DNP Scholarly Project Final Approvals

The DNP student Richard Kirby **and the Scholarly Project** Prevention of Extubation Failure **meet all the requirements for the degree of Doctor of Nursing Practice at University of Saint Francis-Fort Wayne, IN.**

Date of Final Approval: 6/18/21

DNP Student Signature: Richard Kirby

DNP Faculty Advisor Signature: Carla Mueller

Graduate Nursing Program Director Signature: Wendy Clark

NAP Program Director Signature:

Copies to: Student File, Graduate office and attached to the Final Project Manuscript.

Prevention of Extubation Failure: DNP Manuscript

Richard N. Kirby, BSN, RN, USF DNP-NAP Student

In Order to Meet Requirements for Doctorate of Nursing Practice at University of Saint Francis

University of Saint Francis Nurse Anesthesia Program

May 23, 2021

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DNP Scholarly Project Final Approval Form

UNIVERSITY of SAINT FRANCIS

DNP Scholarly Project Proposal Initial Approval

To: Richard Kirby, DNP-NAP Student

From: Dr. Susan Lown, Course Coordinator NURS 715

Re: DNP Project Proposal Review Council Endorsement

Date: 12-2-2020

DNP Scholarly Project Title: Prevention of Extubation Failure

DNP Scholarly Project Review Council:

DNP Project Advisor Signature:

Dr. Carla Mueller, Professor Division of Nursing

DNP Project Proposal Review Council Member Signature:

Dr. Gregory Louck, Assistant Professor Division of Nursing and Director Nurse Anesthesia Program

DNP Project Proposal Review Council Member Signature:

Dr. Susan Lown, Associate Professor Division of Nursing

Date of initial approval by DNP Scholarly Project Review Council:
Initial review 11-12-2020 – LHN IRB approval letter received . S.Lown 12-2-2020

1 - Student File
2 - Attached to Proposal

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Abstract

Background: This DNP project was a quality improvement project. The project was designed to answer the following PICOT question: In adult surgical patients that undergo general anesthesia and receive an endotracheal tube, does the use of the SPORC-2 risk stratification tool reduce the risk of extubation failure within 72 hours after surgery?

This project took place at Kosciusko Community Hospital (KCH) in Warsaw Indiana. The goal of this project was to improve the process of identification of the risk for extubation failure in surgical candidates, and to ultimately decrease the rate of extubation failure. After an extensive literature review, it was determined by this author and the facility that the Score for the Prediction of Postoperative Respiratory Complications-2 (SPORC-2) was to be used to identify risk (Lukannek et al., 2019). The SPORC-2 is a risk stratification tool that has been developed and externally validated to determine the percent risk for extubation failure following anesthesia via an endotracheal tube (Lukannek et al., 2019). The SPORC-2 was implemented in the preoperative and intraoperative phase by anesthesia providers to identify risk of extubation failure. Data analysis occurred to identify if the frequency of extubation failure was changed significantly as a result of this QI project. This was determined through comparison of preintervention data to postintervention data on the frequency and percentage of patients that experience extubation failure.

Methodology: The timeline of this project began September of 2020, with the IRB review completed at the University of Saint Francis. Support for the QI project was consistently received since the introduction of the QI project in March of 2020. Support was granted from not only anesthesia providers at KCH but also the operating room manager. After IRB at the University of Saint Francis, implementation of the QI project began at KCH. The project was

implemented in November of 2020 and continued through January of 2021. The total duration of project implementation and data collection was for three months. In February of 2021 data collection occurred to compare preintervention data to postintervention data. Dissemination of project results occurred in April of 2021.

Results: The preintervention results included 327 tracheal intubations with anesthesia administration, four cases of reintubation after extubation, and six patients remained intubated after surgery (D. Plautz, personal communication, February 1, 2021). The percentage of tracheal intubations after extubation following the administration of general anesthesia for this timeframe was 0.012%. The percentage of patients that remained intubated after anesthesia delivery was 0.018%.

The intervention phase resulted in 285 patients intubated. No patients during this time were reintubated after tracheal extubation within 72 hours after extubation (0%). Six of these patients remained intubated after anesthetic delivery (0.021%). Therefore, the frequency of reintubation after extubation decreased and the frequency of patients that remained intubated remained the same with an increase in the percentage by 0.003%.

Conclusion: The use of a risk stratification tool alone does not prove a reduced occurrence of extubation failure. Instead, it is recommended that risk stratification tools be paired with risk reduction techniques in anesthetic care delivery.

Contents

Chapter 1: Introduction

Problem

Problem Statement

At Kosciusko Community Hospital (KCH) in Warsaw Indiana, anesthesia providers do not utilize an evidence-based tool or method to identify the risk of failure to extubate (D. Plautz, personal communication, February 18, 2020). In the last quarter of 2019, the facility experienced four cases of extubation failure that required tracheal reintubation (D. Plautz, personal communication, February 18, 2020). After identifying the increased frequency of extubation failure, the operating room director and anesthesia providers desired to identify a method to stratify risk of extubation failure (L. Beeson & D. Plautz, personal communication February 18, 2020).

Background of the Problem

During surgery, patients receiving general anesthesia may also have an endotracheal tube in place to assist in maintaining the airway. Patients receiving an endotracheal tube and general anesthesia during surgery may experience extubation failure (Ball et al., 2016; Ead, 2004; Foster et al., 2019; Kacmarek, 2019). Extubation failure requires reintubation with an endotracheal tube to maintain airway patency and oxygenation. This results in an increased work demand on the anesthesia provider, healthcare team and poor outcomes for the patient. Mechanical ventilation may be required in the patient that is reintubated. It is the responsibility of the anesthesia provider to safely place and remove an endotracheal tube. Additionally, the anesthesia provider can promote a safe recovery from anesthesia and minimize postoperative respiratory complications through risk stratification of extubation failure.

Reintubation after extubation can be caused by postoperative respiratory failure not responsive to alternative oxygenation and ventilation support methods. Respiratory failure is one of the most frequently experienced adverse events postoperatively (Ball et al., 2016; Canet et al., 2015; Howie & Dutton, 2012). The most frequently stated cause of morbidity and mortality in the perioperative period includes difficulty in management of the airway (Howie & Dutton, 2012).

The occurrence of postoperative respiratory complications ranges from as low as five to as high as 25 percent of patients (Ball et al., 2016; Ead, 2004; Foster et al., 2019; Kacmarek, 2019). Up to 40 percent of surgical patients that receive abdominal surgery develop respiratory failure (Kacmarek, 2019). The prevalence of extubation failure nationally with the need for reintubation is about 0.19% to 1.03% (Alvarez et al., 2015; Ead, 2004). Postoperative respiratory failure increases patient mortality, morbidity, healthcare cost, workload, postanesthesia care unit (PACU) stay, hospital length of stay, and increases emotional and psychological stress on patients and family members (Alvarez et al., 2015; Ball et al., 2016; Foster et al., 2019; Haritos et al., 2019; Howie & Dutton, 2012; Lange et al., 2018; Lukannek et al., 2019;Pompei & Rocca, 2013). Postoperative extubation failure with unplanned reintubation is an independent risk factor associated with a nine-fold increase in 30-day mortality (Alvarez et al., 2015). The median cost of postoperative pulmonary complications is $64,704 per occurrence (Alvarez et al., 2015; Haritos et al., 2019). The financial cost of postoperative pulmonary complications in the United States is around $3.42 billion annually (Mazo et al., 2014).

Extubation failure is multifactorial in its cause (Alvarez et al., 2015). It is important to examine the cause of extubation failure and to obtain a solution to extubation failure. Each operative phase was examined as each phase offers potential contributors to extubation failure.

This includes the preoperative, intraoperative, and postoperative phases of surgery. Then, recommendations based on the literature findings and the gap in literature were discussed.

Practice/Knowledge Gap

The anesthesia providers at Kosciusko Community Hospital do not utilize a risk stratification tool to identify patient risk for postoperative extubation failure (D. Plautz, personal communication, February 18, 2020). This was identified at a staff meeting held by the operating room manager on February 18, 2020. This meeting was held specifically to address the topic of extubation failure at Kosciusko Community Hospital. At the meeting, it was identified that there was a knowledge deficit in the availability of risk stratification tools. Additional team members at this meeting include but were not limited to the chief nursing officer, postanesthesia care unit nurses, preoperative care unit nurses, and respiratory therapy. The operating room director identified that the facility had four cases of extubation failure in the last quarter of 2019 (L. Beeson, personal communication, February 18, 2020). This is an increase from the previous quarter of zero cases of extubation failure.

Needs Assessment

The facility vision was to reduce the rate of extubation failure in adult patients that undergo general anesthesia (L. Beeson, personal communication, February 18, 2020; D. Plautz, personal communication, February 18, 2020). This vision included the identification of patients at risk for extubation failure with use of a validated risk stratification tool (L. Beeson, personal communication, February 18, 2020; D. Plautz, personal communication, February 18, 2020). Additionally, the operating room director and anesthesia staff desired to optimize patients intraoperatively and postoperatively to promote successful extubation (L. Beeson, personal communication, February 18, 2020; D. Plautz, personal communication, February 18, 2020). A

written letter of support from the facility leadership for the DNP project can be found in Appendix A. Also found in Appendix A is the IRB approval form for Lutheran Health Network.

DNP Project Overview

Scope of Project

Factors that were included in this project include utilization of the Score for Prediction of Postoperative Respiratory Complications (SPORC-2) risk stratification tool by anesthesia providers to calculate the risk of extubation failure expressed in percentage. The SPORC-2 tool has been modified from its original design by removal of two subsections of the tool due to copyright issues. The modified SPORC-2 tool was referred to as the "SPORC-2 tool" for simplicity and can be found in Appendix B. The project intervention was targeted toward anesthesia providers, not patients. The anesthesia provider was responsible for care delivery to patients after the SPROC-2 was utilized.

Stakeholders

Stakeholders included but were not limited to anesthesia providers at Kosciusko Community Hospital, Midwest Anesthesia Associates, Kosciusko Community Hospital, Lutheran Health Network, and patients that benefit from this quality improvement (QI) project. Other stakeholders included the American healthcare system, as prevention of extubation failure can promote healthcare cost savings.

Budget and Resources

Cost

The budget of this DNP project was described as in-kind cost, direct cost, and overall cost. In-kind cost consists of the time spent on the project by the DNP project team leader. This included all steps of the DNP project; preparation, implementation, and evaluation. Additionally, some materials for the project were in-kind such as cardboard boxes, tape, paper, pens, and paper copies of the SPORC-2 tool. Direct costs included paid time of anesthesia providers for a brief educational session to detail the use of the SPORC-2 tool; 10 minutes at $100 per hour for six anesthesia providers equates to approximately $100. Additional staff costs included the operating room manager's time spent assisting coordination of the project and a data extraction manager if available; this was estimated at approximately $200. There was no cost associated with copyright use of the SPORC-2 tool. The accumulated time that anesthesia providers spent on the SPORC-2 tool is estimated to be five minutes per patient. With the quote of five minutes per provider at $100 per hour with ten cases a day, the daily cost equates to approximately $83 per day. If the tool was used for ten cases per day for the 90-day intervention period, the total cost of anesthesia provider would be $7,470. This cost however can decrease as anesthesia providers become more efficient with the SPORC-2 tool use. Additionally, this cost is negligible to nonexistent if anesthesia providers receive a salary as compared to hourly pay. As previously mentioned, the average cost associated with the consequences of extubation failure is approximately $64,704 per occurrence (Alvarez et al., 2015; Haritos et al., 2019). Therefore, the benefit of prevention of extubation failure outweighs the potential cost of the project.

Description of Resources

Resources included items, location, and individuals. Items included paper, printer ink, pens, and a cardboard box. Location included space at KCH such as a room to provide a brief presentation on the use of the SPORC-2 tool. Individuals included the DNP project team leader, anesthesia providers and the operating room manager. One pen per provider was needed. One piece of printer paper with the SPORC-2 tool printed on the front and the percentage risk on the back was needed for each patient that met inclusion criteria. The minimal use of resources contributed to a low cost.

Process and Outcomes

General Timeline

The process included identification of the problem, conduction of a literature review, provision of a solution, implementation of the SPORC-2 risk stratification tool, and collection of data for evaluation to determine significance of the QI project. The outcomes were measured by data analysis, discussed later in this summary.

IRB review at the University of Saint Francis (USF) occurred December 2nd of 2020. Support for the QI project was consistently received since the introduction of the QI project in March of 2020. Support was granted from not only anesthesia providers at KCH but also the operating room manager. After IRB and approval at the University of Saint Francis, implementation of the QI project began at KCH. The project was implemented in November of 2020 and continued through January of 2021. The total duration of project implementation and data collection occurred for three months. In February of 2021 data collection occurred to compare preintervention data to postintervention data. Dissemination of project results occurred in April of 2021. A table to outline the timeline can be found in Appendix C.

Setting and Target Population

The setting for this QI project was the surgical department at Kosciusko Community Hospital in Warsaw Indiana. Within the surgical department the setting narrowed to the preoperative unit and the operating room. The target population consisted of six anesthesia providers; both physician anesthesiologists and certified registered nurse anesthetists.

Inclusion criteria that participants in this QI project abided by include a valid license to practice anesthesia in the state of Indiana. Exclusion criteria included student registered nurse anesthetists and resident physician anesthesiologists.

Inclusion criteria for use of the SPORC-2 tool by anesthesia providers for patients included patients that underwent non-cardiac surgery, general anesthesia, tracheal intubation, and planned post-procedural extubation in operating room. Exclusion criteria for use of the SPORC-2 tool by anesthesia providers for patients included patients less than 18 years of age, ASA status of 6, and surgery within 10 days prior to procedure to be performed (Lukannek et al., 2019).

Expected Outcomes

Aim 1:

To identify the risk of extubation failure in adult surgical patients undergoing general anesthesia.

Outcome 1a:

Utilization of the SPORC2 risk stratification tool by anesthesia provider occurred in 75% of patients that met inclusion criteria during the preoperative and intraoperative period.

Aim 2:

To decrease the rate of reintubation after extubation 72 hours after the administration of general anesthesia.

Outcome 1b:

The rate of reintubation after extubation (extubation failure) within 72 hours after surgery decreased by 50% after the risk stratification tool was implemented.

Risk Analysis

There was no risk associated with this QI project. The project focused on anesthesia providers; the target of the project. This project did not place anesthesia providers or patients at increased risk for physical or psychological harm.

Confidentiality

A unique five-digit code was randomly generated by the DNP project team leader for each anesthesia provider. This code was given to each anesthesia provider and remained confidential. Each anesthesia provider was to write this code on each SPORC-2 tool prior to placement in the collection box. The code was listed on the DNP project team leader's computer in order to identify the anesthesia provider who completed the form. This information was password protected and was not shared with anyone other than the anesthesia provider and the DNP project team leader. Additional individuals who may view this information included DNP faculty at the University of Saint Frances. This is required for academic purposes of the DNP project.

Informed Consent

The project team leader obtained consent from participants after the project received University of Sant Francis IRB approval. Facility IRB submission was completed through the Lutheran Health Network IRB submission process. Consent was obtained prior to the implementation of the project at KCH. The consent form used can be found in Appendix D.

Chapter 2: Synthesis of Supporting Evidence and Project Framework

Relevant Theory and Concepts

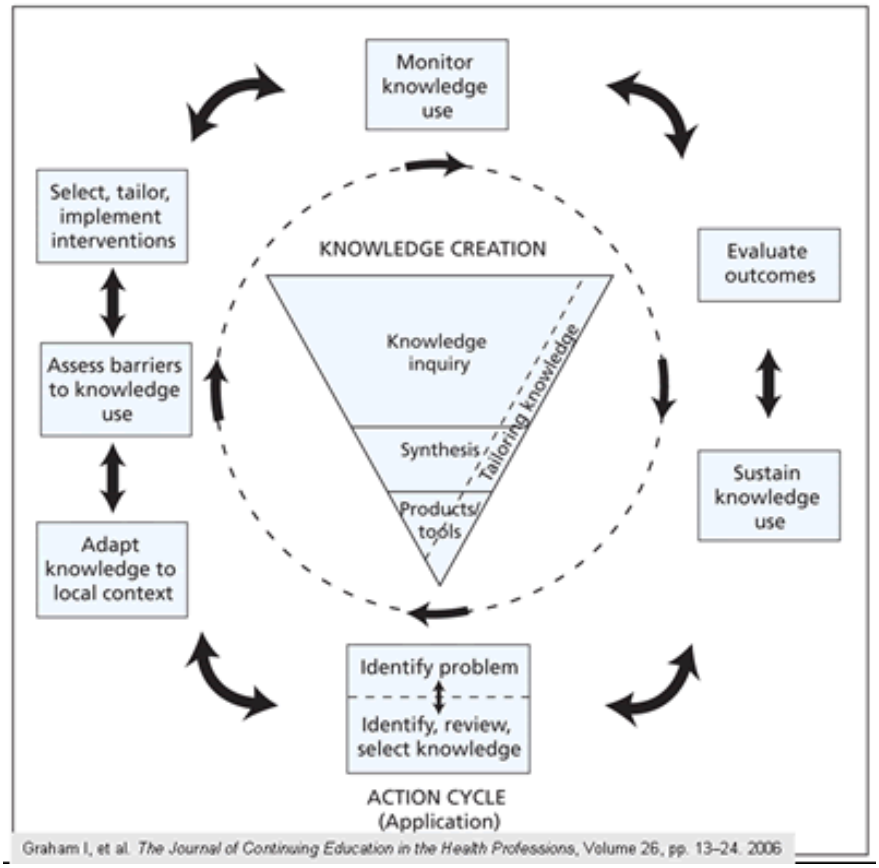
Knowledge to Action Framework.

