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Evaluation of a Spontaneous Breathing Trial Extubation Protocol on Patient Outcomes

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Abstract

Background: Evidence correlates better patient outcomes with shorter ventilator days therefore, without contraindications, patients should be removed from continuous mechanical ventilation as soon as safely possible. Exactly how to assess readiness to extubate and when to extubate is still up in the air.

Purpose: Evaluation of a 30-minute spontaneous breathing trial extubation protocol on patient outcomes and to also evaluate staff education of the 30-minute spontaneous breathing trial extubation protocol on adherence and patient outcomes

Methods: This is a retrospective and prospective evidence-based quality improvement project comparing patient outcomes before and after staff education as well as patient outcomes between a 2-hour spontaneous breathing trial protocol and a 30-minute spontaneous breathing trial protocol. The project took place in a 10-bed surgical intensive care unit within St. Elizabeth Healthcare hospital in the Edgewood campus located in Northern Kentucky. 101 out of 4136 patients were included in the sample. 16 in the post education group, 40 in the 2-hour group, and 45 in the 30-minute group.

Results: Patient ventilator hours between the 30-minute SBT group and the post education group were 29 and 28 (p 0.91) respectively and SBT hours were 2.11 and 2.15 (p 0.89) respectively. Extubation failures between the 2-hour group and the 30-minute group were 2 out of 40 and 2 out of 45 (p 0.9) respectively and unplanned extubations 3 out of 40 and 1 out of 45 respectively. Within the 30-minute group ventilator hours resulted in a mean of 29 hours and 59.14 hours for the 2-hour group (p 0.001). SBT hours for the 30-minute group resulted in a 2.15 hour mean and 3.42 for the 2-hout group (p 0.022).

Conclusion: The statistically significant shorter ventilator and spontaneous breathing trial hours in the 30-minute group compared to the 2-hour group is an encouraging piece of evidence for the active spontaneous breathing trail protocol in the surgical intensive care unit. This, coupled with the lack of any statistically significant negative patient outcomes between the 30-minute and 2-hour groups, provides supporting evidence to continue the use of the 30-minute spontaneous breathing trial protocol over the 2-hour protocol in the surgical intensive care unit.

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Luke Linz, DO—Committee Member/Clinical Mentor

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Dedication

I dedicate this to my son and family who have always supported me in all my ventures. Without you I would not be the man that I am today. I am grateful for the patience you have shown to me throughout the years, even if I have not always reciprocated that same patience. To my son I say dream big. Never think that something is out of reach. I will be there to support you as you have supported me.

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Evaluation of a Spontaneous Breathing Trial Extubation Protocol on Patient Outcomes

Background and Significance

Continuous mechanical ventilation (CMV) carries higher rates of ventilator induced lung injury (VILI), ventilator associated pneumonia (VAP), thromboembolism, diaphragmatic muscle atrophy, delirium, gastrointestinal stress ulceration, gastrointestinal hypomotility, fluid retention, inflammation, increased length of hospital stay, increased ventilator hours, as well as higher rates of mortality and morbidity ((Esteban, Anzueto & Frutos, 2003), (Funk et al., 2009), (Levine et al., 2008), (Klompas et al., 2015), (Klompas et al., 2014), (Slutsky & Ranieri, 2013), (Rouby & Brochard, 2007), (Girard et al., 2008), (Goligher et al., 2018), (Martin et al., 1992), (Uchino et al., 2005)). Therefore, it is imperative to extubate patients as soon as possible, barring any contraindications.

