4'11" (59)	47.7	191	286	382
5'0" (60)	45.5	182	273	364	5'0" (60)	50	20	300	400
5'1" (61)	47.8	191	287	382	5'1" (61)	52.3	209	314	418
5'2" (62)	50.1	200	301	401	5'2" (62)	54.6	218	328	437
5'3" (63)	52.4	210	314	419	5'3" (63)	56.9	228	341	455
5'4" (64)	54.7	219	328	438	5'4" (64)	59.2	237	355	474
5'5" (65)	57	228	342	456	5'5" (65)	61.5	246	369	492
5'6" (66)	59.3	237	356	474	5'6" (66)	63.8	255	383	510
5'7" (67)	61.6	246	370	493	5'7" (67)	66.1	264	397	529
5'8" (68)	63.9	256	383	511	5'8" (68)	68.4	274	410	547
5'9" (69)	66.2	265	397	530	5'9" (69)	70.7	283	424	566
5'10" (70)	68.5	274	411	548	5'10" (70)	73	292	438	584
5'11" (71)	70.8	283	425	566	5'11" (71)	75.3	301	452	602
6'0" (72)	73.1	292	439	585	6'0" (72)	77.6	310	466	621
6'1" (73)	75.4	302	452	603	6'1" (73)	79.9	320	479	639
6'2" (74)	77.7	311	466	622	6'2" (74)	82.2	329	493	658
6'3" (75)	80	320	480	640	6'3" (75)	84.5	338	507	676
6'4" (76)	82.3	329	494	658	6'4" (76)	86.8	347	521	694

MEDICATIONS

Rapid Sequence Intubation

Stable Hemodynamics

Ketamine (IBW): 2 mg/kg IV/IO
Rocuronium (IBW): 1 mg/kg IV/IO
Etomidate (ABW): 0.2-0.6 mg/kg IV/IO (20 mg max)

Elevated Shock Index or Hypotension

Push Dose Epi: 5-20 mcg IV/IO
Mix 1 mL of 1 mg/10 m Epi in 9 mL NS =10 mcg/mL
- **Adult: 10-20 mcg**
- **Pediatric**
  - **1-10 kg:** 1 mcg/kg IV/IO
  - **10-50 kg:** 10 mcg IV/IO

Ketamine (IBW): 0.25-0.5 mg/kg
Rocuronium (IBW): 2 mg/kg IV/IO
Etomidate (ABW): 0.15 mg/kg IO

Additional Vasopressor Reference

Epinephrine Drip: (mix 2 mg Epi in 250 mL NS)
- **Adult:** 2-35 mcg/min or 1-2 mcg/kg/min IV/IO
- **Ped:** 0.1-3 mcg/kg/min IV/IO

Norepinephrine Drip: (mix 4 or 8 mg NE in 250 mL NS)
- **Adult:** 2-35 mcg/min or 0.01-3 mcg/kg/min IV/IO
- **Ped:** 0.05-2 mcg/kg/minute

Calcium Chloride:
- **Adult:** 1 GM SIVP in Hemorrhage
- **Ped:** 20 mg/kg of 10% solution SIVP (max 2 gm)

Vasopressin:
- **Adult:** 0.03 units/min (Not first-line pressor. Do not titrate.)

Checklist with Revision to Rocuronium Dosing (See red arrows)

Intubation Checklist Page 1 (Front)

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6'3" (75)	80	320	480	640
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MALE				
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- **Adult: 10-20 mcg**
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- **Adult:** 1 GM SIVP in Hemorrhage
- **Ped:** 20 mg/kg of 10% solution SIVP (max 2 gm)

Vasopressin:
- **Adult:** 0.03 units/min (Not first-line pressor. Do not titrate.)

Appendix F

Data Collection Tool

Data Points Retrieved for Each Intubation Performed During a Transport by a/an ____Crew member.		
Age		
Checklist Used (yes/no)		
Location (hospital, scene, ambulance, helicopter, fixed wing)		
Time of Intubation		
First Pass Success (yes/no) (GAMUT Definition)		
Leading with Suction (suction prior to blade insertion) (yes/no)		
Steps to avoid hypoxia		
Oral or Nasal Airway (yes/no/type)	**Time**	**Details**
LMA (yes/no) prior to ETT Intubation		
HFNC (yes/no/# of liters of oxygen)		
NRB (yes/no/# of liters of oxygen)		
CPAP (yes/no/settings)		
BiPAP (yes/no/settings)		
Suction (other than prior to blade insertion) (yes/no)		
SANS Hypoxia = O2 Sat >90% after start of intubation (yes/no)		
Steps to Avoid Hypotension	**Time**	**Details**
IVF Bolus (yes/no) amount		**(mls)**
Push Dose Epinephrine		**(dose)**
Epinephrine Infusion		**(dose)**
Norepinephrine infusion		**(dose)**
Vasopressin Infusion		**(dose)**
Increase Rocuronium dose (> 1mg/kg) (this does not improve hypotension, but assures adequate drug administration during shock state)		**(dose)**
Decrease Ketamine dose (< 2mg/kg) (yes/no)		**(dose)**
Other agents used for intubation procedure itself instead of Ketamine and Rocuronium (yes/no/describe)		
Avoidance of Hypotension (yes/no) (SI < 1 after intubation)		
Choice of Equipment		