The Knowledge-to-Action framework (Figure 1) was developed by Graham et al. in 2006 in Canada (Field et al., 2014; Graham et al., 2006). The Knowledge-to-Action Framework was developed to translate evidence into interventions within the healthcare system (Field et a., 2014; Graham et al., 2006). The benefit of utilization of a framework is that a framework provides a logical and systematic way to organize thoughts. Additionally, a framework increases the likelihood of successful evidence-based practice implementation resulting in practice change (Field et al., 2014).

The Knowledge-to-Action Framework has two major parts: knowledge creation and the action cycle (Field et al., 2014; Graham et al., 2006). The framework is cyclical and dynamic. The action cycle can be performed one step at a time or all at once (Field, et al., 2014). Barriers and facilitators to knowledge implementation are assessed with the use of this framework (Graham et al., 2006). The framework is also adapted to the specific setting it is to be used (Graham et al., 2006).

Figure 1

Knowledge to Action Framework



(Graham et al., 2006)

The Knowledge-to-Action Framework begins with identification of a problem, in this case, the rate of reintubations after surgery. The framework then requires knowledge inquiry, knowledge synthesis, and utilization of knowledge tools and products (Graham et al., 2006). During this time, knowledge is identified, reviewed, and selected according to the problem. Then the action cycle begins with adoption of knowledge to the local context of the facility. Next the assessment of barriers to knowledge use must occur followed by selection of and tailoring of interventions to be implemented. After this, the knowledge use must be monitored, after which outcomes are evaluated. Lastly, knowledge use must be sustained. After these seven steps, the

cycle begins again with identification of the problem (Graham et al., 2006; Field et al., 2014). That is if a problem exists; then the cycle would repeat.

This framework was utilized to identify the problem at Kosciusko Community Hospital; increased extubation failure rates. The framework was then utilized to generate knowledge on risk, causes, and solutions to extubation failure. This information will be discussed in the literature review section of this paper. Next this author will adapt the knowledge to the local context of Kosciusko Community Hospital. After this, barriers to the use of the new knowledge will be assessed. Thereafter, specific interventions will be selected for implementation. After the knowledge is used, outcomes must be evaluated. It is important to identify if the intervention improved outcomes. Then, use of the new knowledge must be sustained. This is important to ensure promotion of change that lasts past the initial implementation of the intervention. Lastly, this author will reassess the problem of extubation failure to identify if a new problem exists with implementation of this intervention.

Literature Review

The literature review for this paper was conducted by this author from January to April of 2020. The terms used during this literature search surrounded the theme of extubation failure. These terms include: extubation, extubation guidelines, extubation guidelines and anesthesia, extubation criteria, extubation checklist, extubation and anesthesia, extubation difficult airway, difficult airway, difficult airway management, difficult airway society, knowledge to action, prevention of extubation failure, extubation failure, reintubation after extubation, and postoperative reintubation. These terms were searched in many databases: ACP PIER, Campbell Collaboration Library of Systematic Reviews, Conchrane Database of Systematic Reviews, Database of Abstracts of Reviews (DARE), Dynamed, Essential Evidence Plus, Joanna Briggs

Institute Evidence-Based Summaries, Joanna Briggs Institute Systematic Review Library, TRIP Database (USF Library), National Guideline Clearinghouse, National Institute of Health and Clinical Excellence, Anesthesia Related Guidelines, Guidelines International Network, and the Registered Nurses of Ontario. From the University of Saint Francis online Library the following databases were searched: CINHAL Plus, EBSCO eBook Collection, EBSCO Open Dissertations, EBSCO Biomedical Reference Collection, Emcare (Ovid), Education Resources Information Center, Health Business, Proquest Nursing and Allied Health, PsycInfo, and PubMed (Medline). Additional databases and resources searched include Google Scholar, Proquest Dissertations and Thesis Global, PsycEXTRA, Directory of Open Access Journals, ASU DNP Final Project Collection, DNP Scholarly Project Repository, University of San Francisco Open Access DNP Scholarly Project Repository, George Washington University DNP Project Repository, Sigma Theta Tau Virginia Henderson e-Repository, FedStats, Indiana.gov Statistics, Allen County, IN Health Statistics, Allen County IN Census statistics, Library of Congress Virtual Reference Shelf, and the American Association of Nurse Anesthetists. Articles that were pertinent to this DNP project discussed in the literature review and are listed in the reference section of this paper.

Preoperative Phase

Risk Factors for Postoperative Respiratory Complications or Reintubation.

Postoperative respiratory complications include but are not limited to respiratory failure, hypoxemia, atelectasis, acute respiratory distress syndrome, pleural effusion, pneumothorax, and bronchospasm (Ball et al., 2016; Brinson & Thornton, 2018). Several factors exist that place the adult surgical patient at risk for respiratory failure and failure to extubate postoperatively. Postoperative respiratory failure can be caused by pneumonia, sepsis, fluid overload, congestive

heart failure, anesthesia complications, aspiration, atelectasis, bronchospasm, and pulmonary embolism (Alvarez et al., 2015; Kacmarek, 2019; Smetana et al., 2006).

Risk factors for postoperative respiratory failure and reintubation include general anesthesia, emergency surgery, heart disease, congestive heart failure, the presence of a known difficult airway, male gender, history of smoking, age 65 years and older, inpatient status, chronic obstructive pulmonary disease (COPD), severe airway anatomical abnormalities, obstructive sleep apnea, increased American Society of Anesthesiologists (ASA) physical status, poor nutritional status, low body mass index, weight loss greater than 10 percent, gastroesophageal reflux disease, surgery of the airway, high-risk surgery, history of reintubation, obesity (body mass index > 35 kg/m^2), increased sputum production, increased surgical duration, multiple failures of weaning, preoperative ventilator status, and upper airway obstruction (Alvarez et al., 2015; Brinson & Thornton, 2018; Foster et al., 2019; Haritos et al., 2019; Kacmarek, 2019; Popat et al., 2012; Smetana et al., 2006; Sorbello & Frova, 2013). Of the many risk factors, several are considered independent risk factors. This includes emergent operation, preoperative ventilator status, history of smoking, history of COPD, increased length of surgical duration, and older age (Alverez et al., 2015; Foster et al., 2019).

Tools Available to Identify Risk.

Risk stratification tools have been shown to decrease the rate of reintubation (Dorsey, Milligan, & Joffe, 2016). It is recommended by the Agency for Healthcare Research and Quality to utilize evidence-based prediction tools to identify the risk for postoperative pulmonary complications (Lukannek et al., 2019). To identify general risk factors associated with surgery, providers can use the National Surgical Quality Improvement Program (NSQIP) (American College of Surgeons, 2020). Several tools exist to help identify the risk of postoperative

respiratory failure and reintubation after extubation. These tools include the Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT), the Prospective Evaluation of a Risk Score for Postoperative Pulmonary Complications in Europe (PERISCOPE) tool, the Score for Prediction of Postoperative Respiratory Complications (SPORC) tool, the Score for the Prediction of Postoperative Respiratory Complications 2 (SPORC-2), and two Reintubation After Planned (RAP) Extubation prediction tools (Canet et al., 2015; Haritos et al., 2019; Lin et al., 2013; Lukannek et al., 2019; Mazo et al., 2014).

National Surgical Quality Improvement Program (NSQIP).

The NSQIP is a tool that is nationally validated, risk-adjusted, and is an outcomes-based program with a goal to measure and improve the quality of surgery (American College of Surgeons, 2020). This tool can be used on a patient and case specific manner to identify the risk of surgical related complications. Data is entered into a calculator after which the risk for various complications are calculated. The calculator then produces a percent risk for each of the following: serious complication, any complication, pneumonia, cardiac complication, surgical site infection, urinary tract infection, venous thromboembolism, renal failure, readmission, return to the operating room, death, discharge to a nursing or rehabilitation facility, and sepsis (American College of Surgeons, 2020). While this does not calculate the specific risk for extubation failure, many of the previously mentioned factors contribute to extubation failure.

Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) and the Prospective Evaluation of a Risk Score for Postoperative Pulmonary Complications in Europe (PERISCOPE).

The ARISCAT risk Stratification Tool to identify postoperative complication rate was developed due to lack of an existing externally validated tool (Mazo et al., 2014). This tool was

externally validated in 63 European medical centers in 21 countries by the PERISCOPE cohort (Canet et al., 2015; Mazo et al., 2014). The ARISCAT tool utilized seven risk factors, with points assigned for each variable. This placed the patient in a low, moderate, or high-risk category for postoperative pulmonary complications (Mazo et al., 2014). The seven risk factors in this study include age, preoperative oxygen saturation, respiratory infection in the last month, preoperative anemia, surgical incision location, duration of surgery, and if the procedure is an emergency (Brinson & Thornton, 2018; Mazo et al., 2014).

The PERISCOPE cohort validation study of the ARISCAT score was performed to show external validity of the tool (Brinson & Thornton, 2018; Canet et al., 2015). This study successfully demonstrated the application of the ARISCAT score to other hospital settings. This increased credibility of the ARISCAT score which increases its applicability, accuracy, and validation (Brinson & Thornton, 2018; Canet et al., 2015).

The PERISCOPE cohort also developed a risk score to specifically predict preoperative respiratory failure (Brinson & Thornton, 2018). This tool assessed seven risk factors: low preoperative oxygen saturation on room air, preoperative respiratory symptoms, heart failure, chronic liver disease, open thoracic or abdominal surgery, duration of surgery, and emergency surgery (Brinson & Thornton, 2018, Canet et al., 2015). While this study was successful in identification of patients at risk for postoperative respiratory failure it has not been externally validated as the ARISCAT study has been (Brinson & Thornton, 2018; Canet et al., 2015).

Score for Prediction of Postoperative Respiratory Complications (SPORC).

The SPORC tool was developed by Brueckmann et al. (2013) and is based on the following factors identified in patients: ASA physical status > 2, emergency status, high-risk service, congestive heart failure, and chronic pulmonary disease (Haritos et al. 2019). Points are

assigned to each category and score ranges identify if the patient is a low, moderate, or high risk for reintubation (Haritos et al., 2019).

Score for the Prediction of Postoperative Respiratory Complications-2 (SPORC-2).

The purpose of the development of the SPORC-2 was to develop and externally validate a prediction score that included preoperative and intraoperative predictors of postoperative respiratory complications (Lukannek et al., 2019). The creation of this tool was based on the original SPORC tool previously discussed. The preoperative predictors examined include ASA physical status 3 or higher, heart failure, chronic pulmonary disease, emergency surgery, and high procedural severity score (Lukannek et al., 2019). The intraoperative predictors examined include oxygen saturation below 90% within five minutes after intubation, duration of surgery, high total noradrenaline equivalent dose, intraoperative blood transfusion, the absence of volatile anesthetic use, and the lack of lung-protective ventilation (Lukannek et al., 2019). The SPORC-2 prediction tool provided a visual diagram to aid in scoring of risk factors (Lukannek et al., 2019).

Reintubation After Planned (RAP) Extubation (Version 1).

The Reintubation After Planned (RAP) Extubation prediction tool is based on the following factors identified in the patient: ASA physical status 2 or 3, surgical type, the presence of COPD or asthma, the presence of conscious disturbance, pneumonia, systemic inflammatory response syndrome (SIRS), room air saturation <95%, temperature <35 degrees Celsius, use of rocuronium, and presence of ascites (Haritos et al., 2019). Haritos et al. (2019), demonstrated that the use of the RAP Extubation prediction tool decreased the percentage of reintubation from 0.00167% in 2010 to 0.00014% in 2016. The study was conducted over eight years from 2010 to 2017. Six of the eight years demonstrated a significant trend resulting in decreased percentage of reintubations. A Mann-Kendall trend test was used with a 2-tailed test ($P = 0.009$) (Haritos et al.,

2019). The identification of patients at risk for extubation failure helps the operative team plan for successful extubation.

Haritos et al. (2019), recommended that a patient with a score that resulted in moderate to high risk should be identified and communicated to the healthcare team that will provide care to the patient. The care to be delivered should place extra focus on targeted fluid management, multimodal analgesia, train-of-four monitoring (TOF), and neuromuscular blockade reversal (Haritos et al., 2019). Patients identified as a moderate to high risk should receive sugammadex for neuromuscular reversal instead of neostigmine, as it results in superior neuromuscular reversal (Haritos et al., 2019). Additionally, it is recommended to utilize noninvasive ventilation in the first hour after extubation for at-risk patients (Haritos et al., 2019). The preparation for prevention of extubation failure can increase if the anesthesia provider is aware of the patient's risk for extubation failure.

Reintubation After Planned Extubation (Version 2).

Lin et al. (2013) retrospectively developed a risk stratification tool to predict extubation failure. This study occurred from 2005 to 2009 and resulted in the development of an internally validated tool to predict extubation failure (Lin et al., 2013). This tool consists of the preoperative assessment of 10 predictors, each associated with risk points. These risks include ASA classification, operation type, conscious disturbance, COPD/asthma, pneumonia, SIRS, room air oxygen saturation, body temperature, muscle relaxant use, and the presence of cirrhosis with ascites (Lin et al., 2013). At the end of the preoperative assessment with this tool the points are summed. This data then is used to determine the probability of reintubation (Lin et al., 2013). The risk stratification tool is aided and simplified with a visual nomogram that can be utilized at

the bedside (Lin et al., 2013). The limitation to this study reported that this was a single center study that requires external validation to improve the tools validity (Lin et al., 2013).

Other Risk Assessment Tools.

Foster et al. (2019) recently developed and validated risk stratification scores for postoperative pulmonary complications for six specific surgical procedures. These procedures include pancreatectomy, esophagectomy, hepatectomy, abdominal aortic aneurysm repair, open aortoiliac repair and lung resection (Foster et al., 2019). Each procedure identified unique risks. However, prolonged surgical time was a common risk factor in all six procedures (Foster et al., 2019).

The Difficult Airway Background.

The difficult airway places the patient at increased risk for edema, bleeding, pneumothorax, aspiration, and trauma to the oropharynx, temporo-mandibular joint, esophagus, trachea, and larynx (Apfelbaum et al., 2013; Sorbello & Fova, 2013). Examples of signs and symptoms of airway complications include chest pain, sore throat, face and neck pain or swelling, difficulty swallowing, and subcutaneous emphysema (Apfelbaum et al., 2013). Such trauma can result in post-intubation airway complications and must be considered upon extubation of the patient with the difficult airway. Therefore, preparation for intubation and extubation of the patient with the difficult airway must occur by the anesthetist. This includes method of intubation, method of extubation, and supply availability upon intubation and extubation (Popat et al., 2012).

The implementation of the American Society of Anesthesiologists (ASA) airway management guidelines reduced airway claims resulted from injury at induction of anesthesia (Popat et al., 2012). However, intra-operative, extubation, and recovery injury claims did not

decrease with the ASA guidelines (Popat et al., 2012). Additionally, death or brain injury is more common during extubation and recovery than induction of anesthesia (Popat, et al., 2012).

Identification of the Difficult Airway.

The difficult airway is identified preoperatively through the evaluation of the patient's history and physical examination. It is important to determine the anticipated level of difficulty in management of the patient's airway prior to the administration of anesthesia. Preparation for difficult mask ventilation and airway placement must occur with supplies readily available (Apfelbaum et al., 2013). The anesthetist should have emergency airway equipment readily available prior to induction of the patient with the identified difficult airway.

The airway assessment begins with assessment of the patient's history. Congenital anomalies that increase the risk for difficult airway management include ankylosis, subglottic stenosis, degenerative osteoarthritis, lingual thyroid or tonsillar hypertrophy, Pierre Robin or Down syndrome, and Treacher-Collins (Apfelbaum et al., 2013).

Physical examination of the airway must occur prior to anesthetic delivery and airway management (Apfelbaum et al., 2013). Many factors constitute the airway assessment to evaluate the airway for potential difficulty. These factors include the modified Mallampati class, interincisor distance, thyromental distance, shape of palate, compliance of mandibular space, length of neck, thickness of neck, head and neck range of motion, length of upper incisors, upper lip bite test, sternomental distance, atlanto-occipital distance, posterior mandibular depth, and Wilson criteria (Apfelbaum et al., 2013; Joyce, 2017). The combination of these airway assessment tools increases the accuracy of airway assessment.

Intraoperative Phase

Intraoperative Factors that Increase Risk for Failed Extubation and Postoperative Respiratory Failure.

Surgeries that increase the risk for extubation failure and postoperative pulmonary complications include emergency surgery, prolonged surgery, head, neck, thyroidectomy, laryngeal, temporomandibular joint, thoracotomy, laparotomy, maxilla-facial, tracheal resections, prolonged shoulder arthroscopic, and prolonged cardio-thoracic procedures (Alvarez et al., 2015; Ball et al., 2016; Popat et al., 2012; Smetana et al., 2006; Sorbello & Frova, 2013). These procedures increase the risk for airway compromise due to edema, hematoma, altered lymphatic drainage, tracheomalacia, atelectasis, and vocal cord paralysis (Ball et al., 2016; Popat et al., 2012). Abdominal surgeries increase the risk for postoperative respiratory failure due to phrenic nerve and diaphragmatic muscle dysfunction (Kacmarek, 2019). The prone and prolonged Trendelenburg position increase the risk for airway edema (Popat et al., 2012).