Problem Identification and Context

Discontinuing a continuous mechanical ventilation carries two essential steps: testing for readiness to begin weaning and actual liberation from mechanical ventilation referred to as weaning. Readiness testing is the evaluation of the patient meeting criteria to a weaning trial and weaning is the act of removing some, or all, of the ventilator support so that the patient takes a greater role in breathing. Determining the readiness to wean is most successful when coupled with a wean predictor tool. The Rapid Shallow Breathing Index (RSBI) is the most commonly used and best studied weaning predictor (Figueroa-Casa et al., 2020; Verceles et al., 2012; and Fadaii et al., 2012; Yang & Tobin, 1991; Zhang & Qin, 2014; El-Khatib, Zeineldine, & Jamaleddine, 2008). RSBI is defined as the ratio of respiratory rate to tidal volume. Patients who cannot breathe independently have a tendency to breathe rapid and shallow. These patients generally have an elevated RSBI. The opposite is true in patients who can tolerate breathing

independently. The suggested RSBI to identify a patient who would fail weaning is >105 breaths/min/L (Yang & Tobin, 1991). The RSBI has a higher probability of predicting weaning failure with RSBI >105 breaths/min/L than of predicting weaning successes with RSBI <105 breaths/min/L (Figueroa-Casa et al., 2020; Verceles et al., 2012; and Fadaii et al., 2012; Meade et al., 2001; Tobin & Jubran, 2006).

One evidenced based guideline method of weaning is a spontaneous breathing trial (SBT). The purpose of an SBT is to evaluate the patient's ability to breathe without the continuous mechanical ventilation. Supported evidence shows clinicians have a tendency to underestimate the patient's ability to do this efficiently, which leads to delayed weaning, which leads to delayed extubation (Funk et al., 2009), (Esteban et al., 2002), (Epstein, Nevins, & Chung, 2000), (Esteban, Anzueto & Frutos, 2003)). A patient's ability to successfully wean, on a spontaneous breathing trial, is associated with lower resource utilization, lower morbidity, and lower mortality rates compared to patients who require longer CMV durations ((Esteban, Anzueto & Frutos, 2003), (Coplin, Pierson, Cooley, Newell & Rubenfeld, 2000), (Unroe, 2010), (Epstein, Ciubotaru & Wong, 1997)). The most effective approaches for weaning include a daily assessment of readiness to wean and the cautious use of sedation ((Dellinger, 2009), (Ely et al., 1996)).

Among the types of SBTs the two most commonly used are a t-piece trial and low-level pressure support ventilation (PSV) (5 to 8 cm H2O). SBTs are an effective, simple, safe and efficient method of weaning (Perkins et al., 2018). Superiority of an SBT method is controversial with recent meta-analysis publication from (Sklar et al., 2017) touting the extubation success rate of t-piece. Yet, another meta-analysis showed that PSV had higher rates of successful extubation (Burns et al., 2017). The American Thoracic Society's most recent

weaning guidelines sides with PSV (Ouellette et al., 2017). For patients with small endotracheal tubes (ETT) the PSV may be more suitable because it aids in overcoming ETT resistance.

Objectives/purpose of the proposed project

1. Evaluate the effectiveness of staff education on patient outcomes related to the extubation protocol, why early extubation is important, and patient factors that are associated with prolonged mechanical ventilation.
2. Evaluate the effectiveness of the 30-minute SBT after January 1, 2019 compared to the 2-hour SBT protocol before January 1, 2019 on continuous mechanically ventilated patient outcomes.
3. Assess level of SICU staff adherence to 30-minute SBT protocol by measuring the time between patient SBT initiation and extubation.
4. Assess the cost effectiveness of the 30-minute SBT after January 1, 2019 compared to the 2-hour SBT protocol before January 1, 2019 by equating the average cost of patient stay while in SICU between the two groups.
5. Evaluate the patient factors associated with prolonged mechanical ventilation.

Conceptual Framework

To provide a guide for clinicians in making choices about clinical practices that affect patient outcomes the Iowa Model of Evidence Based Practice was utilized in this project to guide the process (Melnyk & Fineout-Overhold, 2015). In order for the proposed project to be successful each of the seven parts within the model are essential steps. The mechanisms of the model are: identifying triggers, clinical applications, organization priorities, forming a team,

piloting a practice change, evaluating the pilot, and evaluating practice changes and dissemination of results.