Mac and Flexible Stylet or Bougie (yes/no)				
Mac and Rigid Stylet (incorrect) (yes/no)				
Hyperangulated and Rigid Stylet (yes/no)				
Hyperangulated and Flexible Stylet (incorrect) (yes/no)				
LMA placed in place of ETT (yes/no)				
Vital Signs				
	Time	**SBP**	**DBP**	**SI**
Blood Pressures (SBP/DPB) immediately prior to intubation x 2				
	Time	**Heart Rate**		
Heart Rate (BPM) Immediately prior to intubation x2				
	Time	**SaO2**		
Oxygen Saturation immediately prior to intubation x 2				
	Time	**EtCO2**		
EtCO2 immediately prior to intubation x 2				
	Time	**SBP**	**DBP**	**SI**
Blood Pressures (SBP/DPB) immediately post intubation x 2				
	Time	**Heart Rate**		
Heart Rate (BPM) Immediately post intubation x2				
	Time	**SaO2**		
Oxygen Saturation immediately post to intubation x 2				
	Time	**EtCO2**		
EtCO2 immediately post intubation x 2				
Confirmation of Endotracheal Intubation	**Time**	**Yes/No**		
Direct Visualization (yes/no)				
Chest XR (yes/no)				
Symmetric Breath Sounds (yes/no)				
Condensation in ETT				

This is a pictorial summary. Each data point will be collected for each intubation (including if there are multiple attempts during a single transport) as well as summarized as an aggregate.

Appendix G

Information Sheet

Quality Improvement Project Information Sheet for Critical Care Transport Team Clinicians

Dear Critical Care Transport Team,

One of the requirements for the degree is the completion of a Quality Improvement Project (QI). My project titled, *Implementation of a Revised Intubation Checklist for a Critical Care Transport Team*, is seeking to implement a revised checklist based on best practices to better serve clinicians in accomplishing important steps thereby setting the stage for the safest possible procedure and creating an optimal environment which can decrease adverse events and ideally improve the outcome for the patient. I will analyze intubation data before and after the incorporation of the revised checklist, through retrospective and prospective chart reviews. The revised intubation checklist will be instituted as standard practice _____, therefore, Critical Care Transport clinicians will be required to participate in this QI initiative in the following ways:

1. View a brief training video/demonstration in the online education website (Moodle) before going live with revised intubation checklist.
2. Practice intubations using the revised checklist with mannequins as needed to become comfortable and familiar with the new checklist at base and in the learning lab and during mandatory quarterly skills practice.
3. Use the new checklist during patient intubations (the checklist will be accessible as a durable tri-fold card in all of the equipment bags and as a downloadable electronic version for personal devices. Copies will also be available for you to carry in your flight suit.
4. If you have questions about the checklist use, ask questions of medical director(s), project lead, and team educators.
5. Document all patient intubation procedures in established EMR.

At the end of 3 months following the introduction of the revised intubation checklist, you will be asked to take a survey online to share your feedback on the revised intubation checklist. Clinician participation in post-intervention survey is voluntary. The post-intervention survey is designed to capture the value of your experience in order to make improvements and build upon the concepts enforced by the checklist.

Risks are none to minimal for the clinicians. The DNP student will ensure confidentially and privacy of patient data from EMR and clinician identities who participate in trainings and use of checklist during an actual intubation patient encounter. Use of the new revised tool might initially increase time for intubation (by a few seconds); however, clinicians are familiar with utilizing a checklist for intubations, updated evidence-based content revisions are minimal, and the literature strongly supports use of a checklist as it can significantly reduce adverse events such as severe hypoxemia and cardiovascular collapse. Risks to patients from chart reviews are none since documentation has occurred after the intubation and patient transport, and patient

confidentiality will be maintained. QA/QI EMR data analysis performed by leadership is common practice within the organization. Additionally, approval from the department medical directors, clinical director, VP of Ethics and Compliance as well as the AVP for Clinical Research have reviewed this project to assure appropriateness. The major potential benefits for using the revised checklist are patient safety and quality of care, prevention of adverse effects, potential CAMTS recognition as best practice and lower stress of clinician to have a checklist which mirrors clinical expectations allowing increased mental bandwidth to manage other aspects of the clinical situation.
I am grateful for your time and support as we evaluate the revised intubation checklist with this QI initiative.