Other factors that contribute to airway edema include laryngoscopy, overinflated or mispositioned ETT cuff, duration of surgery, anaphylaxis and fluid overload (Alvarez et al., 2015; Popat et al., 2012). Additional risk factors that can increase the risk for extubation failure include cardiovascular instability, pulmonary edema, impaired respiratory function, narcotic overdose, neurological/neuromuscular impairment, hypothermia or hyperthermia, acid-base imbalance, excess secretions, pneumonia, electrolyte abnormalities, anesthesia mismanagement and abnormal clotting (Alvarez et al., 2015; Popat et al., 2012). Interestingly, the most modifiable factor that increases the risk for extubation failure is perioperative management, including management of anesthesia (Alvarez et al., 2015). Therefore, it is worth discussion of strategies to reduce extubation failure.

Intraoperative Lung Protective Ventilation Strategies.

Pulmonary complications, such as hypoxemia, atelectasis, and neuromuscular weakness, can be caused by anesthesia, postoperative pain and surgery (Ball et al., 2016; Lukannek et al., 2019; Pompei & Rocca, 2013). This can result in increased morbidity, mortality, length of stay, and cost (Ball et al., 2016; Lukannek et al., 2019; Pompei & Rocca, 2013). Mechanical ventilation can cause or worsen lung injury (Mills, 2018; Pompei & Rocca, 2013). The administration of large tidal volumes without positive end expiratory pressure (PEEP) increases the chance of development of acute respiratory distress syndrome (ARDS) (Mills, 2018; Pompei & Rocca, 2013). The pathophysiology of this includes increased inflammatory mediators and procoagulants (Pompei & Rocca, 2013).

High tidal volumes 10-12 mL/Kg can cause barotrauma and volutrauma of the alveoli (Mills, 2018; Pompei & Rocca, 2013). Lung protective ventilation consists of tidal volumes of 6-8 mL/Kg of predicted body weight, administration of 5-8 cmH_2O PEEP, maintenance of plateau pressure below 16 cmH_2O, and the use of recruitment maneuvers (Alvarez et al., 2015; Ball et al., 2016; Foster et al., 2019; Lukannek et al., 2019; Mills, 2018; Pompei & Rocca, 2013;). This method lung protective ventilation has been shown to reduce atelectasis in the operative patient (Alverez et al., 2015; Ball et al., 2016; Lukannek et al., 2019; Mills, 2018; Pompei & Rocca, 2013).

Extubation Guidelines.

Historically much attention has been placed on the process of intubation of the patient with the difficult airway with less attention placed on the extubation process (Popat et al., 2012). Guidelines that exist that discuss the management of the difficult airway include the Canadian Airway Focus Group (1998), the American Society of Anesthesiologists (ASA) difficult airway

guidelines (2003), the Societa Italiana Anesthesia Analgesia Rianimazione Terapia Intensiva (SIAARTI) recommendations (2005), and the Difficult Airway Society (DAS) difficult intubation guidelines (2004) (Popat et al., 2012). However, these guidelines do not produce much detail on the management of the extubation process (Apfelbaum et al., 2013; Popat et al., 2012). The American Society of Anesthesiologists offer some guidance on extubation of the difficult in the Practice Guidelines for Management of the Difficult airway (Apfelbaum et al., 2013). The DAS produced extubation guidelines in 2011 to aid the anesthetist in the extubation process. In general, guidelines improve outcomes in infrequent, life-threatening situations (Popat et al., 2012). Both guidelines will be discussed individually in the following sections of this paper.

American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway.

The American Society of Anesthesiologists (ASA) Practice Guidelines for Management of the Difficult Airway provide guidance on extubation of the patient with a difficult airway. The ASA guidelines state that a preformulated extubation plan should be in place (Apfelbaum et al., 2013). This extubation plan must consist of consideration of awake versus deep extubation, knowledge of general factors that increase the risk for adverse respiratory events, and the presence of an airway management plan for extubation failure (Apfelbaum et al., 2013). While the guidelines state this, the guidelines do not offer information to guide the anesthesia provider in selection of extubation strategy (awake versus deep) or risk factors for extubation failure. The ASA guidelines provide information on airway management strategies, such as the use of an instrument to guide reintubation after extubation (Apfelbaum et al., 2013). The ASA guidelines do not detail on when or how to use these airway adjuncts.

The ASA guidelines provided information on post anesthesia care. This includes documentation of the difficult airway, inform the patient, other healthcare workers, and surgeon of the difficult airway, and to reassess the patient for complications after extubation (Apfelbaum et al., 2013). The ASA guidelines also suggest the provision of a written report of the difficult airway to place in the medical chart and to give to the patient (Apfelbaum et al., 2013). Then the ASA guidelines provide examples of complications and signs of symptoms of airway complications (Apfelbaum et al., 2013). The ASA guidelines are useful for the anesthesia provider to as they provide a general basis for extubation of the patient with the difficult airway. However, it is important to consider if there are additional resources for the anesthesia provider to guide the extubation process of the difficult airway.

Difficult Airway Society Extubation Guidelines.

The DAS guidelines detail the hazards of the extubation process and the management of extubation. The DAS guidelines then recommended utilization of the four-step process: plan extubation, prepare for extubation, perform extubation, and post-extubation care, recovery, and follow up (Popat et al., 2012). The DAS provided easy to use algorithms intended for daily use by the anesthesia provider to guide the extubation process. The DAS provided three algorithms; the basic algorithm, the low-risk algorithm, and the at-risk algorithm (Popat et al., 2012). The purpose of the DAS guidelines is to promote an extubation strategy that utilizes a systematic approach and risk stratification to identify patients at risk for extubation complication and failure (Popat et al., 2012). See the Appendix G for a visual diagram of each DAS algorithm.

Problems may be encountered during the extubation process. The DAS guidelines suggested these problems include issues with airway reflexes (exaggerated laryngeal reflexes, reduced airway reflexes, dysfunctional laryngeal reflexes), depletion of oxygen stores at

extubation, airway injury, physiological compromise in other systems, and human factors (Popat et al., 2012).

The first step of the DAS extubation guidelines, plan extubation, takes place prior to the induction of anesthesia (Popat et al., 2012). This step involves assessment of the airway and identification of risk factors (Popat et al., 2012). This step helps the anesthetist to identify which algorithm should be used; the low-risk or at-risk algorithms (Popat et al., 2012). The low risk algorithm is used for uncomplicated and routine extubation. The at-risk algorithm is used for patients that have airway related risk factors (Popat et al., 2012). Risk factors include pre-existing airway difficulties, peri-operative airway deterioration, and restricted airway access (Popat et al., 2012).

The second step of the DAS extubation guidelines, prepare for extubation, is used to optimize the patient for extubation (Popat et al., 2012). This step should occur again at the end of the surgical procedure prior to extubation (Popat et al., 2012). This step includes assessment of the airway, larynx, and lower airways (Popat et al., 2012). The purpose of the step is to better prepare for extubation and assess the patient at his or her current state, which may alter the extubation plan.

The third step in the DAS extubation guidelines is to perform extubation. This step has general considerations that can be used for both the low-risk and at-risk patients. The considerations include preoxygenation, patient position in reverse Trendelenburg or semi-recumbent, suction of the airway under direct visualization, alveolar recruitment maneuvers, insertion of a bite block, insertion of an airway exchange catheter, avoidance of airway stimulation, consideration of deep versus awake intubation, consideration of laryngeal mask

exchange, medications to attenuate coughing, and drugs to improve cardiovascular or respiratory function (Popat et al., 2012).

Within step three there is the consideration of deep versus awake extubation. This consideration is followed with recommendations and a step by step guide on how to perform each. The DAS low-risk extubation guideline algorithm also provides a sequence for awake extubation (Popat et al., 2012). This sequence is a step by step guide that is simple and short and can be used in the operating room setting to facilitate extubation in a systematic, evidence-based manner. The deep extubation sequence is not listed on the visual diagram algorithm, however it is discussed in the DAS guidelines. Additionally, the DAS guidelines provide a step by step guide on laryngeal mask airway exchange in the at-risk patient (Popat et al., 2012).

The DAS guidelines provide an at-risk algorithm in a diagram that is easy for the anesthetist to systematically follow within the operative period. Additionally, the DAS guidelines provide a step by step sequence in the use of remifentanil infusion for the at-risk extubation patient (Popat et al., 2012). Furthermore, the DAS guidelines provide a step by step sequence for the use of an airway exchange catheter for the at-risk extubation patient (Popat et al., 2012). This includes both the placement of an airway exchange catheter before extubation and utilization of an airway exchange catheter after extubation (Popat et al., 2012).

The DAS guidelines also discussed the decision to maintain intubation of the patient that extubation is considered unsafe and transfer to the critical care unit (Popat et al., 2012). The DAS guidelines also discussed elective surgical tracheostomy and the use of a prophylactic rescue subglottic cannula.

The fourth step of the DAS extubation guidelines detailed post-extubation care, recovery, and follow-up (Popat et al., 2012). In this step the DAS recommended the administration of

oxygen during transfer to the postanesthesia care unit (PACU). Additionally, it is recommended to utilize portable monitors if the patient is in an unstable condition (Popat et al., 2012). The DAS guidelines state that heart rate, respiratory rate, blood pressure, peripheral oxygen saturation, temperature, level of consciousness, and pain score should be used to monitor the patient postoperatively (Popat et al., 2012). Additionally, capnography may be used to better monitor ventilation in the postoperative patient (Popat et al., 2012). This is because carbon dioxide capnography is real time data while peripheral oxygen saturation is a result of delayed data measurement.

The DAS guidelines continued to elaborate on step four. The patient with airway compromise should remain upright, nothing by mouth (NPO), on standard monitoring and end-tidal carbon dioxide monitoring. Additionally, this patient should receive high-flow humidified oxygen after surgery (Popat et al., 2012). The patient should be encouraged to cough and deep breathe to clear secretions. Utilization of the patient's home continuous positive airway pressure (CPAP) is also beneficial (Popat et al., 2012). Otherwise, a nasopharyngeal airway may be useful in relief of airway obstruction. Steroid administration can reduce airway edema (Popat et al., 2012). Recommended steroid dosage includes 100 mg of hydrocortisone every 6 hours or equivalent steroid therapy (Popat et al., 2012). Epinephrine 1 mg can reduce airway edema resulting in obstruction or stridor (Popat et al., 2012). Lastly the use of Heliox is beneficial as it is less dense than oxygen, however it limits the percentage of oxygen that can be administered (Popat et al., 2012).

Airway Exchange Catheter.

An airway exchange catheter is a long, hollow, rigid tube that is placed through the endotracheal tube prior to extubation. Once extubation is performed, the exchange catheter is left

in place. Utilization of an airway exchange catheter is considered a method of protective extubation in the patient with an identified difficult airway or a patient that has sustained airway trauma (Ead, 2004; Popat et al., 2012; Sorbello & Frova, 2013). The airway exchange catheter is used as a conduit to improve the ability to intubate a patient after extubation. Additionally, the airway exchange catheter can be used to administer oxygen through jet ventilation (Apfelbaum et al., 2013; Ead, 2004; Pompei & Rocca, 2013). According to the DAS guidelines, the use of an airway exchange catheter resulted in reduced complications such as bradycardia, low oxygen saturation, and hypotension (Popat et al., 2012). Additionally, the use of an airway exchange catheter resulted in improved reintubation with a reduced rate of esophageal intubations (Popat et al., 2012).

Assessment of Patient Readiness for Extubation.

It is important to assess the patient's readiness to extubate and to optimize factors for successful extubation and prevention of respiratory complications and extubation failure. Factors to consider include neuromuscular readiness, respiratory readiness, airway reflex, and airway patency (Sorbello & Frova, 2013). Airway patency is arguably one of the most important factors in determining readiness for extubation, as lack of patency can progress to a cannot intubate and cannot ventilate situation (Sorbello & Frova, 2013).

It is recommended to perform a cuff leak test in the patient at risk for supraglottic edema and airway obstruction post extubation. Additionally, assessment of post extubation stridor must occur as this is a sign of airway obstruction (Sorbello & Frova, 2013). As the factors that guide the decision to extubate the patient are complex there are developed extubation criteria, checklists, and recommendations that should be utilized.

Extubation Checklist.

A systematic review revealed that the use of a checklist is beneficial in the prevention of error and has served to improve performance in healthcare and non-healthcare industries (Hales et al., 2008). Howie and Dutton (2012) developed an evidence-based extubation checklist to increase provider documentation and reduce the rate of extubation failure. A Fishers exact test was used (P = 0.001) to confirm the hypothesis (Howie & Dutton, 2012). The checklist increased documentation of readiness for extubation by anesthesia providers from 54% to 92.5% (Howie & Dutton, 2012). Additionally, extubation failures decreased from 2.5 to 1.2 patients per month (Howie & Dutton, 2012). The checklist included eight extubation criteria: awake, follows commands, agitated, cooperative, train-of-four, muscle relaxant reversed, normothermia (97-99 degrees Fahrenheit), and ETT leak test (Howie & Dutton, 2012). The checklist consisted of selection options of yes, no, and not applicable for two sections (Howie & Dutton, 2012). The use of a checklist is also beneficial in the reduction of postextubation stridor and extubation failure (Lange et al., 2018).

Extubation Criteria.

Several extubation criteria to optimize the patient for successful extubation exist. Extubation criteria includes spontaneous respiration with normal rate and pattern. Hemodynamic stability with normal heart rate, rhythm, and blood pressure. Protective airway reflexes present, such that the patient is not tolerating the endotracheal tube resulting in gagging or coughing. Additionally, the swallow reflex is present. The patient should be able to follow simple commands. Adequate diaphragmatic strength should be present. This can be assessed by the ability to perform a five second head lift or leg lift with the presence of adequate grip strength. The patient can clear his or her own secretions. Oxygen saturation is >95% with the oxygen

percentage (FiO_2) at 40% or less. The arterial pressure of oxygen should be >80 mmHg. The arterial concentration of carbon dioxide should be <45 mmHg. Tidal volume should be >5mL/kg. Vital Capacity should be >15 mL/kg. Negative inspiratory pressure should be >-20 cm H_2O. Acid-base pH should be >7.35 but <7.50. The patient should be normothermic, neuromuscular blockade must be completely reversed, and metabolic parameters must be within normal limits (Ead, 2004; Howie & Dutton, 2012).

Neuromuscular Reversal.

Train-of-four (TOF) is used to assess the level of neuromuscular blockade in the patient that has received neuromuscular blocking agents. A TOF ratio of 0.7 to 0.9 is associated with residual neuromuscular weakness (Popat et al., 2012). Residual neuromuscular weakness increases the risk of decreased airway muscle tone, airway obstruction, impairment of hypoxic ventilatory response, hypoxia, and increased risk for aspiration (Popat et al., 2012; Renew, 2019). A TOF ratio of 0.9 or higher is associated with a decreased postoperative airway complication rate (Popat et al., 2012).

The use of an accelerometer (a method of objective neuromuscular blockade monitoring) should occur to more accurately assess neuromuscular blockade as it has demonstrated decreased postoperative pulmonary complications (Cappellini et al., 2018; Haritos, et al., 2019; Popat et al., 2012; Renew, 2019). Subjective neuromuscular monitoring has been demonstrated to be inaccurate. For example, up to 40% of patients may have a train-of-four below 0.9 and 15% of patients may have a train-of-four below 0.7 (Ball et al., 2016). Additionally, it has been demonstrated that residual neuromuscular blockade exists in 60% of patients at during extubation, even if 70% of these patients received neostigmine for neuromuscular reversal (Ball

et al., 2016). Therefore, it is worth consideration of optimal neuromuscular monitoring and appropriate neuromuscular blockade reversal.

The use of sugammadex for neuromuscular reversal has been shown to provide a faster and safer option for moderate to heavy reversal of rocuronium than does neostigmine (Haritos et al., 2019; Hristovska et al., 2017; Popat et al., 2012; Pompei & Rocca, 2013; Renew, 2019). It is recommended to administer Sugammadex if additional neuromuscular reversal is needed as opposed to additional doses of neostigmine as increased administration of neostigmine can result in neuromuscular weakness if maximal dose is surpassed (Haritos et al., 2019).

Various studies have demonstrated that the combination use of neostigmine with Sugammadex has been shown to be effective and cost saving (Aouad et al., 2017; Cheong et al., 2015; Nakata et al., 2012). Combination drug therapy resulted in decreased recovery time, decreased Sugammadex dosage requirements, and decreased adverse effects of neostigmine (Aouad et al., 2017; Cheong et al., 2015; Nakata et al., 2012).

Postoperative Phase

Postextubation Complications.

Postextubation complications that can increase the risk for respiratory adverse events or reintubation exist in the surgical patient. These risks include but are not limited to laryngospasm, laryngeal edema, esophageal perforation, aspiration, pneumothorax, hypoventilation, cardiovascular instability, bronchospasm, airway trauma, increased intrathoracic pressure, hypoxia, airway obstruction, and subglottic edema (Apfelbaum et al., 2013; Ead, 2004; Popat et al., 2012). According to the American Society of Anesthesiologists guidelines the anesthesia provider should assess the patient postoperatively to identify complications (Apfelbaum et al., 2013).