A problem focused trigger of patient's ventilator hours being longer than expected was realized to be a priority with the SICU. A team was formed to address the problem collectively composed of attending physicians in the SICU, the SICU nursing manager, respiratory therapy and pulmonology. Relevant research and literature were assembled and then critiqued for us in practice. It was decided that a sufficient research base existed to support a change in practice from a 2-hour SBT protocol to a 30-minute SBT protocol. A new 30-minute SBT protocol was developed and placed into practice in the SICU on January 1 2019. This project is the evaluation of the implemented 30-minute protocol and this paper is the dissemination of the results.

Proposed Intervention and Expected Outcomes

The purpose of this project was to evaluate outcomes in a continuous mechanical ventilation spontaneous breathing trail protocol in a 10-bed surgical intensive care unit at St. Elizabeth Healthcare in Edgewood, Kentucky. The protocol change was prompted by longer than expected ventilator days in surgical patients and lower than expected failed extubation rates. Prior to the change, which occurred Jan. 1 of 2019, the original protocol SBT carried an average duration of 2 hours followed by a 2-hour rest period before extubation. The new protocol SBT duration is 30 minutes with a rapid shallow breathing index (RSBI) <105 and immediate extubation. This will be a case control retrospective chart review study comparing outcomes prior to January 1, 2019 to outcomes after January 1, 2019 as well as outcomes after a staff education presentation in August, 2020 covering the use of the extubation protocol and patient factors that are associated with prolonged mechanical ventilation. The expected outcomes of this project include: decreased length of ventilator hours; decreased length of stay in ICU; and lower

rates of ventilator associated pneumonia within 48 hours of intubation as well as the education of staff on the extubation protocol, why early extubation is important, and patient factors that are associated with prolonged mechanical ventilation.

Literature Review

Background

Continuous mechanical ventilation (CMV) carries higher rates of ventilator induced lung injury (VILI), ventilator associated pneumonia (VAP), thromboembolism, diaphragmatic muscle atrophy, delirium, gastrointestinal stress ulceration, gastrointestinal hypomotility, fluid retention, inflammation, increased length of hospital stay, increased ventilator hours, as well as higher rates of mortality and morbidity than without CMV ((Burns et al., 2017), (Ouleatte et al., 2017), (Chittawatanarat et al., 2018), (Figueroa-Casas et al., 2020), (Esteban, Anzueto & Frutos, 2003), (Funk et al., 2009), (Levine et al., 2008), (Klompas et al., 2015), (Klompas et al., 2014), (Slutsky & Ranieri, 2013), (Rouby & Brochard, 2007), (Girard et al., 2008), (Goligher et al., 2018), (Martin et al., 1992), (Uchino et al., 2005)). CMV is uncomfortable for patients and normally requires sedation. Due to all of the above it is imperative to extubate patients as soon as possible, barring any contraindications. The aim of this literature review is to support that the implementation of an SBT protocol with RSBI, in conjunction with a PSV is supported by the evidence to improve patient outcomes in regards to extubation.

Methods

A review of the literature was accomplished using Cochrane Database of Systematic Reviews (CDSR), PubMed and CINAHL. Keywords and phrases used in the search included: extubation; intensive care unit (ICU) and/or critical care unit; extubation protocol; pressure support ventilation; rapid shallow breathing index; weaning index. The search was restricted to

peer-reviewed, original research studies with available full text published between 2005 to 2019. The inclusion criteria for selecting studies were that the study focus was on extubation readiness testing or weaning for extubation. 'ICU' was broadly defined to include any of the following: MICU, SICU, TICU, STICU, and CVICU. Exclusion criteria was used to further narrow the remaining studies to those who only used some form of either PSV or RSBI or both as criteria for extubation.

Findings

The findings come in two parts. The first part related to PSV and the second to RSBI. There were no studies that covered both PSV and RSBI in relation to extubation. A total of 363 studies were found, 42 met inclusion criteria and 32 were excluded. A total of 5 publications met the inclusion and exclusion criteria for PSV and 5 publications met the inclusion and exclusion criteria for RSBI. These 10 publications were included in the integrative review**.** All studies were evaluated using the Johns Hopkins Nursing Evidence-Based Practice Appendix C: Evidence Level and Quality Guide (Dang & Dearholt, 2017).