Sincerely,

DNP Student Project Lead, Loretto Heights School of Nursing, Regis University

Appendix H

Post Study Survey

The answers to these questions pertain to your experience both with simulated and actual intubations during the study period.

1. Did the revised checklist contribute to achieving first pass tracheal intubation success (yes/no)?
2. Did the revised checklist prompt the intubating team to utilize methods/adjuncts which help to avoid hypoxia in the peri-intubation period?
3. Did the revised checklist help you avoid hypoxia (yes/no)?
4. Did the revised checklist help prompt the intubating team to recognize an elevated shock index and to take steps to avoid/treat hypotension in the peri-intubation period (yes/no)?
5. Was the revised checklist helpful in prompting the intubating team to use the optimal blade and stylet/bougie combination for the patient/circumstance (yes/no)?
6. Did the revised checklist serve as a helpful reminder to perform and document methods of verifying ETT placement in addition to waveform capnography (yes/no)?
7. Did you and/or your partner utilize the revised checklist during an actual patient intubation (yes/no)?
8. Please describe your role at ____ (adult/peds clinician or HROB clinician).
9. What did you find most useful about the revised intubation checklist and the attached resources? Please provide as much detail as possible.
10. Do you have any suggestion for improving the revised checklist? Please provide as much detail as possible.

APPENDIX I

Summary of Pearson Correlation Data with p values less than or equal to .05

ORIGINAL INTUBATION CHECKLIST GROUP (PRE)

Variable	Variable	P-Value	Correlation Coefficient	N	Low-Mod-High	Direction
PRE SI>=1 POST ETT	PRE SI >=1 PRIOR to ETT	0.002	0.828	11	High	Positive
PRE SI>=1 POST ETT	PRE SBP <90 POST ETT	0.049	0.577	12	Mod	Positive
PRE SBP <90 POST ETT	PRE SI >=1 PRIOR to ETT	0.04	0.624	11	Mod	Positive
PRE Were steps to avoid hypotension	PRE SI >=1 PRIOR to ETT	0.019	0.69	11	Mod	Positive
PRE # steps to avoid hypotension	PRE SBP <90 POST ETT	0.039	0.731	8	Mod to High	Positive

REVISED CHECKLIST GROUP (POST)						
POST Were steps to avoid Hypoxia	POST # steps taken to avoid hypoxia	<.001	-0.931	8	High	Negative
POST were steps to avoid hypotension	POST Was the correct stylet/blade combo	0.027	0.632	12	Mod	Positive
POST were steps to avoid hypotension	POST SBP post intubation <90	0.048	0.607	11	Mod	Positive
POST Was the correct stylet/blade combo used	POST SpO2 prior <90%	0.035	-0.667	10	Mod	Negative
POST Was the correct stylet/blade combo used	POST SBP post ETT <90	0.04	0.624	11	Mod	Positive
POST SBP Post ETT <=90	Post SI Post ETT >=1	0.003	0.81	11	Mod	Positive
POST #steps taken to avoid hypotension	POST Were steps taken to avoid hypotension	<001	0.261	8	Weak	Positive
POST intubator leading with suction	POST FPS	0.003	Cannot be computed b/c variable constant			

- **PRE = data collected from retrospective chart review where the original checklist was used.**
- **POST = data collected from prospective chart review where new intubation checklist was used.**

Appendix J

Wilcoxon Tests

Original Checklist Group (PRE) Compared to Revised Checklist Group (POST)

Test Statistics[a]