Noninvasive Respiratory Support for Postextubation Respiratory Failure.

Several options exist for management of the patient with postoperative respiratory failure. Options for this include noninvasive ventilation, continuous positive airway pressure, and high-flow nasal canula (Kacmarek, 2019; Pompei & Rocca, 2013). These methods decrease the rate of tracheal reintubation and postoperative respiratory failure, decrease mortality, and length of hospital stay (Ball et al., 2016; Cereda et al., 2013; Pompei & Rocca, 2013).

Noninvasive ventilation involves a mask that covers both the mouth and nares. This mask is connected to a machine that can be titrated to meet oxygen and ventilation requirements of the patient with postoperative respiratory failure (Kacmarek, 2019; Cereda et al., 2013). Multiple studies have demonstrated the effectiveness of postoperative noninvasive ventilation with improved outcomes in various surgical procedures (Ball et al., 2016; Kacmarek, 2019; Cereda et al., 2013). Noninvasive ventilation has been shown to improve the partial pressure of arterial oxygen in lung surgery, reduce work of breathing, improve gas exchange, and recruit atelectatic alveoli (Aguilo´ et al. 1997; Auriant, 2001; Ball et al., 2016; Kacmarek, 2019; Cereda et al., 2013; Perrin et al., 2007). Additionally, noninvasive ventilation has been shown to reduce mortality in patients with postoperative respiratory failure (Auriant, 2001; Ball et al., 2016; Kacmarek, 2019). Noninvasive ventilation can be used to treat respiratory failure or as a preventative measure in patients at risk for postoperative respiratory failure (Ball et al., 2016; Cereda et al., 2013). A Cochrane systematic review identified that noninvasive ventilation use after extubation can decrease death, weaning failure, pneumonia, and length of stay (Burns et al., 2018).

In abdominal or thoraco-abdominal surgical procedures, the use of noninvasive ventilation improved forced vital capacity, oxygen saturation, and FEV_1 (Joris et al., 1997;

Kacmarek, 2019). Noninvasive ventilation resulted in decreased reintubations after extubation, fewer anastomotic leakages, and fewer cases of acute respiratory distress syndrome in patients that had an esophagectomy that experienced acute respiratory failure postoperatively (Ball et al., 2016; Kacmarek, 2019; Michelet et al, 2009). Drawbacks of this method include patient discomfort, pressure ulcers, sinus and ear pain, dried oral and pharyngeal secretions, pneumothorax, eye irritation, aspiration, hypotension, and gastric distension (Kacmarek, 2019).

Continuous positive airway pressure (CPAP) is the use of positive end expiratory pressure (PEEP) in the spontaneously breathing patient that does not require ventilation (Kacmarek, 2019). CPAP use with a low oxygen concentration following extubation has been demonstrated to reduce the rate of postoperative atelectasis in nonsmokers (Ball et al., 2016). Additionally, preinduction oxygenation with CPAP has been shown to decrease atelectasis and improve oxygenation (Cereda et al., 2013). Drawbacks of CPAP are the same as listed for noninvasive ventilation (Kacmarek, 2019). These negative effects of CPAP use should be considered on a patient specific basis.

High flow nasal canula utilizes a nasal canula to deliver high flows of oxygen (Kacmarek, 2019). High flow nasal canula reduces dead space ventilation by about 33 percent by clearing carbon dioxide from the upper airway (Kacmarek, 2019). This results in decreased work of breathing and minute ventilation (Kacmarek, 2019). Adverse effects of high flow nasal canula include drying of secretions and pressure ulcer development on the nares and ears (Kacmarek, 2019).

Summary of Supportive Evidence

It has been identified that postoperative respiratory failure and extubation failure is a problem at both the national level and institutional level. The impact of these two postoperative

occurrences impacts mortality, morbidity, healthcare cost, duration of stay, and labor requirements. A variety of tools exist that can be used to identify the risk of postoperative pulmonary complications and failure to extubate. The difficult airway requires attention to the extubation process as much as the intubation process. The presence of a difficult airway has the potential to affect postoperative respiratory outcomes. Various factors influence the risk of postoperative respiratory failure. This includes preoperative, intraoperative, and postoperative factors. Additionally, patient comorbidities and surgical procedure alters postoperative respiratory outcomes.

The Difficult Airway Society offers comprehensive guidelines on the extubation process (Popat et al., 2012). The DAS guidelines are specific to both the low-risk and at-risk patients. Visual algorithms and step-by-step sequences are provided by the DAS to aid in ease of use in the clinical arena. The guidelines provided by the DAS are invaluable and underutilized. Intraoperative protective lung ventilation is essential to decrease postoperative pulmonary complications. Protective extubation methods can aid in oxygenation and facilitation of reintubation (Popat et al., 2012).

The assessment of patient readiness for extubation must be performed in each anesthetic case by each anesthesia provider. Proper assessment can identify readiness to extubate and improve successful extubation. Tools exists to aid in the consistency of the assessment of and documentation of extubation readiness. Specific extubation criteria is abundantly evident throughout the literature. Neuromuscular reversal is pivotal to adequate respiratory muscle strength and for the patient to maintain protective airway reflexes (Haritos et al., 2019; Popat et al., 2012; Pompei & Rocca, 2013). The use of Sugammadex should occur in patients requiring

deep neuromuscular reversal or additional neuromuscular reversal (Haritos et al., 2019; Popat et al., 2012; Pompei & Rocca, 2013).

The postoperative phase presents with challenges to extubation success. Early noninvasive ventilation has proven beneficial for the reduction of postoperative pulmonary complications and reintubation. The use of CPAP, BIPAP and high flow nasal canula all have been beneficial in the postanesthesia care unit after extubation (Aguilo´ et al. 1997; Auriant, 2001; Kacmarek, 2019; Perrin et al., 2007; Pompei & Rocca, 2013).

Chapter 3: Project Design

Methodology

The methodology of this QI project consisted of gathering data (frequency) of extubation failure prior to implementation and again after implementation of the QI project. A brief educational session was held to explain the SPORC-2 risk stratification tool. After this, the DNP project team leader remained available for the first day of implementation to guide its use. If an anesthesia provider was not available for in person education, the anesthesia provider was permitted to choose if he or she desired to receive education in person or via a virtual communication method such as Microsoft Teams, Zoom, or telephone. If this occurred, the DNP project team leader contacted the anesthesia provider individually to schedule an educational session. Thereafter, anesthesia providers were permitted to contact the DNP project team leader via telephone or email for additional assistance. Successful teaching was measured by anesthesia providers demonstration of the SPORC-2 tool to the DNP project team leader. After a three-month period of utilization of the SPORC-2 tool, the DNP project manager calculated results in SPSS to identify frequencies of extubation failure and SPORC-2 tool usage.

Project Design

The DNP project was a quality improvement (QI) project. After problem identification, a literature review was conducted, revealing the SPORC-2 as the best method to stratify risk for extubation failure. The project design supports improvement in the process of identifying the risk for extubation failure. This is done as described in the literature review.

Ethical Considerations

The benefit of participation in this QI project included identification of risk for extubation failure in surgical patients. Risk stratification for extubation failure allowed for the

anesthesia provider to conduct informed decision making. The project is considered ethical as it improves the quality of evidence-based care delivery. The QI project does not place the anesthesia provider or patient at increased risk for harm.

An informed consent form was developed for anesthesia providers to sign prior to participation in this DNP project. The informed consent detailed the minimal to no risk associated with the project. The informed consent can be found in Appendix D. CITI training was completed by this author prior to development and implementation of this DNP project. Proof of CITI training can be found in Appendix E. Confidentiality related to this DNP project was ensured as discussed in Chapter 1 of this paper.

Project Schedule

IRB review at the University of Saint Francis began September of 2020. Support for the QI project was consistently received since the introduction of the QI project in March of 2020. Support was granted from not only anesthesia providers at KCH but also the operating room manager. After IRB at the University of Saint Francis, implementation of the QI project began at KCH. The project was implemented in the Fall of 2020 and continued through Spring of 2021. The total duration of project implementation and data collection occurred for three months. In February of 2021 data collection occurred to compare preintervention data to postintervention data. Dissemination of project results occurred in Summer of 2021.

Implementation Methods

This DNP project's implementation method included the utilization of the SPORC-2 assessment tool by anesthesia providers to calculate the risk of extubation failure expressed in percentage. The SPORC-2 tool was modified from its original design by removal of two subsections of the tool due to copyright issues. Anesthesia providers who utilized this tool were

informed that removal of these two subsections decreased the accuracy of risk stratification. The modified tool underscored the risk for extubation failure by 3 to 8 points. The modified SPORC-2 tool was referred to as the "SPORC-2 tool" for simplicity.

An educational session was provided to anesthesia providers (participants); this session detailed how to use the SPORC-2 tool. Participants then demonstrated the proper use of the SPORC-2 tool via application of the tool to a written patient scenario (see Appendix I). Participants utilized the SPORC-2 tool to determine if the patient met inclusion criteria or exclusion criteria. The demographics of age, gender, and American Society of Anesthesiologists physical status were recorded on the tool as well.

After training, the providers implemented the SPORC-2 tool during actual patient care pre-operatively and intraoperatively. Then, the points awarded for each section of the tool were totaled. The back of the document provided the percentage risk of extubation failure associated with the total points. The points and percentage were circled on the back side of the document. The tool was used to provide the anesthesia provider with a numerical representation of the risk for extubation failure. After the procedure ended and the patient was extubated, the anesthesia provider folded the SPORC-2 tool paper and placed it in a designated location within the surgical department. The location to place this document was in a secure area; the document was placed in a box that was wrapped in paper. The purpose of the box having been wrapped in paper was to identify if the box was opened prior to retrieval by the DNP project team leader. This box had a slit cut into its top to allow for placement of the document without removal of other documents. Weekly the project team leader collected the box and replaced it with a new empty box. After the box was collected each week the DNP project team leader entered data from the completed

SPORC-2 tools into a data package management system (SPSS) on his password protected computer. This repeated on a weekly basis until the three-month intervention period had elapsed.

Measures/Tools/Instruments

The primary tool used was the SPORC-2 risk stratification tool. This tool was used to calculate the projected risk for reintubation after extubation following general anesthesia. This tool measured the previous list of inclusion/exclusion criteria, patient age, gender, and ASA status. Additional variables measured for each patient according to occurrence included the presence of or occurrence of: chronic obstructive pulmonary disease (COPD), heart failure, emergency surgery, high-risk surgical service (vascular surgery, transplant, neurosurgery, thoracic, general surgery and burns), duration of the procedure, number of packed red blood cell units administered, the presence of lung protective ventilation, the administration of noradrenaline equivalent > 0.18 mg, and the use of a volatile anesthetic (Lukannek et al., 2019).

The SPORC-2 tool was provided as a separate document. The one-page document contained assessment of inclusion/exclusion criteria and the SPORC-2 tool on the front with the percentage risk associated with total points on the back. The SPORC-2 tool was developed and externally validated by Lukannek et al. (2019).

Evaluation Plan

Evaluation of the use of the SPORC-2 tool occurred as the DNP project team leader compared returned documents to the number of patients that met inclusion criteria that were intubated. Evaluation of the success of the QI project was identified as the frequency and percentage of extubation failure prior to and after the implementation phase of the project.

Methods for Collection of Data.

The setting for data collection occurred in the preoperative area (preoperative anesthetic interview) and during the intraoperative phase of anesthesia delivery. The intraoperative phase was located within one of 4 surgical suites. The setting otherwise was previously described in the section titled “Implementation Methods.”

Data collection began with baseline data for preintervention group of patients. This consisted of a retrospective EMR review of the last quarter in 2019 to determine the frequency of intubation and the frequency of reintubation within 72 hours. The project team leader performed this duty if not otherwise performed by the data manager. Then the frequency and the percentage of patients that underwent intubation and extubation failure was calculated. Thereafter, a paper copy of the SPORC-2 tool was completed for qualifying patients and returned to the designated secure collection box and collected weekly by the DNP project team leader.

The target number of completed SPORC-2 tools was determined when baseline data was obtained. The target number of patients in the post-intervention group was to be as close to the pre-intervention group as possible. To determine statistical significance the sample of the second group (post-intervention) was estimated to be anywhere from 100-500 patients.

The DNP project team leader was responsible for collecting data from the EMR to obtain baseline and post-intervention data. This process was guided by a CRNA at the facility and/or the data manager. If the data manager was able to extract this data easily, then this was the preferred method of data collection.

Anesthesia providers (CRNA/anesthesiologist) were responsible for collecting the data for each SPORC-2 tool. The DNP project team leader was responsible for checking to make sure that the data was complete. The CRNA clinical coordinator advocated for filling out the SPORC-

2 tool for patients that qualified. The DNP project team leader was responsible for storing the data on a password-protected computer and network-drive. The DNP project team leader entered the data into the statistical package (SPSS) for analysis. The DNP project team leader cleaned the data prior to and after entry into the statistical software.

Data was collected twice. 1) Pre-intervention retrospective chart review. 2) Post-intervention prospective chart audit. If a data collector was not the DNP project team leader, then the DNP project team leader communicated data collection needs with the data extraction individual. The DNP project team leader communicated weekly via email/telephone until data was collected at each point needed. The DNP project team leader reviewed data collected for accuracy of information. Data were collected the same way during each data collection phase. Definitions of each category within the SPORC-2 tool was provided for reference when utilizing the SPORC-2 tool; these can be found in Appendix H. This served to help eliminate subjectivity in evaluation of extubation failure risk with the SPORC-2 tool.

For each surgical patient intubated, inclusion/exclusion criteria were identified to determine if the patient met the requirements for the SPORC-2 tool. After this each anesthesia provider completed the SPORC-2 tool for each patient that received general anesthesia via an endotracheal tube. The anesthesia providers completed the preoperative and intraoperative aspects of the SPORC-2 tool. This tool was in paper format. Once completed, the anesthesia provider inserted the paper into a designated drop-box within the facility. The specifics of the data collection plan were provided above.

Data Analysis Plan.

A baseline for the frequency of extubation failure was determined after a retrospective chart review. This was represented as both a frequency and a percentage of the total number of

patients that were intubated. After the SPORC-2 tool was implemented, frequencies of each of the previously discussed variables occurred for each patient that the SPORC-2 tool was utilized. Then, after the implementation phase, the frequency of extubation failure was assessed and compared to the total number of patients intubated. Thereafter the frequency and percentage of patients that experienced extubation failure were calculated. All data analysis occurred in SPSS. Frequencies of extubation failure were obtained based upon a retrospective chart review.

The frequency of tracheal reintubation after extubation (within 72 hours) was determined for both the preintervention period and intervention period. The data source for this was the electronic medical record via retrospective review. The baseline data was obtained from the last quarter of 2019, as this is when the problem was identified with an increased frequency of reintubation after extubation.

The number of completed SPORC-2 tools was determined by the number of paper format completed SPORC-2 tools. Once completed, these evaluations were placed in a designated area. From here the DNP student obtained them and entered the information into a data management system on his password protected computer. The frequency of use for the SPORC-2 tools was then compared to the number of patients intubated.

Data for each variable on the completed SPORC-2 tools were entered into SPSS on a weekly basis. The frequency of tracheal reintubation after extubation (within 72 hours) was measured after implementation of the SPORC-2 tool.

Dissemination Plan

This DNP project was disseminated to various parties of interest. These parties included DNP and anesthesia faculty at the University of Saint Francis, CRNA students at the University of Saint Francis, and administrative faculty and anesthesia providers at Kosciusko Community

Hospital. A presentation was provided at the University of Saint Francis. A summarized presentation was provided to Stakeholders at Kosciusko Community Hospital if desired.

Plan for USF Presentation

The DNP project was disseminated in the Summer of 2021 to individuals at the University of Saint Francis via a PowerPoint presentation. This presentation gave an overview of the problem, background, PICO question, literature review, implementation phase of the project, data collection, and data analysis of this DNP project. Appropriate social distancing per state and local guidelines were maintained during the presentation. Individuals who were not able to attend had the option to attend the presentation online via a live Microsoft Teams meeting.

Verbal or Written Executive Summary to DNP Project Site/Stakeholders

A written Executive Summary was provided to stakeholders at Kosciusko Community Hospital. A summarized presentation was also provided upon request. This presentation was provided in person in a room provided by the facility if available. If this option was not available or was not desired, the DNP team leader offered to provide a presentation via a virtual method such as Microsoft Teams.

Implementation Process Analysis

The implementation process was evaluated upon retrospective reflection. This was beneficial as it revealed barriers and promotors to implementation of this DNP project. This was helpful as it provided useful insight to individuals who may want to repeat this project at a different facility. This may prove beneficial for overcoming barriers and increasing the success of future project implementation.

Implementation Summary

This DNP project began implementation on December 3, 2020 at Kosciusko Community Hospital in Warsaw Indiana. Anesthesia providers at KCH received education individually on the DNP project. Education took place on December 3, 2020 in the physician's lounge. Materials present included, the SPORC-2 risk stratification tool, a SPORC-2 drop-box, definitions for the variables of the SPORC-2 risk stratification tool, consent forms, and a case scenario. All these documents can be found in the Appendix.