Of the six PSV studies two are systematic meta-analysis with level 1 evidence (Burns et al., 2017; Ouleatte et al., 2017), one is a randomized controlled trial with level 2 evidence (Subira et al., 2019), two are prospective randomized studies (Perren et al., 2002; Chittawatanarat et al., 2018) with level 3 evidence, and 1 is a prospective non-randomized study with a level 3 evidence (Ezingeard et al., 2006). Of the RSBI studies two are retrospective cohort study with level 2 evidence (Verceles, 2012; Figueroa-Casas et al., 2020), one is a cross sectional study with level 2 of evidence (Fadaii et al., 2012), and two are prospective observational with level 3 evidence (Santos Bien et al., 2015; Souza & Lugon, 2015).

The literature supports the use of PSV, over T-piece, as the method of choice for SBT weaning leading to extubation (Burns et al., 2017; Ouleatte et al., 2017; Subira et al., 2019; Perren et al., 2002; Chittawatanarat et al., 2018; Enzingeard et al., 2006). There are other SBT methods but PSV and T-piece are by far the most commonly used. It is also the overall consensus of the literature that reducing the CMV duration to be set as a high priority for intubated patients. The supporting evidence for discontinuing CMV as early as safely possible is related to the high rate of complications associated with endotrachraceal tube (ETT) placement.

PSV SBT carried a higher rate of passing the weaning trial, vs. T-piece, and moving on to extubation. Oulleate et al. (2017) reported that weaning trials with PSV had a relative risk of 1.11 and a confidence interval of 1.0-1.18. Burns et al. (2017) agreed and stated that PSV carried a 6% greater SBT pass rate than T-piece. Sabira et al. (2017) reported similar results at 8.2% greater SBT success rates with PSV vs. T-piece. Although, Chittawatanarat et al. (2018) reported a lower SBT success rate, relative risk 0.79 with confidence interval of 0.70-0.88, with PSV vs. T-piece. Ezingeard et al. (2006) went even further to wean patients on PSV who first failed SBT on T-piece. Of the 21 patients who failed T-piece SBT 8 of them were successfully weaned and extubated on PSV.

There are only two published literature pieces between 2002 and 2019 that look at differences in duration of PSV SBT (Perren et al., 2002; Subira et al., 2019). Perren et al. (2002) reported no difference between a 30-minute PSV SBT and a 120-minute PSV SBT. The 30-minute and 120-minute PSV SBT success rates were 93% and 88% respectively with both having an 85% success rate of extubated patients remaining extubated longer than 48 hours. Subira et al. (2019) looked at the differences between a 30-minute PSV SBT and a 2-hour T-piece SBT. They reported an SBT success rate of 92.5% and 84.1% in the PSV and T-piece

groups respectively with a difference of 8.4% and 95% confidence interval of 4.7%-12.1%. Both studies suggest that a 30-minute PSV SBT results in higher wean passing rates than either a 120-minute PSV SBT or a 2-hour T-piece SBT.

The prognostic value of the RSBI has been in question for decades at this point. Many of the recent publications conclude that the RSBI does not hold high validity in predicting successful extubation among intubated patients (Figueroa-Casa et al., 2020; Verceles et al., 2012; and Fadaii et al., 2012). Santos Bien et al. (2015) and Souza and Lugon (2015) differ from the other three and report that RSBI has a slight predictive value of weaning success. But all five studies conclude that the RSBI should not be used alone as the only predictive tool for successful extubation. Verceles et al. (2012) and Fiueroa-Casas et al. (2020) suggest that the RSBI would hold greater predictive value if used as a trend or calculated differently such as the modified RSBI rate or the serial RSBI.

Discussion

Limitations

The studies have multiple limitations. 3 of the 4 RSBI studies were conducted at a single cohort medical center which will affect the generalizability of the findings to other institutions (Fadaii et al., 2012; Figueroa-Casa et al., 2020; Verceles et al., 2012). Of the multiple ways to collect data for RSBI only one study presented the tool used to collect said data (Verceles et al., 2012). A lack of randomization is a severe limitation of some studies which leaves open the opportunity of bias within the studies (Enzigeard et al., 2006). Also, the total number of subjects in each trial, even within the systematic reviews, were small. This decreases the generalizability of the studies. One final limitation which is present in all the studies is the lack of blinding. At this point it is very difficult to blind SBTs.