	POST First Pass Success – PRE First Pass Success	POST Were steps taken to avoid hypoxia? – PRE Were steps taken to avoid hypoxia?	POST Number of steps takent to avoid hypoxia – PRE Number of steps takent to avoid hypoxia	POST Were steps taken to avoid hypotension – PRE Were steps taken to avoid hypotension	POST Number of steps taken to avoid hypotension – PRE Number of steps taken to avoid hypotension	POST Was the correct stylet used with blade chosen? – PRE Was the correct stylet used with blade chosen?	POST Was the correct blade chosen for the situation? – PRE Was the correct blade chosen for the situation?	POST Did the intubator lead with suction? – PRE Did the intubator lead with suction?	POST Was the SI prior to intubation greater than or equal to 1? – PRE Was the SI prior to intubation greater than or equal to 1?	POST Was the SBP prior to intubatin less than or equal to 90 mmHG? – PRE Was the SBP prior to intubatin less than or equal to 90 mmHG?	POST Was the SpO2 prior to intubatin less than 90%? – PRE Was the SpO2 prior to intubatin less than 90%?	POST Was the SI post intubation greater than or equal to 1? – PRE Was the SI post intubation greater than or equal to 1?	POST Was the SBP post intubation less than or equal to 90 mmHG – PRE Was the SBP post intubation less than or equal to 90 mmHG	POST Was the SpO2 post intubation less than 90%? – PRE Was the SpO2 post intubation less than 90%?	POST Was ETT placement verified by Capnography and at least one other method – PRE Was ETT placement verified by Capnography and at least one other method	POST Aggregate Data – PRE Aggregate Data
Z	-1.000[b]	-.447[b]	.000[c]	-.447[b]	.000[c]	-2.985[b]	.000[c]	.000[c]	-.447[d]	.000[c]	.000[c]	-.816[b]	-1.633[b]	.000[c]	.000[c]	-.846[d]
Asymp. Sig. (2-tailed)	.317	.655	1.000	.655	1.000	.003	1.000	1.000	.655	1.000	1.000	.414	.102	1.000	1.000	.398

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. The sum of negative ranks equals the sum of positive ranks.

d. Based on positive ranks.

Original Checklist Group (PRE) First Pass Success Compared to Other Original Checklist (PRE) Data

Test Statistics[a]

	PRE Were steps taken to avoid hypoxia? – PRE First Pass Success	PRE Were steps taken to avoid hypotension – PRE First Pass Success	PRE Was the correct stylet used with blade chosen? – PRE First Pass Success	PRE Was the correct blade chosen for the situation? – PRE First Pass Success	PRE Did the intubator lead with suction? – PRE First Pass Success	PRE Was the SI prior to intubation greater than or equal to 1? – PRE First Pass Success	PRE Was the SBP prior to intubatin less than or equal to 90 mmHG? – PRE First Pass Success	PRE Was the SpO2 prior to intubatin less than 90%? – PRE First Pass Success	PRE Was the SI post intubation greater than or equal to 1? – PRE First Pass Success	PRE Was the SBP post intubation less than or equal to 90 mmHG – PRE First Pass Success	PRE Was the SpO2 post intubation less than 90%? – PRE First Pass Success	PRE Was ETT placement verified by Capnography and at least one other method – PRE First Pass Success
Z	-.378[b]	-.816[b]	-2.919[b]	-1.732[c]	.000[d]	-1.633[b]	-2.333[b]	-2.333[b]	-1.134[b]	-2.449[b]	-2.333[b]	-1.732[c]
Asymp. Sig. (2-tailed)	.705	.414	.004	.083	1.000	.102	.020	.020	.257	.014	.020	.083

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. Based on negative ranks.

d. The sum of negative ranks equals the sum of positive ranks.

Revised Checklist Group (POST) First Pass Success Compared to Revised Checklist (POST) Data

Test Statistics[a]

	POST Were steps taken to avoid hypoxia? – POST First Pass Success	POST Number of steps takent to avoid hypoxia – POST First Pass Success	POST Were steps taken to avoid hypotension – POST First Pass Success	POST Number of steps taken to avoid hypotension – POST First Pass Success	POST Was the correct stylet used with blade chosen? – POST First Pass Success	POST Was the correct blade chosen for the situation? – POST First Pass Success	POST Did the intubator lead with suction? – POST First Pass Success	POST Was the SI prior to intubation greater than or equal to 1? – POST First Pass Success	POST Was the SpO2 prior to intubatin less than 90%? – POST First Pass Success	POST Was the SBP post intubation less than or equal to 90 mmHG – POST First Pass Success	POST Was the SpO2 post intubation less than 90%? – POST First Pass Success	POST Was ETT placement verified by Capnography and at least one other method – POST First Pass Success
Z	-1.000[b]	-1.265[b]	-1.342[b]	-.378[b]	-.577[b]	-1.000[c]	-.577[b]	-2.646[b]	-2.828[b]	-2.000[b]	-3.162[b]	-1.000[c]
Asymp. Sig. (2-tailed)	.317	.206	.180	.705	.564	.317	.564	.008	.005	.046	.002	.317

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. Based on negative ranks.