Anesthesia providers were educated on the background of the project, need for the project, the background of the SPORC-2 risk stratification tool, and how to use the SPORC-2 risk stratification tool. Each anesthesia provider was required to complete the case scenario while using the SPORC-2 risk stratification tool. If performed incorrectly, the anesthesia provider received instruction on how to correctly utilize the SPORC-2 risk stratification tool. All questions from anesthesia providers were answered. The DNP project team leader was available in person for the remainder of the day to answer any questions related to the project. Thereafter, the DNP project team leader was available via phone and email to answer questions.

The preoperative registered nurses were also made aware of the DNP project and SPORC-2 risk stratification tools. These nurses were instructed to place one copy with each anesthesia consent form on the patient's chart. The nurses were instructed not to place patient identifying data on the SPORC-2 risk stratification tool. This was suggested by anesthesia providers as it will increase the rate of SPORC-2 risk stratification tool completion.

A copy of the definitions of the SPORC-2 risk stratification tool variables were placed in each operating room. Two drop-boxes were placed in the postanesthesia recovery unit. These boxes were clearly labeled, and instruction was provided to each anesthesia provider.

Each week following the start date for the DNP project, the DNP project team leader contacted various anesthesia providers to inquire of the completion of SPORC-2 risk stratification tools. Upon contact, each provider contacted stated that they were completing the SPORC-2 risk stratification tools for patients who met inclusion criteria. The chief of anesthesia was also contacted on January 5, 2021. The chief of anesthesia was requested remind anesthesia providers to complete the SPORC-2 risk stratification tools. The chief of anesthesia complied with the DNP project team leader's request on this date.

Chapter 4: Results and Outcomes Analysis

Data Collection Techniques

Data collection for this project consisted of various timeframes and methods of data collection. Data were collected to identify a baseline for the timeframe when the problem was identified. Data were also collected during the implementation phase of the project. Implementation phase data consisted of data obtained from the electronic medical record (EMR) and data obtained from completed SPORC-2 risk stratification tools.

Baseline statistical data was obtained from when the problem of extubation failure was initially identified. This timeframe was the fourth quarter of 2019 (October 1 to December 31). Data obtained from this timeframe was obtained by retrospective chart audit by Danette Plautz CRNA. Data obtained include the total number of tracheal intubations during anesthesia administration and the frequency of intubation after extubation following anesthesia. The results included 327 tracheal intubations with anesthesia administration, four cases of reintubation after extubation, and six patients remained intubated after surgery (D. Plautz, personal communication, February 1, 2021). The percentage of tracheal intubations after extubation following the administration of general anesthesia for this timeframe was 0.012%. The percentage of patients that remained intubated after anesthesia delivery was 0.018%.

The intervention phase also underwent a manual chart audit by Danette Plautz CRNA. Between December third, 2020 to March third, 2021 (90-day intervention period), 679 scheduled anesthetic cases were reviewed. 285 of these patients met inclusion criteria for endotracheal intubation. No patients during this time were reintubated after tracheal extubation within 72 hours after extubation (0%). Six of these patients remained intubated after anesthetic delivery (0.021%). Therefore, the frequency of reintubation after extubation decreased and the frequency

of patients that remained intubated remained the same with an increase in the percentage by 0.003%.

Measures/Indicators

All data analysis was completed on SPSS. Data entered was obtained from 92 SPORC-2 Evaluation forms. These forms were obtained from the SPORC-2 drop-boxes. The variables entered into SPSS included the provider ID number, patient age, gender, ASA physical status, presence of heart failure, emergency procedure, ASA physical status greater than or equal to 3, chronic pulmonary disease, duration of procedure, post-tracheal intubation desaturation less than or equal to 90 percent, median fraction of inspired oxygen of greater than 0.62, administration of packed red blood cells, absence of lung protective ventilation, noradrenaline equivalent greater than 0.18 mg, the absence of volatile anesthetic use, the total score, and the percent risk associated with the total score. Date entry was reviewed by the DNP project team leader for missing data entry.

Data analysis was completed to determine the frequency of occurrence for each of the variables found within the SPORC-2 evaluation form. The results of the descriptive statistics can be found in Table 2 through Table 10. These tables can be found in Appendix J. The results of the tables was based on 91 patients and are detailed below.

Regarding patient demographics, the mean age was 52 years. Data analysis revealed that 38 patients were male, and 52 patients were female. The distribution of patients based on ASA physical status can be found in Appendix J table 1.

Table 1 resulted in four patients with ASA status of one, 42 patients with ASA status of two, 41 patients with ASA status of three, and two patients with ASA status of four. Table 2 resulted in five patients with heart failure. Table 3 resulted in 39 procedures considered to be

emergencies. Table 4 Resulted in 21 patients having COPD. Table 5 resulted in 70 patients with a surgical duration of less than 140 minutes, 13 patients with a surgical duration of 140 to 220 minutes and five patients with a surgical duration greater than 220 minutes. Table 6 resulted in 23 patients that experienced oxygen desaturation to less than 90 percent after tracheal intubation. Table 7 indicates that 63 patients experienced an inspired oxygen fraction greater than 61 percent ($FiO2 > 0.61$). Table 8 indicates that two patients received packed red blood cells. Table 9 indicates that six patients received lung protective ventilation. Table 10 indicates that 2 patients had a noradrenaline equivalent of greater than 0.18 mg. Table 11 indicates that 91 patients received a volatile anesthetic agent.

Data analysis was completed to show a graphic representation of the distribution of points and associated risk for extubation failure in the 91 patients that the SPORC-2 evaluation form was used for. The frequency of total points can be viewed in Figure 2 and the frequency of risk for extubation failure can be viewed in Figure 3. The lower the total point value the lower risk for reintubation after extubation. The higher the total point value the high risk for reintubation after extubation. The lowest total point value scored was 0 while the highest was 26. The corelated percentage risk based on total points for reintubation after extubation can be found in the appendix as previously described. Figure 3 indicates the distribution of percentage risk according to frequency. The left side of the graph indicates lower percentage risk while the right side indicates higher risk for reintubation after extubation.

Figure 2

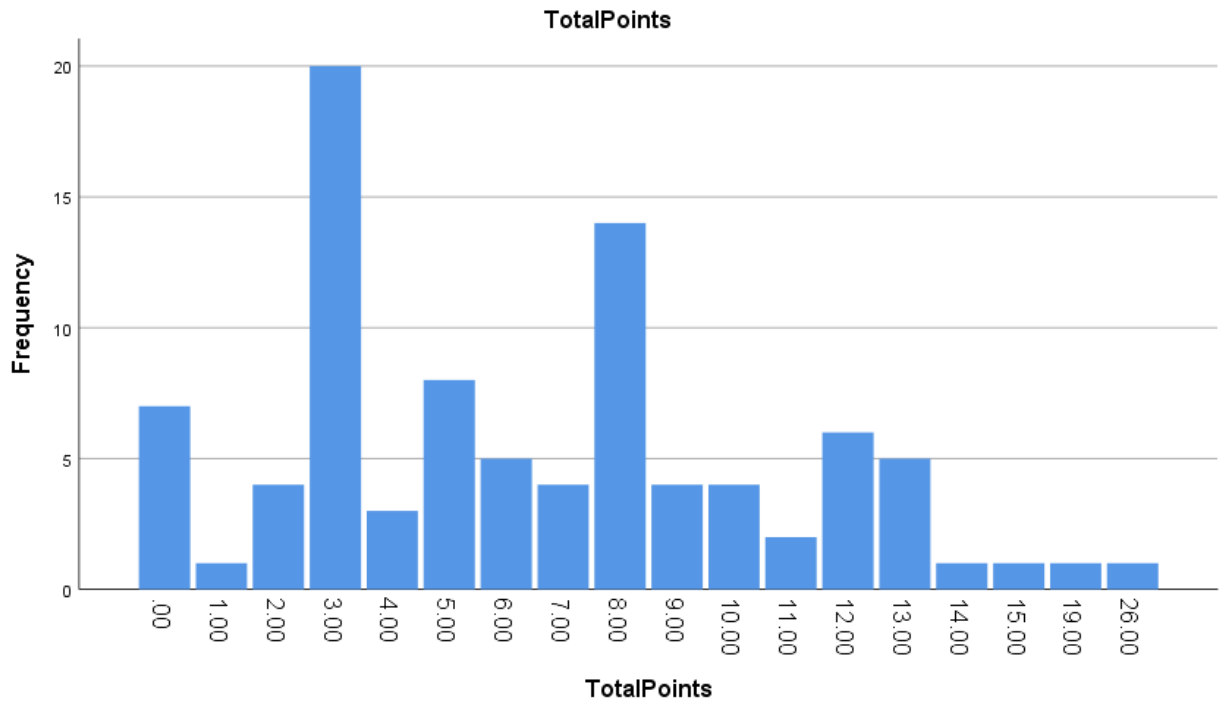
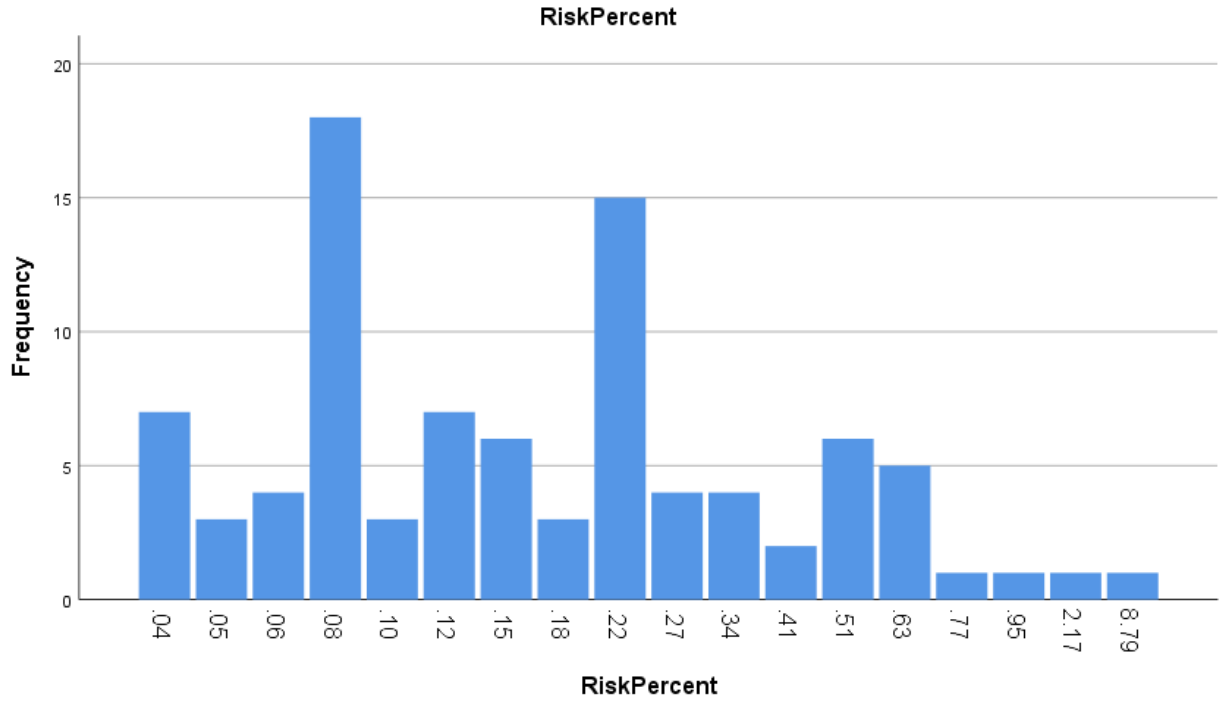


Figure 3



Data Analysis Inferences

The results of statistical analysis can be found above. In this section the aims and outcomes will be discussed for this project.

Aim 1:

To identify the risk of extubation failure in adult surgical patients undergoing general anesthesia. This aim was met when the SPORC-2 was used, as the SPORC-2 provided a numerical percentage risk for extubation failure in patients who met inclusion criteria.

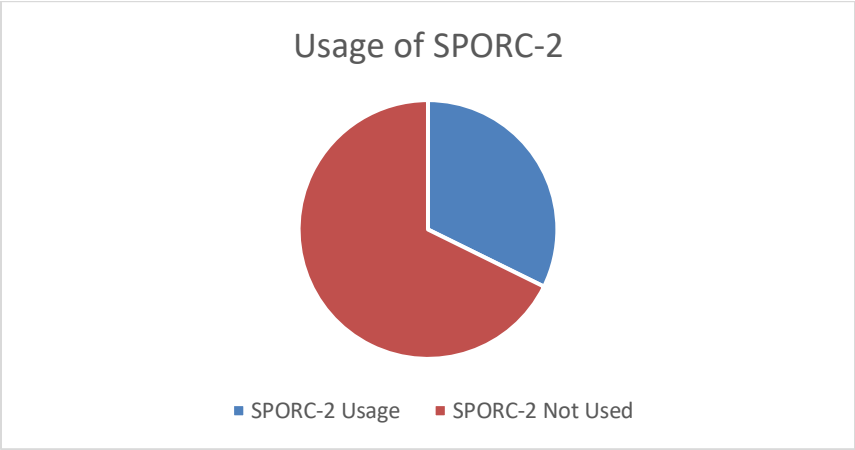
Outcome 1a:

Utilization of the SPORC2 risk stratification tool by anesthesia provider occurred in 75% of patients that met inclusion criteria during the preoperative and intraoperative period.

Results

285 patients received endotracheal anesthesia, 92 of these patients were assessed for extubation failure. The percentage of use for the SPORC-2 risk stratification tool was 32% (Figure 4) This is below the goal of 75%. Therefore, this aim was not met. This aim could have been better met if the DNP project team leader was notified of onboarding of new anesthesia providers. The chief of anesthesia would have been an appropriate individual for this task.

Figure 4



Aim 2:

To decrease the rate of reintubation after extubation 72 hours after the administration of general anesthesia.

Outcome 1b:

The rate of reintubation after extubation (extubation failure) within 72 hours after surgery decreased by 50% after the risk stratification tool was implemented. The preintervention 90-day period.

Results

The preintervention baseline data resulted in 327 patients intubated for general anesthesia, four reintubations (0.012%), and six patients that remained intubated after anesthesia. The postintervention data resulted in 285 patients intubated for general anesthesia, no reintubations (0%), and six patients that remained intubated after general anesthesia. There was a 400% decrease in tracheal reintubations after general anesthesia. Therefore, aim 2 has been met for this DNP project.

Gaps

The risks associated with extubation failure are numerous as discussed in the literature review. This DNP project does not conclude that there is a direct causation of risk stratification with a decreased frequency of reintubation after extubation following general anesthesia. However, there is a relationship that exists between the two. Additionally, the SPORC-2 risk stratification tool was only used in 92 (32%) of the patients that were intubated. Therefore, lakc of use of the SPORC-2 risk stratification tool for the other 193 (68%) patients makes it impossible to determine if these patients benefited from risk stratification. Use of the SPORC-2 risk stratification tool would have made this determination more possible.

Unanticipated Consequences

Unanticipated consequences that altered the DNP project include attrition of participation and onboarding of new anesthesia staff. Upon data entry into SPSS, lack of provider utilization of the SPORC-2 risk stratification tool became evident. Additionally, the onboarding of a new anesthesia provider occurred during the implementation phase. However, the DNP project team leader was not notified of this change. Therefore, the DNP project team leader was unable to include the new anesthesia provider in the project implementation. These events have decreased the total number of completed SPORC-2 forms.

Expenditures

Expenditures for this DNP project were minimal. Expenditures for the DNP project team leader was limited to travel cost to and from the hospital, supply of paper copies of the SPORC-2 form, and the provision of pens. The DNP project was at no direct cost to anesthesia providers. However, the cost can be estimated in time spent by the anesthesia provider on the DNP project. This estimation can be found in the budget section of this paper.

Chapter 5: Leadership and Management

Organizational Culture

The culture of Kosciusko Community Hospital (KCH) was assessed using the Institutional and Organizational Assessment Model (IOA Model). The four subcategories of this model included organizational motivation, organizational performance, organizational capacity, and the external environment (Reflect & Learn, n.d.).

Organizational Motivation

Lutheran Health Network, including KCH, supported the DAISY award international recognition program, this reinforced the delivery of compassionate care by nurses (Lutheran Health Network, 2020). In addition to compassion, Lutheran Health Network was committed to quality and innovative care, emphasizing service, education, and value of care (Lutheran Health Network, 2020). Also, it was Lutheran Health System's goal to do this while respecting the dignity and ethics of everyone (Lutheran Health Network, 2020). This demonstrated that Lutheran Health Network supports evidence-based practice; innovation, quality, education, and value are all based upon evidence-based practice. This was optimal for the success of this author's DNP project.

According to the operating room director, the culture of KCH was considered adaptable, creative, achievement and goal oriented (L. Beeson, personal communication, May 28, 2020). The culture of the surgical department was considered flexible and goal oriented (L. Beeson, personal communication, May 28, 2020). The perspective on change within the hospital was "for the most part very adaptable" (L. Beeson, personal communication, May 28, 2020). Also, core values of KCH included honesty, integrity, and transparency (L. Beeson, personal

communication, May 28, 2020). These characteristics aware optimal to successful implementation of this DNP project.