Implications for Practice

A gap exists in the literature with the concurrent use of PSV SBT and RSBI. There are currently no studies that look at both. Although, there is support for the use of each independently. And there is only one study in the last ten years which looked at the duration of SBTs. From the literature there is evidence that PSV SBT is the superior method and that a 30-minute duration has equal or greater extubation success rates vs. 120-minutes. The literature also supports the use of RSBI as a predictor of weaning success in conjunction with other variables. Each of these evidenced based practices are valid, reliable and applicable.

Conclusion

The intent of this literature review was to show that the implementation of a PSV SBT protocol is an evidence-based strategy that improves extubation outcomes in the ICU. The intent is to implement extubation protocol improvement project using the evidence from this literature review to develop an interprofessional protocol improves communication between and throughout the ICU team caring for intubated patients. This project also has the potential to increase the number of patients extubated at the earliest and most appropriate time.

Agency Description

Site Description

Implementation of this DNP project was at the St. Elizabeth Healthcare Hospital in Edgewood, Kentucky. St. Elizabeth Healthcare is the largest healthcare provider in Northern Kentucky consisting of 6 hospitals and 115 facilities. Within the St. Elizabeth Healthcare network, the Edgewood campus is the largest hospital be made up of 510 inpatient beds. This Edgewood hospital is an academic teaching facility that offers its community a spectrum of services from outpatient laboratory to general medicine and specialized surgery. The healthcare

network serves the population of Northern Kentucky and beyond. The project will be conducted at the St. Elizabeth Edgewood campus in the surgical intensive care unit (SICU). The SICU is a 10-bed unit that is staffed by a multidisciplinary team of registered nurses (RN), respiratory therapists (RT), advanced practice registered nurses (APRN), doctors of medicine (MD), and doctors of osteopathic medicine (DO). The SICU admits patients from surgery, patients who have been diagnosed with an acute stroke, and overflow patients from the medical intensive care unit.

Project Sample and Recruitment

Inclusion criteria are surgical intensive care unit patients who require continued mechanical ventilation after surgery. The target patient population is adult surgical intensive care patients, ages 18-80 years, of both genders. Exclusion criteria includes patients who were mechanically ventilated for airway protection, require vasopressor support, on paralytics, in hypothermia protocol, have an arterial blood gas pH less than 7.3, diagnosed with myocardial infarction within 24 hours, tracheostomy dependent, terminal weaning, a serum hemoglobin concentration less than 7 g/dL, intractable or persistent hypotension, chronic ventilator dependence, neuromuscular disease, central nervous system defect, and those remaining intubated to go back to surgery or those expected to die.

Patient recruitment for the project was processed through electronic medical record reviews. Medical records of patients admitted to the SICU, within the specified dates, were verified for inclusion criteria and then sorted out for exclusion criteria. Those patients who met inclusion and exclusion criteria were added to the database for the project.

Alignment of DNP project and Site

In numerous ways this project aligned with the St. Elizabeth Healthcare mission, goals, and strategic plan. The mission is stated, "as a catholic healthcare ministry, we provide comprehensive and compassionate care that improves the health of the people we serve." This project is congruent with the mission because it looks to evaluate the use of a protocol that has the intent to shorten the recovery time and lessen the burden of complications encircled by delayed extubation.

This project also aligned with the strategic plan vision of St. Elizabeth Healthcare stated as, "St. Elizabeth will lead the Northern Kentucky region to become one the healthiest communities in America." By decreasing the time intubated and thereby shortening the total critical care time this project aimed to evaluate the outcomes which lead to decreased complication burdens on the community leading to a healthier overall community.

St. Elizabeth Healthcare's Nursing Shared Leadership Charter has a Nursing Philosophy which states, "our practice is guided by our unique Dynamic Caring Model within the framework of shared leadership and governance which includes collaboration, innovation, and evidence-based practice." This project aligned with this guidance because it not only addresses this protocol's evidenced-based practice foundation but also the innovation it took to create a new protocol and the multidisciplinary collaboration essential to make it happen.