Original (PRE) and Revised Checklist Group (POST) Comparing Steps Taken to Avoid Hypoxia and Oxygen Saturations < 90% Prior to and After Intubation

Test Statistics[a]

	PRE Was the SpO2 prior to intubatin less than 90%? - PRE Were steps taken to avoid hypoxia?	PRE Was the SpO2 post intubation less than 90%? - PRE Were steps taken to avoid hypoxia?	PRE Was the SpO2 prior to intubatin less than 90%? - PRE Were steps taken to avoid hypotension	PRE Was the SpO2 post intubation less than 90%? - PRE Number of steps takent to avoid hypoxia
Z	-2.449[b]	-2.449[b]	-1.890[b]	-1.414[b]
Asymp. Sig. (2-tailed)	.014	.014	.059	.157

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Test Statistics[a]

	POST Was the SpO2 prior to intubatin less than 90%? - POST Were steps taken to avoid hypoxia?	POST Was the SpO2 post intubation less than 90%? - POST Were steps taken to avoid hypoxia?	POST Was the SpO2 prior to intubatin less than 90%? - POST Number of steps taken to avoid hypotension	POST Was the SpO2 post intubation less than 90%? - POST Number of steps takent to avoid hypoxia
Z	-2.449[b]	-2.646[b]	-1.633[b]	-.577[b]
Asymp. Sig. (2-tailed)	.014	.008	.102	.564

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Original (PRE) and Revised Checklist Group (POST) Comparing Steps (and Number of Steps) Taken to Avoid Hypotension and Shock Index >=1 or SBP <90 mmHg.

Original Checklist

Test Statistics[a]

	PRE Was the SI prior to intubation greater than or equal to 1? - PRE Were steps taken to avoid hypotension	PRE Was the SI post intubation greater than or equal to 1? - PRE Were steps taken to avoid hypotension	PRE Was the SBP prior to intubatin less than or equal to 90 mmHG? - PRE Were steps taken to avoid hypotension	PRE Was the SBP post intubation less than or equal to 90 mmHG - PRE Were steps taken to avoid hypotension
Z	-1.414[b]	-.577[b]	-1.890[b]	-2.000[b]
Asymp. Sig. (2-tailed)	.157	.564	.059	.046

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Test Statistics[a]

	PRE Was the SI prior to intubation greater than or equal to 1? - PRE Number of steps taken to avoid hypotension	PRE Was the SI post intubation greater than or equal to 1? - PRE Number of steps taken to avoid hypotension	PRE Was the SBP prior to intubatin less than or equal to 90 mmHG? - PRE Number of steps taken to avoid hypotension	PRE Was the SBP post intubation less than or equal to 90 mmHG - PRE Number of steps taken to avoid hypotension
Z	-1.134[b]	-1.414[b]	-1.890[b]	-2.121[b]
Asymp. Sig. (2-tailed)	.257	.157	.059	.034

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Revised Checklist

Test Statistics[a]

	POST Was the SI prior to intubation greater than or equal to 1? - POST Were steps taken to avoid hypotension	POST Was the SI post intubation greater than or equal to 1? - POST Were steps taken to avoid hypotension	POST Was the SBP prior to intubatin less than or equal to 90 mmHG? - POST Were steps taken to avoid hypotension	POST Was the SBP post intubation less than or equal to 90 mmHG - POST Were steps taken to avoid hypotension
Z	-1.134[b]	-.577[c]	-2.236[b]	.000[d]
Asymp. Sig. (2-tailed)	.257	.564	.025	1.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. Based on negative ranks.

d. The sum of negative ranks equals the sum of positive ranks.

Test Statistics[a]

	POST Was the SI prior to intubation greater than or equal to 1? - POST Number of steps taken to avoid hypotension	POST Was the SI post intubation greater than or equal to 1? - POST Number of steps taken to avoid hypotension	POST Was the SBP prior to intubatin less than or equal to 90 mmHG? - POST Number of steps taken to avoid hypotension	POST Was the SBP post intubation less than or equal to 90 mmHG - POST Number of steps taken to avoid hypotension
Z	-1.633[b]	.000[c]	-1.633[b]	.000[c]
Asymp. Sig. (2-tailed)	.102	1.000	.102	1.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. The sum of negative ranks equals the sum of positive ranks.

- **PRE = data collected from retrospective chart review where the original checklist was used**
- **POST = data collected from prospective chart review where new intubation checklist was used.**

Appendix K

Survey Data Summary

Did the Revised checklist contribute to:	Yes	No	% Favorable
First Pass Success	7	9	44%
Methods to avoid hypoxia	12	4	75%
Methods to recognize and avoid hypotension	9	7	56%
Use optimal blade/stylet for circumstance	9	7	56%
Multiple methods of verification ETT placement	8	8	50%
Used during live intubation	8	8	50%