Upon asking open-ended questions about the mission and culture of KCH the view of one individual who worked in the surgical department described the mission as “to provide excellent patient care and create a safe working environment for practitioners and staff.” The culture of the surgical department is said to be a “family atmosphere since we all spend so much time together.” Additionally, this family culture extended to outside of the work environment in that the staff members help care for one another when sick or facing challenge outside of work. This author has also witnessed this culture upon clinical rotations at KCH. This culture is beneficial in that it promoted teamwork among staff members; however, it posed a potential challenge for the DNP student to gain respect and trust as the staff members are closely bonded.

Organizational Performance

This author’s perspective on the effectiveness and efficiency of performance regarding delivery of care or implementing new evidence-based interventions was based upon first-hand experience. Upon clinical rotations in the surgical department at KCH, this author noted that the preoperative assessment process was organized and succinct. The operating room turnover was fast with adequate but not excessive time between cases. Regarding efficiency of change, this author proposed the idea of extubation failure, a month later, evidence-based interventions were identified and implemented by the OR manager, anesthesia department, respiratory therapy department, and chief nursing officer. Efficiency at KCH is “very productive” and “quality oriented” (L. Beeson, personal communication, May 28, 2020). This was beneficial for this author’s DNP project as the project was a quality improvement project.

Regarding policy implementation and change, KCH is part of the Lutheran Health Network; thus, some change was mandated by Lutheran Health Network. A staff member identified that most changes were physician driven and evidence based. Additionally, it was identified that if the rationale for change was explained, change was easier to accept. The organization that promotes change based on evidence was optimal for this author's DNP project as this quality improvement project was evidence based.

Organizational Capacity

Kosciusko Community Hospital was a facility within the Lutheran Health Network. Lutheran Health Network is part of a larger system called Community Health Systems (CHS), this includes Kosciusko Community Hospital (Community Health Systems, 2020). CHS was founded in 1985 and owns 97 hospitals in 17 states (Community Health Systems, 2020).

Lutheran Health Network had more than 7000 employees and provides facilities that include urgent care clinics, physician offices, outpatient centers, and hospitals (Lutheran Heath Network, 2020). Of the eight hospitals there are 973 beds, 797 of which were in Allen county (Lutheran Health Network, 2020). Kosciusko community hospital had a capacity of 72 beds and the operating room had four operating suites and two procedure rooms (Lutheran Health Network, 2020). KCH was the only hospital in Kosciusko county that is a certified stroke and chest pain center (Lutheran Health Network, 2020).

Regarding finance, KCH partook in planning, strict analysis, and control management to ensure that changes to healthcare delivery are appropriate and beneficial (L. Beeson, personal communication, May 28, 2020). The performance of KCH was considered agile (L. Beeson, personal communication, May 28, 2020). Process at KCH was based upon strategic planning, operations planning, and financial planning (L. Beeson, personal communication, May 28,

2020). These aspects of KCH are beneficial in that adaptation to them with this author's DNP project helped ensure optimal outcomes for the facility and patients.

External Environment

Lutheran Health Network was one of the largest healthcare systems in the Fort Wayne and surrounding area (Lutheran Health Network, 2020). Lutheran Health Network sponsored the community with $10.3 million, invested $116 million in 2018, payed $18.4 million in taxes, and had an overall local impact of $723 million (Lutheran Health Network, 2020). Lutheran Health Network strived to invest in technology and innovation to provide a higher quality of care and attract and retain workers (Lutheran Health Network). This was demonstrated at KCH as the surgical department recently (Fall of 2019) invested in a da Vinci robot to perform robotic assisted laparoscopic surgery. It was evident by the financial spending of Lutheran Health Network that the company strives for innovation. This is beneficial in that innovation is evidence-based. Therefore, the DNP project was more likely to succeed in this innovative culture.

Lutheran Health Network strived to promote diversity within its workforce (Lutheran Health Network, 2020). Employees at Lutheran Health Network facilities receive annual training to promote culturally competent care (Lutheran Health Network, 2020).

Administrative legal aspects that influence KCH included the Centers for Medicaid and Medicare, Joint Commission, and the Indiana State Board of Health (L. Beeson, personal communication, May 28, 2020). Social and cultural aspects that influenced the culture of KCH included compassionate care delivery and inclusion (L. Beeson, personal communication, May 28, 2020). These were important aspects to consider as this author abided by political and legal

authorities. Additionally, it was important to include stakeholders at the table for discussion of this DNP project.

Parkview Health is considered a competitor hospital network in Fort Wayne and Warsaw Indiana. Additionally, many Parkview Health hospitals were magnet status while Lutheran Health Network hospitals were not (American Nurses Credentialing Center, n.d.). Magnet status hospitals promote education and professional development that improve organization and patient outcomes (American Nurses Credentialing Center, n.d.). The lack of Magnet status could have been a barrier to implementation of this DNP project because Magnet hospitals promote improvement and innovation (American Nurses Credentialing Center, n. d.).

Change Strategy

Change is essential for a DNP project to succeed. Lippitt's model of change can be examined to understand the change that occurred at KCH. This model consists of seven steps: develop the need for change, establish motivation and capacity to change, determine resources, establish goals and an action plan, examine alternatives, execute the change, and maintain the change (White, 2016). Lippitt's model of change has proven beneficial to guide change. For example, a research mentorship program has been implemented with guidance of Lippitt's model of change (Manyibe et al., 2015).

To begin there must be a need for change (White, 2016, p. 59). This was evident as there were four cases of extubation failure in the postanesthesia recovery unit and six cases of failure to extubate after surgery in the fourth quarter of 2019. Next motivation was evident as a staff meeting was held to address needed change to correct the problem of extubation failure. Capacity was also assessed in the form of available staff to aid in making change possible. Resources such as postoperative BIPAP and availability of respiratory therapy was assessed. The

goal of preventing extubation failure was then established. An action plan that included risk stratification of extubation was also executed. Alternative options of risk stratification tools were assessed, as can be found in the literature review. Next intentions were transformed into change at KCH. Lastly change was maintained through continued support of risk stratification and culture change from treatment to prevention of extubation failure following general anesthesia.

Leadership Style

The leadership style at KCH was stated to be "strategic and democratic" (L. Beeson, personal communication, May 28, 2020). This author's firsthand experience of the leadership style at KCH fits the description of transformational leadership. This is true as transformational leadership focuses on practice, culture, change, and relationship (Terhaar, 2016, p. 117). An example includes a "family-like" culture focused on caring for one another's needs both at work and outside of work. Another example includes the willingness of staff to change to improve practice to reflect evidence-based practice, as demonstrated by the meeting held on the topic of extubation failure in the first quarter of 2020.

Interprofessional Collaboration

Interprofessional collaboration was evident during the problem identification and implementation of this DNP project. As mentioned, an interprofessional staff meeting was held to discuss the problem at depth and length. The implementation phase of this DNP project primarily involved anesthesia providers and nursing staff at KCH. These two professionals worked symbiotically to increase efficiency and use of the SPORC-2 risk stratification tool. This was done as preoperative nurses aided in the placement of the SPORC-2 risk stratification tool in a convenient location for anesthesia providers to obtain. This teamwork also increased the frequency of use of the SPORC-2 risk stratification tool.

Conflict Management

There were several conflicts among the DNP project team or anesthesia providers at KCH for this DNP project. These conflicts include the initial urgency to address the problem of extubation failure at a sooner timeframe than the DNP project's anticipated timeline. This however was interrupted as the COVID19 pandemic put the DNP project to a stop until it could be resumed in the Fall of 2020. This however worked to the benefit of the DNP project as it allowed for adequate time to complete each step of the DNP project according to the DNP timeline.

Additional conflict included the difficulty of obtaining Lutheran Health Systems IRB approval and data extraction from the electronic medical record (EMR). However, with persistence of communication to key individuals both IRB and data extraction for the DNP project was achieved.

Despite these conflicts, the project was readily accepted as buy-in was high and a problem was established. The relationship established by the DNP project team leader with anesthesia providers was strong prior to implementation of this DNP project. This increased acceptance of and adherence to the DNP project.

Chapter 6: Discussion

Impact of Project

This DNP project positively impacted the ability of anesthesia providers to assess the risk of extubation failure after anesthesia. With use of this externally validated risk stratification assessment tool anesthesia providers were able to accurately identify percentage risk of extubation failure. After completion of the intervention phase of the DNP project, anesthesia providers had the option to continue use of the SPORC-2 risk assessment or to discontinue its use. Anesthesia providers were informed of this during the education session provided the day implementation began.

With the multitude of reasons that extubation failure can occur, it is difficult to determine if the use of the SPORC-2 risk stratification tool has a direct correlation with a decrease in the frequency of extubation failure. However, it is possible that improved risk assessment by anesthesia providers could have improved decision making during anesthesia care delivery.

Decisions and Recommendations

It is recommended to continue to utilize the SPORC-2 risk stratification tool for patients who undergo endotracheal intubation during general anesthesia administration. Additionally, it is recommended for anesthesia providers to continue to explore risk factors for extubation failure. It is recommended that anesthesia providers decrease modifiable risk factors and adapt anesthesia care delivery to nonmodifiable risk factors of extubation failure. Additionally, the use of Sugammadex for neuromuscular reversal in patients with residual neuromuscular blockade and high risk for extubation failure should occur. The use of Sugammadex has been discussed previously in the literature review of this paper.

Limitations of the Project

The limitations of this project include the fact that the SPORC-2 risk stratification form used has been modified from its original form. This has decreased the accuracy of the SPORC-2 risk stratification form used. Additionally, identification of the percentage risk for extubation failure does not provide the anesthesia provider with a clear intervention. Therefore, the anesthesia provider must use the information gained from identification of risk during the delivery of anesthesia on a patient specific basis.

Application to Other Settings

Since the SPORC-2 risk stratification tool in its original form has been externally validated it can be used in any postoperative setting. This excludes those surgical procedures and patient populations that are included in the exclusion criteria. Additionally, the inclusion criteria must be met for the SPORC-2 risk stratification tool to be accurately utilized. The SPORC-2 risk stratification tool may be suitable for the measurement of extubation failure in the patient who has not received general anesthesia, such as a patient in the intensive care unit. However, the SPORC-2 risk stratification tool has not been used or externally validated for this purpose. Therefore, application to this setting can exclude necessary risk factors and include unnecessary risk factors.

Strategies for Maintaining and Sustaining

To maintain use of the SPORC-2 risk stratification tool is a decision to be made by anesthesia providers on an individual basis. If improved decision making was perceived during the use of the tool, then continuation of its use should occur. Additionally, a motivator for continued use of the tool may be the advocation of the use of Sugammadex in patients with a higher risk for extubation failure. Sugammadex is available at KCH, however, its use is regulated

by the pharmacy department. This has been a barrier to its use by anesthesia providers. Therefore, provision of proof for the need for Sugammadex such as high risk for extubation failure may prove helpful in promotion of the use of Sugammadex.

Lessons Learned

To review, this author's DNP project surrounds the idea of prevention of extubation failure. The project goal was to reduce the frequency of reintubation after extubation following general anesthesia administered via an endotracheal tube. This was done through risk stratification of patients to undergo general anesthesia via an endotracheal tube. To be discussed include the supports, risks, unforeseen circumstances, and changes to implementation strategies.

The DNP project was heavily supported as it was clearly identified to be a problem at Kosciusko Community Hospital (KCH). A staff meeting was held to address the problem that included the operating room manager, chief of anesthesia, certified registered nurse anesthetists, respiratory therapy, and the chief of nursing. The support of key stakeholders made this project possible and successful. Additionally, the strong relationships developed with anesthesia staff greatly benefited buy in an trust of the DNP project team leader.

There was no risk associated with this DNP project. Patients nor providers were placed in physical or psychological harm. Anesthesia providers were provided with an informed consent that detailed the alterations made to the risk stratification tool to be used. These modifications decreased the accuracy of the risk stratification tool. Therefore, patients' risk was actually higher than scored. Anesthesia providers were made aware of this and were instructed to take this into consideration when providing anesthesia care.

The main unforeseen circumstances during the DNP project include the difficulty of IRB and data collection. Determination of if IRB review was required and the method to submit to

IRB were both difficult. Fortunately, the search for IRB application began early; this allowed adequate time to complete facility IRB on time. The second unforeseen circumstance was the difficulty of preintervention and postintervention data collection. Data collection was made difficult as there was not an individual available to extract data from the EMR with a time efficient method. This resulted in the need for a CRNA to manually extract data from the EMR. A retrospective chart analysis was conducted to obtain both datasets. While this was not the most efficient method to obtain data, the goal of data collection was achieved.

Changes to implementation strategies include the search to contact a data extraction individual at a sooner date and improving data collection during the implementation phase. This would have increased the chance of finding an individual who can easily extract data from the EMR in a more efficient manner. Data collection during the implementation phase could have been made easier if a count of total intubations were also collected during the implementation phase as opposed to after implementation was complete. This would eliminate the need for a lengthy retrospective chart analysis.

The eight DNP essentials were utilized during creation and implementation of this DNP project. DNP Essential I: Scientific Underpinnings for Practice, was heavily utilized during the literature review aspect of the project. Critical examination of the evidence was detailed in chapter two of this paper.

DNP Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking, was utilized during this DNP Project. The goal of this DNP project was to reduce the frequency of extubation failure, with an improvement in care delivery and patient outcomes. Achievement of this was not without careful planning and communication with key

stakeholders to tailor the DNP project to the organizational, cultural, political, and economic aspects of the facility of interest.

DNP Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice was used in this DNP project. This DNP Essential was demonstrated abundantly in Chapter 2 of this paper. Synthesis of literature occurred in each area of interest according to the literature review. Critical thinking was utilized to determine the accuracy of the articles prior to incorporation into the literature review. Additionally, information technology such as various databases were used to locate the literature during the literature review.

DNP Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care, was used during this DNP project. This is evident in chapter 3 during the planning of the DNP project. Ethical aspects were taken into consideration as detailed in this paper and informed consent.

DNP Essential V: Health Care Policy for Advocacy in Health Care, was also utilized in this DNP project. This was evident as the DNP project team leader served as both organizer and leader for the DNP project. The support of key stakeholders such as the operating room manager and anesthesia providers were obtained prior to the implementation of this DNP project.

DNP Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes was utilized in this DNP project. As evidenced in chapter 1 of this paper interdisciplinary collaboration occurred during this DNP project. For example, the collaboration among anesthesia providers, operating room manger, nurses, and respiratory therapy occurred during this DNP project.

Essential VII: Clinical Prevention and Population Health for Improving the Nation's

Health, was utilized during this DNP project. Risk stratification of extubation failure alters the preoperative assessment of patients to undergo anesthesia. The project goal was to reduce the occurrence of extubation failure after general anesthesia. Therefore, the goal of this project is aimed at improvement of population health, one anesthetic at a time.

Lastly, DNP Essential VIII: Advanced Nursing Practice, was also utilized during this DNP project. This occurred through the identification of a problem within a healthcare institution. This problem was identified with irrefutable evidence and compared to national data. An organizational assessment was performed prior to development of an implementation plan. Anesthesia providers were oriented to the DNP project with seamless transition into participation in the DNP project. Results were collected and analyzed using information technology. Results were disseminated thereafter.

Chapter 7: Conclusion

Potential Project Impact on Health Outcomes Beyond Implementation Site

The impact on health outcomes beyond the implementation site are limited as it depends on dissemination by anesthesia providers to other anesthesia providers at different facilities. However, dissemination of this DNP project to future anesthesia providers at the University of Saint Francis may impact anesthesia care delivery by those providers. The adoption of the SPORC-2 risk stratification tool to anesthesia practice must be made on an individual basis.

Health Policy Implications of Project

There are no health policy implications currently in use for this DNP project or the use of the SPORC-2 risk stratification tool at KCH. The adoption of the use of the tool as policy may be beneficial, however it is not a national standard of care at this time. However, use of the tool can be made policy for the use of Sugammadex for neuromuscular reversal. Although this provides increased proof for the need of Sugammadex, it may serve as yet extra paperwork and another barrier for the use of Sugammadex.

Proposed Future Direction for Practice

In the future it would be beneficial to obtain full copyright permission for the SPORC-2 risk stratification tool in its original form. Two of the variables have been removed from the SPORC-2 risk assessment tool utilized in this project. This has decreased the accuracy of the risk stratification performed. Inclusion of these variables can increase the validity of the tool to its original intended state.

It is also beneficial for anesthesia providers to adopt practice that promotes the reduction of risk factors associated with extubation failure. The use of improved neuromuscular

monitoring, lung protective ventilation, and Sugammadex are also feasible options for improved future practice. The evidence to support this can be found in the literature review of this paper.

Additionally, risk stratification alone has not been proven to decrease the risk or occurrence of reintubation after extubation after general anesthesia. Indeed, the cause of extubation failure is multifactorial as discussed in the literature review. In addition to risk stratification, recommendations are to decrease the risk of extubation failure by altering modifiable risk factors in favor of prevention of extubation failure. The details of these factors can be found in the literature review.

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Appendices

Appendix A

Letter of Project Agreement: Prevention of Extubation Failure, DNP Project

09/21/2020

To the Kosciusko Community Hospital Institutional Review Board:

This letter is written in support of the University of Saint Francis DNP/NAP student Richard Kirby. This student is the DNP project team leader of the Doctor of Nursing Practice Project Scholarly Project titled Prevention of Extubation Failure. This project is a quality improvement project, not a research project.