This project continued to align with the critical objectives outlined in the shared leadership charter of St. Elizabeth Healthcare. The first critical objective of the charter, "to provide quality care that is evidenced based, outcome oriented, cost effective, individualized, and that is consistent with the mission of the organization goals and objectives," is congruent with multiple aspects of this project. Outcome oriented is the premise of the protocol driven

standardization of extubations in the SICU. Standardizing the extubation protocol decreases variability and controls costs all geared toward increasing positive patient outcomes. Evidenced based practice has been addressed above and stands to reason here.

The fourth critical objective, "to ensure optimal patient care through continuous learning, monitoring and evaluation of patient care outcomes and nursing practice," was tailor made for this project. This project will evaluate the SICU extubation protocol to ensure optimal patient care by continuously learning through monitoring essential patient care outcomes. Monitoring these outcomes will help the organization optimize patient care by the continuous process of learning from evaluation.

Stakeholders and their roles in the project

- **St. Elizabeth Healthcare Institute of Clinical Research** has a vested interest in the care of patients participating in clinical research coordinated with St. Elizabeth Hospital.
- **Surgical Intensive Care Provider** served as a clinical mentor throughout the project. He is the author of the protocol which will be evaluated by this project.
- **Surgical Intensive Care Clinical Nurse Specialist** actively participated in the project as an expert of the SICU and the lead in educating RN in carrying out the protocol.
- **Manager of Respiratory Therapy** played a critical role as the expert and lead of the RT department and personnel executing the protocol.
- **Critical Care Nurse Manager** was a key facilitator in the distribution and execution of the protocol.

- **Intensive care providers (MD's and APRN's)** were a key participant in deciding which patients meet criteria and carrying out the protocol.
- **Critical care Registered Nurses** were active participants in carrying out protocol.
- **Patients** received care based upon the protocol.

Site-specific Facilitators and Barriers to Implementation

Facilitators	Barriers
Mission and strategic plan align with project	Recent change in care structure within the SICU
SICU provider is project mentor	Change is hard, reluctance of staff
RT manager supports project and is key facilitator	Coronavirus
Principle investigator worked on and is familiar with unit	Staff turnover

Project Design

This retrospective and prospective evidence-based quality improvement project was used to determine the impact of a change in practice, surgical intensive care unit-based, of the continuous mechanical ventilation management protocol and re-education program used to enforce the importance of the protocol. This involved a retrospective and prospective electronic health record review of selected participants meeting the inclusion and exclusion criteria. The protocol change occurred on January 1, 2019 and the education occurred in August of 2020. Therefore, participants were selected from three groups with January 1, 2019 and August 2020 being the delineation between the groups. One group were participants before January 1, 2019,

the 2-hour group, the second group were participants between January 2019 and August 2020, the 30-minute group. The third group, the post-education group, were the group after the implementation of the staff education in August 2020.

January 1, 2019 was the implementation of the 30-minute SBT protocol within the SICU. As guided by the Iowa Model of Evidence-Based Practice Model(Melnyk & Fineout-Overhold, 2015) as the mechanism of initial piloting of the practice change. It was decided upon by the formed team that the pilot was appropriate for continued adoption within the SICU as the next mechanism in the Iowa Model of Evidence-Based Practice to promote quality patient care.

The re-education program was utilized to reinforce the evidenced based backing of the liberation protocol. The re-education program will consist of a voice over presentation which will be available to all nursing staff in the SICU. Compliance to the protocol was compared before and after the re-education program.

Project Methods

A retrospective and prospective electronic health record review was conducted to gather data. The 2-hour group contained data from January 1, 2018 through December 31, 2018. The 30-minute group contained data from January 1, 2019 through December 31, 2019. The post education group contained data from August, 2020 to the end of the study duration likely January, 2021. These date ranges were the definitive time frames from which data will be used with January 1, 2019 as the protocol date and August, 2020 the intervention date. Data collected was analyzed and compared between the 2-hour group, 30-minute group and post education group.