Anesthesia providers at Kosciusko Community Hospital understand that this project's goal is to prevent reintubation after extubation following general anesthesia. The project intervention is to implement the Score for the Prediction of Postoperative Respiratory Complications-2 (SPORC-2) risk stratification tool. This tool is to be used by anesthesia providers in the preoperative and intraoperative periods. The SPORC-2 tool does not include an intervention associated with patient care or anesthetic delivery. The target population for the SPORC-2 tool includes anesthesia providers. No interventions toward patients are part of the DNP project.

This letter is written as an agreement between Kosciusko Community Hospital and the DNP project team leader Richard Kirby. This letter states that continued support and commitment to the student's DNP project for implementation of the SPORC-2 tool will occur. If this project has been determined to be exempt from IRB, please indicate below.

IRB Needed _____ Exempt from IRB _____

Signature of leadership individual at Kosciusko Community Hospital:

Lora L. Beeson RN

Sincerely,

Richard Kirby, BSN, SRNA

Richard Kirby

Kirbyrn@cougars.sf.edu

Lutheran Health Network
Institutional Review Board (IRB) Expedited Approval Letter

November 13,2020

Dr. Richard Kirby
University of St. Francis
2701 Spring Street
Fort Wayne, IN 46804

Re: **LHN File:** **20-570**
Study Name: **Prevention of Extubation Failure**

Submission: **Protocol Version Date June 10, 2015**
Exempt from Informed Consent

Dear Dr. Kirby

Enclosed is the **expedited** Approval Form of the Lutheran Health Network Institutional Review Board (IRB) for the above referenced study.

Should you have any questions or require any additional information, please do not hesitate to contact me at 260-435-7718.

Sincerely,

Gordon Bokhart Pharm D,
Director of Research
Lutheran Hospital
Fort Wayne, IN 46804

enclosure

Lutheran Health Network
Institutional Review Board (IRB) Approval Form

IRB Name:	Lutheran Health Network Institutional Review Board
IRB Address:	7950 W. Jefferson Blvd. Fort Wayne, IN 46804
Principal Investigator:	Dr. Richard Kirby
Study Site(s):	Warsaw Health Systems LLC Dba Kosciusko Community Hospital 2101 Dubois Drive Warsaw, IN 46580
Protocol Title and Number:	Prevention Of Extubation Failure

Date Received Expedited Review By IRB: Nov 13, 2020

The items below have been submitted for review **(check all that apply)**:

- ☒ Original Protocol Version 1, Date August 30, 2020
- ☐ Protocol Revision: Dated _____
- ☐ Investigator Brochure: Dated _____ / _____ / _____
- ☐ Informed Consent Form (indicate one or all that apply):
  Version number _____
  Date _____
  IRB stamp or notation with approval date of _____
- ☐ No clinical trial personnel, who are IRB members, deliberated or voted on this protocol.
- ☐ Subject Advertisements, Recruiting Materials, and Written Information – specify:
- ☐ Other documents – specify:
  _____

Approval:
- ☒ **Expedited Approval** granted on 11/13/2020 to 11-12-2021
- ☐ Approval granted on _____ from _____ to _____
- ☐ Conditional approval* granted on _____
- ☐ Not approved*

*Comments: **This study is exempt from informed consent form.**

The IRB performing this review is duly constituted and operates in accordance and compliance with local and federal regulations and ICH guidelines.

Gordon Bokhart Pharm D.		11-13-2020
Printed Name (IRB Chair or designee)	Signature	Date of Signature

Appendix B

SPORC-2 Evaluation Form Provider ID: Date:

Inclusion Criteria; yes, must be answered for each variable for the patient to be included.

Non-cardiac surgery Yes ☐ No ☐

General Anesthesia Yes ☐ No ☐

Tracheal Intubation Yes ☐ No ☐

Planned post-procedural extubation in operating room Yes ☐ No ☐

Exclusion Criteria; no, must be selected for each variable for the patient to be included.

Age <18 years old Yes ☐ No ☐

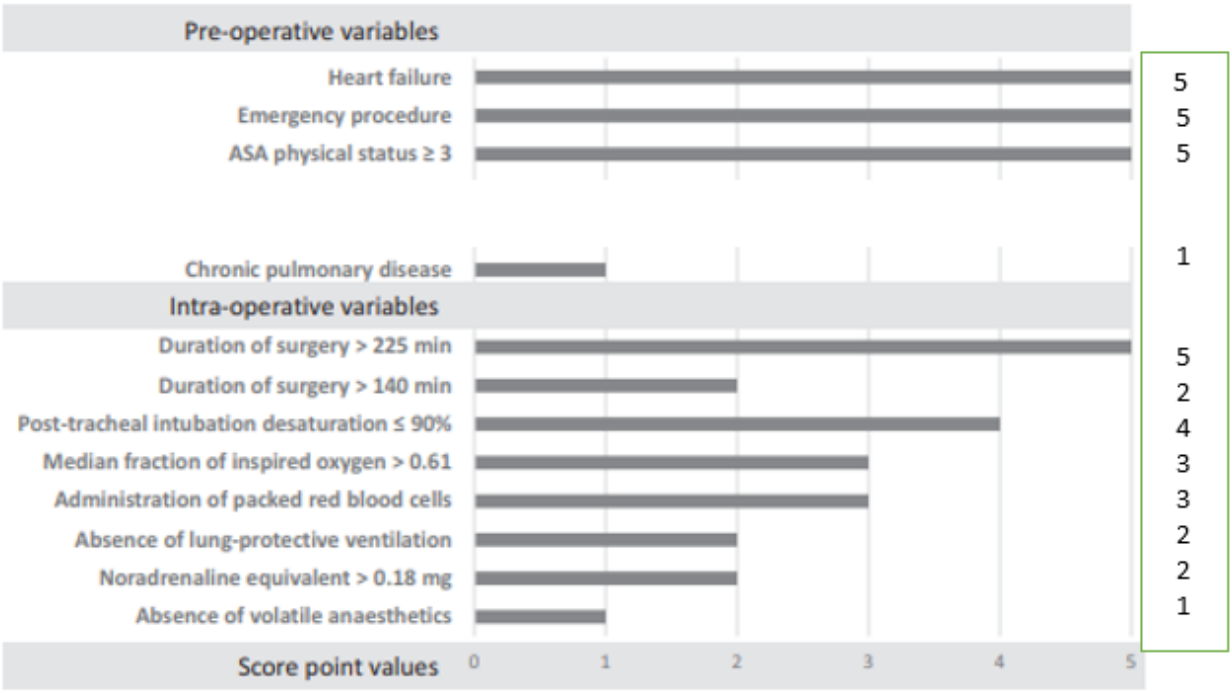
ASA level 6 Yes ☐ No ☐

Surgery within 10 days prior to index procedure Yes ☐ No ☐

Other Demographics:

Age: Gender: ASA Physical Status:

Score for the Prediction of Postoperative Respiratory Complications (SPORC-2) -Modified



(Lukannek et al., 2019)

Total Points:

Score Point Value for Predicted Risk for Reintubation

Score point value	Predicted risk for reintubation (%)	95% CI	
0	0.04	0.03 -	0.05
1	0.05	0.04 -	0.06
2	0.06	0.05 -	0.08
3	0.08	0.06 -	0.09
4	0.10	0.08 -	0.11
5	0.12	0.10 -	0.14
6	0.15	0.12 -	0.17
7	0.18	0.15 -	0.21
8	0.22	0.19 -	0.25
9	0.27	0.24 -	0.31
10	0.34	0.29 -	0.38
11	0.41	0.37 -	0.46
12	0.51	0.46 -	0.56
13	0.63	0.57 -	0.69
14	0.77	0.70 -	0.84
15	0.95	0.87 -	1.03
16	1.17	1.08 -	1.26
17	1.44	1.33 -	1.55
18	1.77	1.64 -	1.90
19	2.17	2.01 -	2.34
20	2.67	2.46 -	2.87
21	3.27	3.00 -	3.53
22	4.00	3.65 -	4.34
23	4.89	4.43 -	5.34
24	5.96	5.37 -	6.55
25	7.24	6.48 -	8.01
26	8.79	7.80 -	9.77
27	10.62	9.36 -	11.88
28	12.78	11.18 -	14.37
29	15.30	13.31 -	17.29
30	18.22	15.77 -	20.66
31	21.55	18.60 -	24.50
32	25.30	21.79 -	28.81
33	29.46	25.38 -	33.55
34	34.00	29.33 -	38.66
35	38.85	33.64 -	44.05
36	43.93	38.25 -	49.61
37	49.14	43.09 -	55.18
38	54.36	48.08 -	60.65
39	59.50	53.11 -	65.88
40	64.43	58.09 -	70.77
41	69.08	62.92 -	75.23
42	73.37	67.51 -	79.23
43	77.26	71.79 -	82.73
44	80.73	75.70 -	85.76
45	83.78	79.23 -	88.33

(Lukannek et al., 2019)

Appendix C

General Timeline

Task	Start Date	End Date
Project Identification	Feb-20	Mar-20
Problem Identification	Feb-20	Mar-20
Framework Selection	Feb-20	Mar-20
Literature Review	Feb-20	Mar-20
CITI Training	Feb-20	Mar-20
Present Literature Review	Mar-20	Apr-20
Risk Identification	Mar-20	Apr-20
Organizational assessment	Apr-20	May-20
SWOT analysis	May-20	15-May-20
Force Field Analysis	May-20	15-May-20
Stakeholder Identification	Mar-20	Jun-20
Budget Assessment	Jun-20	21-Jun-20
Choose risk identification tool	Jun-20	1-Jul-20
Obtain copyright privileges	Jun-20	1-Jul-20
Identify what demographic data will be needed and construct a demographic data sheet.	Jul-20	25-Jul-20
Select measurements/instruments	Jul-20	25-Jul-20
Get a letter of support from the host institution	Aug-20	25-Aug-20
Informed Consent	Sep-20	1-Oct-20
Executive Summary	Aug-20	1-Sep-20
IRB Initial proposal	Sep-20	1-Oct-20
Executive summary improvement	Sep-20	1-Nov-20
Executive summary review again	Oct-20	1-Nov-20
Education Development	Aug-20	Nov-20
Educate Team	Dec-20	Dec-20
Implement Plan	Dec-20	Mar-20
Evaluate Plan/data analysis	Feb-21	Apr-21
Disseminate Project	Apr-21	May-21

Appendix D

Prevention of Extubation Failure: Quality Improvement Project Informed Consent

Introduction: I am Richard Kirby a DNP student in the Nurse Anesthesia Program at the University of Saint Francis in Fort Wayne Indiana. I am conducting a quality improvement project on the reduction of extubation failure. I would appreciate your participation in this project to reduce the occurrence of extubation failure after surgery. By signing this consent form, you agree to following sections of the consent.

Purpose of the Project: The purpose of this quality improvement project is to improve the identification of patients at risk for extubation failure and reduce the rate of extubation failure (reintubation after extubation) in the postanesthesia care unit (PACU). This project applies to the adult population that will receive general anesthesia and an endotracheal tube (ETT). This information will aid the anesthesia providers in the future selection of best-practice interventions during the perioperative period.

Procedures: This quality improvement project will utilize the Score for the Prediction of Postoperative Respiratory Complications 2 (SPORC-2) to assess the risk for extubation failure in adult surgical patients (Lukannek et al., 2019). A completed SPORC-2 document will be turned in to a secure location for each surgical patient that meets inclusion criteria.

Explanation of the Risk and Benefits of the Quality Improvement Project: This QI project does not place the anesthesia provider in physical or phycological risk. The QI project has the benefit of identifying risk for extubation failure in surgical patients. However, if the modified version of the SPORC-2 is utilized, the percentage chance of reintubation as identified by the SPORC-2 may be lower than the actual risk that the patient presents. Thus, underestimation of risk may occur. This modified version of the SPORC-2 does not consider the procedural severity score subcategories. The omission of these two categories omit the potential of 3 to 5 points added to the total risk to be summed. This fact should be considered by the anesthesia provider when utilizing this modified version of the SPORC-2 tool.

Explanation of Safeguards: The information on the SPORC-2 tool will not contain patient identifiers. The anesthesia provider will provide a five-digit number on the document that represents his or her identity. This number will be assigned by the project team leader and will be known to only the project team leader and the anesthesia provider. Data obtained from the SPORC-2 document will be incorporated into SPSS on the DNP project team leader's personal computer. This computer will be password protected. No agencies or groups will receive this data.

Freedom to Withdraw: Anesthesia providers may withdraw from this quality improvement project at any time without penalty. Participation in the quality improvement project is voluntary.

Student Participation: Students will not participate in this QI project.

Inquiries: Once the quality improvement is completed, I would be glad to provide you with the results if requested in writing. To request results or ask any questions please contact me at:

Richard Kirby
9536 Woodstream Drive
Fort Wayne, Indiana 46804
(765) 481-0562
Email: KirbyRN@cougars.sf.edu

If you have any complaints about your treatment as a participant in this study, please call or write:
IRB Chairperson
University of Saint Francis
2701 Spring Street
Fort Wayne, Indiana 46808
(260) 399-7700
Administration email: irb@sf.edu
I have received an explanation of this study and agree to participate. I understand that my participation in this study project is strictly voluntary.

Name_____Date_____
This quality improvement project has been approved by the University of Saint Francis' Institutional Review Board for the Protection of Human Subjects for a one-year period.

Appendix E

CITI PROGRAM

Completion Date 07-Feb-2020
Expiration Date N/A
Record ID 34899313

This is to certify that:

Richard Kirby

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Information Privacy Security (IPS) (Curriculum Group)
Researchers (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wb9f31452-2756-44aa-8541-eec77164ff3a-34899313

CITI PROGRAM

Completion Date 29-Jan-2020
Expiration Date 28-Jan-2023
Record ID 34899315

This is to certify that:

Richard Kirby

Has completed the following CITI Program course:

GCP – Social and Behavioral Research Best Practices for Clinical Research (Curriculum Group)
GCP – Social and Behavioral Research Best Practices for Clinical Research (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w1f21af8e-0267-4ef4-9844-dd8867377adf-34899315

CITI PROGRAM

Completion Date 01-Feb-2020
Expiration Date 31-Jan-2023
Record ID 34899316

This is to certify that:

Richard Kirby

Has completed the following CITI Program course:

Public Health Research (Curriculum Group)
Public Health Research (Course Learner Group)
1 - Basic (Stage)

Under requirements set by:

University of Saint Francis

Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w8f4ece29-0ba5-4381-b6bd-350ca5a61498-34899316

CITI PROGRAM

Completion Date 21-Mar-2020
Expiration Date 21-Mar-2023
Record ID 34899314

This is to certify that:

Richard Kirby

Has completed the following CITI Program course:

Social and Behavioral Responsible Conduct of Research (Curriculum Group)
Social and Behavioral Responsible Conduct of Research (Course Learner Group)
1 - RCR (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w89018049-3562-4d2d-94af-c3281b77e3f7-34899314

CITI PROGRAM

Completion Date 17-Mar-2020
Expiration Date 17-Mar-2023
Record ID 34899312

This is to certify that:

Richard Kirby

Has completed the following CITI Program course:

Social & Behavioral Research - Basic/Refresher (Curriculum Group)
Social & Behavioral Research (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w848b0b5b-8da5-4c81-b8e4-96b62f9038c8-34899312

Appendix F

KN

Kirby, Richard N
Tue 6/16/2020 8:21 AM
To: info@anaesthetists.org

pdf Lukannaek et al__2019 the de...
484 KB

Hello,

I am a Doctor of Nursing Practice (DNP) student and a student registered nurse anesthetist (SRNA) at the University of Saint Francis in Fort Wayne Indiana. I am working on a DNP project to decrease the rate of postoperative extubation failure (reintubation after extubation). I found the Score for the Prediction of Postoperative Respiratory Complications (SPORC-2). I want to know if I can use this tool in a quality improvement project by putting it into practice. I appreciate guidance on the appropriate method to obtain privileges that do not violate copyright laws. Attached is the article for reference.

Thank you,
Richard Kirby
kirbyrn@cougars.sf.edu

DC

Darren de Claro <DarrendeClaro@anaesthetists.org>
Tue 6/16/2020 8:31 AM
To: Kirby, Richard N

WARNING: This email originated from outside of USF. Do **NOT** click links or attachments unless you recognize the sender and know the content is safe.

Dear Dr Kirby,

Thank you for your email. I have forwarded this on for the attention of our secretariat.

Best Regards,
Darren

Darren De Claro
Reception, IT and Office Administrator

Association of Anaesthetists

21 Portland Place, London, W1B 1PY
Mobile 07843587302
Email DarrendeClaro@anaesthetists.org **Web** www.anaesthetists.org

A

anaesthesia <anaesthesia@anaesthetists.org>
Wed 6/17/2020 5:34 AM
To: Kirby, Richard N

WARNING: This email originated from outside of USF. Do **NOT** click links or attachments unless you recognize the sender and know the content is safe.

Dear Richard

I have checked this with the Editor-in-Chief as I wasn't quite sure and he replies: 'he can use it and reference it in any written protocols or publications'

Best wishes

Rona

Rona Gloag
Editorial Co-ordinator, *Anaesthesia*
Association of Anaesthetists

KN

Kirby, Richard N
Tue 6/23/2020 2:07 PM
To: anaesthesia <anaesthesia@anaesthetists.org>

Another question:

Can I implement the SPORC2 risk stratification tool into the electronic medical record at a facility? If not can I print paper copies of this tool and use it to calculate the risk for patients?

Thank you,

Richard Kirby

...

A

anaesthesia <anaesthesia@anaesthetists.org>
Wed 6/24/2020 4:04 AM
To: Kirby, Richard N

WARNING: This email originated from outside of USF. Do **NOT** click links or attachments unless you recognize the sender and know the content is safe.

Hello

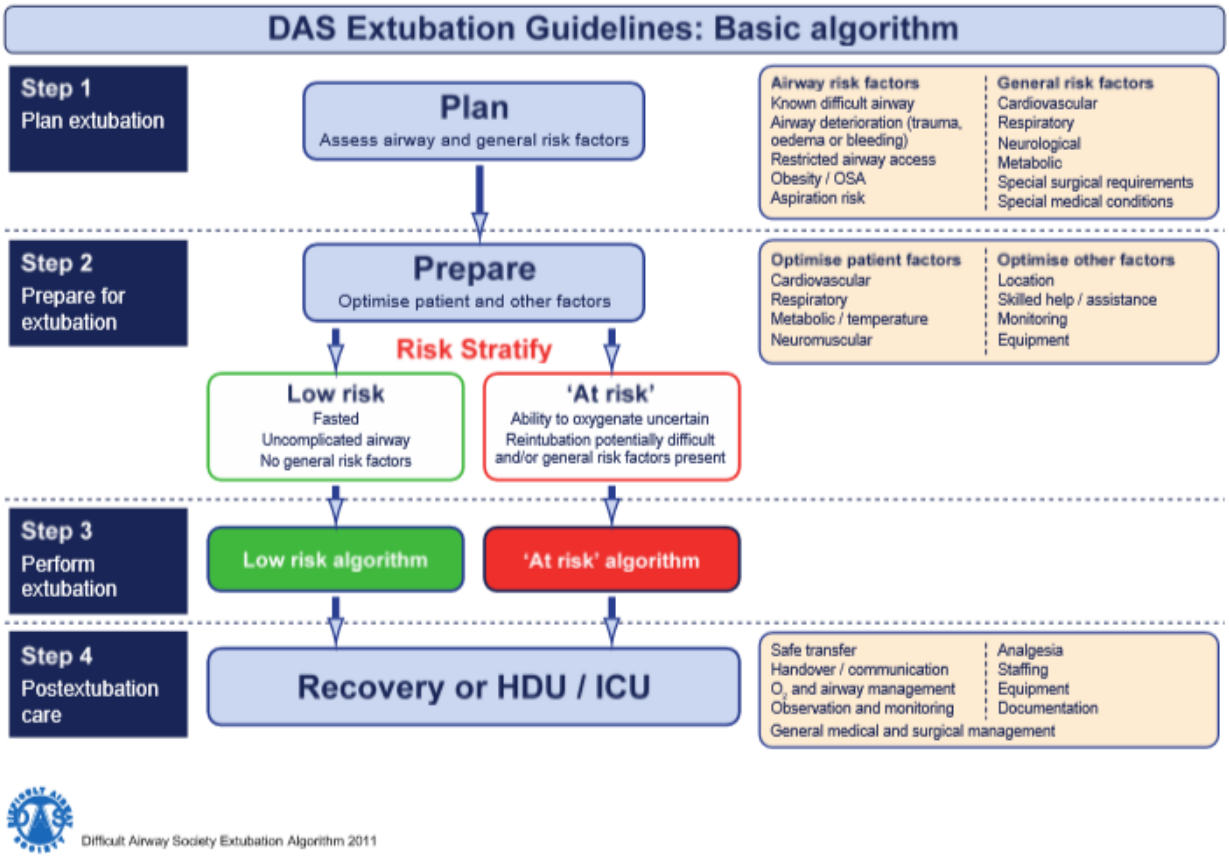
Yes you can do that - again, no need for permission, this does not break copyright law.

Best wishes

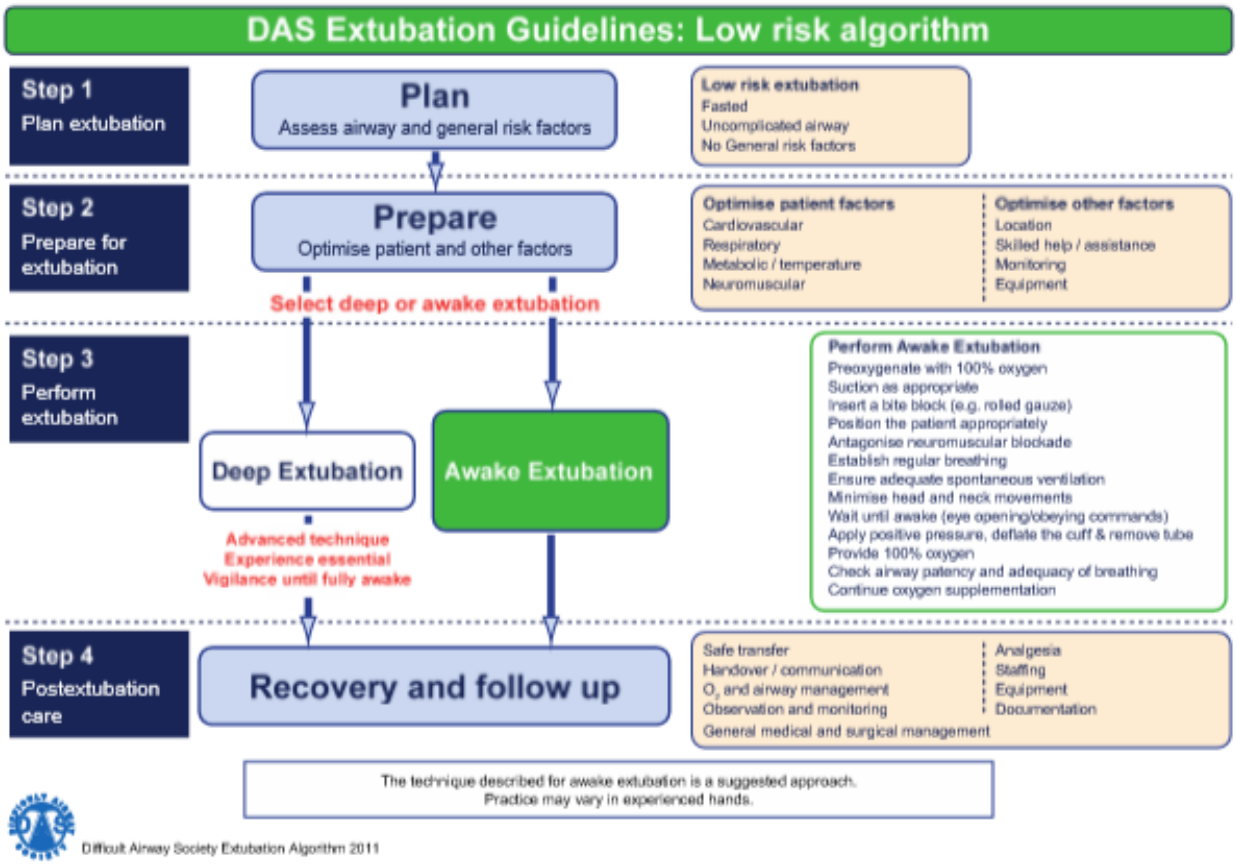
Rona

Rona Gloag
Editorial Co-ordinator, *Anaesthesia*
Association of Anaesthetists

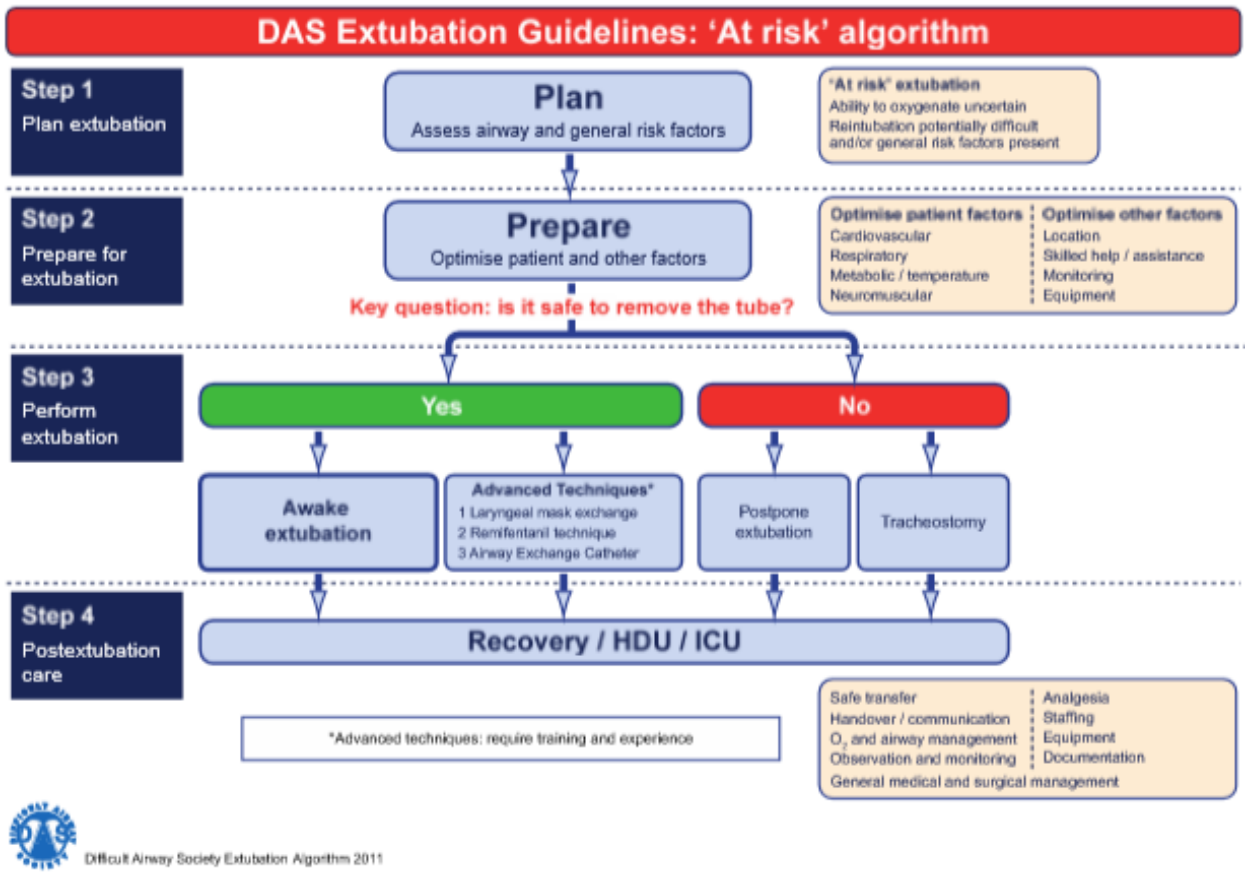
Appendix G



(Difficult Airway Society, 2011)



(Difficult Airway Society, 2011)



(Difficult Airway Society, 2011)

Appendix H

Variable	Description	ICD 9 codes	ICD 10 codes
Preoperative variables			
Demographics / Baseline characteristics			
ASA physical status ≥ 3	I: normal, healthy II: mild systemic disease III: severe systemic disease IV: severe systemic disease that is a constant threat of life V: moribund, not expected to survive without the operation VI: brain death (excluded)		
History of chronic pulmonary disease	Other pulmonary heart disease (excluding Eisenmenger defect)	416.8	I27.8*
	Pulmonary heart disease, unspecified	416.9	I27.9*
	Bronchitis, not specified as acute or chronic	490	J40.*
	Simple and mucopurulent chronic bronchitis	491.*	J41.*
	Unspecified chronic bronchitis	491.*	J42.*
	Emphysema	492.*	J43.*
	Other chronic obstructive pulmonary disease	496.*	J44.*
	Asthma	493.*	J45.*
	Status asthmaticus		J46.*
	Bronchiectasis	494.*	J47.*
	Coalworker's pneumoconiosis	500.*	J60.*
	Pneumoconiosis due to asbestos and other mineral fibers	501.*	J61.*
	Pneumoconiosis due to dust containing silica	502.*	J62.*
	Pneumoconiosis due to other inorganic dusts	503.*	J63.*
	Unspecified pneumoconiosis	505.*	J64.*
	Pneumoconiosis associated with tuberculosis		J65.*
	Airway disease due to specific organic dust (e.g. byssinosis, cannabinosis)		J66.*
	Allergic alveolitis/hypersensitivity pneumonitis due to organic dust (e.g. farmer's lung, bagassosis)	495.*	J67.*
	Chronic respiratory conditions due to chemicals, gases, fumes and vapours	506.4*	J68.4*
	Chronic and other pulmonary manifestations due to radiation	508.1	J70.1*
	Chronic drug-induced interstitial lung disorders		J70.3*
	Respiratory conditions due to other specified external agents	508.8	
	Pneumopathy due to inhalation of other dust	504.*	
History of heart failure	Heart failure	428.*	150.*
Procedure-related			
Emergency status	Emergent vs. non-emergent surgery		
"High risk" surgical services	Services with reintubation rates above average: vascular surgery, transplant surgery, neurosurgery, thoracic surgery, general surgery, and burn surgery		

(Lukannek et al., 2019).

Surgical complexity	Quantified by the Procedure Severity Score[a]		
Intraoperative parameters			
Duration of surgery	in minutes		
Post-intubation desaturation	SpO2 ≤ 90 % at five minutes after intubation		
FiO_2	Median Fraction of Inspired oxygen		
Vasopressor dose	Total intraoperative norepinephrine equivalent dose in mg		
Neuromuscular blockade agents (NMBA) dose	Total intraoperative NMBA dose, expressed as multiples of NMBA-specific effective dose (ED95, median effective dose required to achieve a 95% reduction in maximal twitch response from baseline)		
Fluid volume	Total intraoperative fluids in ml		
Opioid dose	Oral morphine equivalent (OME) dose in mg		
Blood transfusion	Administration of packed red blood cell units, yes/no		
Fentanyl dose	Total intraoperative fentanyl dose, mcg		
Volatile anaesthetics	Total dose of volatile anaesthetics (quantified by mean end tidal concentration), MAC (minimal alveolar concentration)		
Absence of protective ventilation	Protective ventilation: driving pressures≤ 15mmHg (plateau pressure median – positive end-expiratory pressure median (PEEP))		

(Lukannek et al., 2019).

Conversion of mmHg to cm H_2O

1 mm Hg = 1.36 cm H_2O

15 mm Hg = 20.4 cm H_2O

Appendix I

Written Case Scenario for SPORC-2 Implementation

Read the following scenario and complete the SPORC-2 risk stratification tool.

A 123kg 63-year old female patient with heart failure, COPD, and diabetes presents to the emergency department for a ruptured appendix. The patient has been NPO for 8 hours. The surgery lasted for 96 minutes. After induction of anesthesia the patient desaturated to 89%, this returned to 92% within 10 minutes. The median FiO2 was 0.64 for the duration of the case. Sevoflurane was used for the maintenance of anesthesia. Plateau pressures were 38 cm H_2O and PEEP was set at 5 cm H_2O.

Calculate the total points and identify the percentage risk for extubation failure.

Flip this page over to see correct answers.

Written Case Scenario for SPORC-2 Implementation

Total Points: 25

Percentage risk for extubation failure: 7.24%

Appendix J

Tables

Table 1

ASA physical status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	2	2.2	2.2	2.2
	I	4	4.4	4.4	6.6
	II	42	46.2	46.2	52.7
	III	41	45.1	45.1	97.8
	IV	2	2.2	2.2	100.0
	Total	91	100.0	100.0	

Table 2

Does the patient have heart failure?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	86	94.5	94.5	94.5
	Yes	5	5.5	5.5	100.0
	Total	91	100.0	100.0	

Table 3

Is this an emergency procedure?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	52	57.1	57.1	57.1
	Yes	39	42.9	42.9	100.0
	Total	91	100.0	100.0	

Table 4

Does the patient have COPD?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	70	76.9	76.9	76.9
	yes	21	23.1	23.1	100.0
	Total	91	100.0	100.0	

Table 5

What is the duration of the procedure?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	3	3.3	3.3	3.3
	< 140 minutes	70	76.9	76.9	80.2
	140 - 220 minutes	13	14.3	14.3	94.5
	> 220 minutes	5	5.5	5.5	100.0
	Total	91	100.0	100.0	

Table 6

Post-tracheal intubation desaturation <90%

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	68	74.7	74.7	74.7
	yes	23	25.3	25.3	100.0
	Total	91	100.0	100.0	

Table 7

FiO2>0.61

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	28	30.8	30.8	30.8
	yes	63	69.2	69.2	100.0
	Total	91	100.0	100.0	

Table 8

Did the patient receive packed red blood cells?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	89	97.8	97.8	97.8
	Yes	2	2.2	2.2	100.0
	Total	91	100.0	100.0	

Table 9

Was lung protective ventilation utilized?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	84	92.3	92.3	92.3
	Yes	6	6.6	6.6	98.9
	2.00	1	1.1	1.1	100.0
	Total	91	100.0	100.0	

Table 10

Was the noradrenaline equivalent > 0.18 mg?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	89	97.8	97.8	97.8
	Yes	2	2.2	2.2	100.0
	Total	91	100.0	100.0	

Table 11

Was a volatile anesthetic agent used?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	91	100.0	100.0	100.0

Figures