Evidence-based intervention

The educational intervention was a presentation of information related to the extubation protocol and information about patient factors which may related to the prolongation of mechanical ventilation. The staff education was presented through the facility operated education portal which is the central hub used to disseminate and record staff education. Each staff member had their own log in for the portal and had access to the educational material related to this study. Hospital units regularly have monthly education requirements which are mandatory. Education related to this study will be the unit's monthly mandatory education for the month of August. The education focused on establishing the importance and reasoning behind the extubation protocol as well as general information about spontaneous breathing trials.

On January 1, 2019, in the SICU, the 30-minute SBT protocol was implemented in place of the 2-hour SBT protocol. The intervention was a new protocol to manage continuous mechanical ventilation (CMV) of patients arriving to the SICU from the operating room (OR). The new protocol initiated the steps needed to liberate and extubate the patient from CMV as soon as possible compared to the replaced 2-hour SBT protocol which had no timeline designated to initiate SBT. Changes from the old protocol to the new protocol included the following and can be viewed in Appendix A and B. The new protocol promoted obtaining an arterial blood gas (ABG) measurement after 30 minutes of an SBT where the old protocol obtained an ABG between 1 to 2 hours of SBT. Both protocols have extubation criteria that a patient must meet before extubation can be considered. These criteria include a respiratory rate less than 30 breathes per minute; maintains spontaneous tidal volume equal to or greater than 4 milliliters per kilogram of body weight; patient can lift head off pillow; arterial blood gas pH between 7.30-7.45; new cardiac arrhythmias; and systolic blood pressure decrease of 15mm/Hg

or increase 20mm/Hg. The new 30-minute protocol added that a patient must have an RSBI less than 105 to the extubation criteria. Once a patient meets all extubation criteria the old protocol gives staff permission to request an order from a physician to extubate the patient. The new protocol gives permission to the staff to extubate the patient once criteria is met.

Procedures

A retrospective and prospective chart review of patient's EHR was used for this study. Data collected was aggregated into spreadsheets for use in SPSS data analysis.

Ethical concerns. Patients protected health information (PHI) is protected by the Health Insurance Portability and Accountability Act of 1996 (HIPPA). This privacy rule addresses the use and disclosure of an individual's health information (Summary of the HIPAA Privacy Rule, 2020). Every option available was implemented to ensure the federal and state laws to protect individual's health information are followed. The facility that this project was conducted within has a robust set of policies in place to protect patients with regard to HIPPA. The principle investigator completed the mandatory education set forth by the facility to safeguard patient's PHI and abided to facility, state and federal privacy policies and laws.

Measures and Instruments. Measures that directly relate to the objectives of this project were included in the collection of data. These study measures included but werw not limited to: ventilator hours, hospital length of stay, diagnosis of ventilator associated pneumonia, 30-day mortality rate, time from SBT to extubation, extubation failure rates defined as re-intubation within 72 hours of extubation, time in SICU, age, sex, weight, body mass index, temperature, respiratory rate, heart rate, mean arterial pressure, blood pressure, oxygen saturation, and fraction of inspired oxygen. Blood serum measurements to be collected included: white blood cell count, hematocrit, hemoglobin, sodium, potassium, glucose, blood urea

nitrogen, creatinine, albumin, total bilirubin, bicarbonate, pH, partial pressure of arterial/venous carbon dioxide, partial pressure of arterial/venous oxygen, and lactate. Measurement tools to used included the Glasgow Coma Scale, Acute Physiology Score, Acute Physiology Age Chronic Health Evaluation III, Charlson comorbidity index, Barthel index, and the International Study Group mechanical ventilation classification. Study measures can be found in detail in Table 1. Instruments used in this project are the CMV management protocol which was evaluated.

Implementation Plan. The implementation occurred in December of 2018 leading up to the inception date of January 1, 2019. It included email dissemination of the new protocol, an educational presentation familiar to facility staff, and a test to evaluate the knowledge of staff regarding the new 30-minute SBT protocol. The protocol was also reviewed during the December monthly staff meeting where SICU staff were given the opportunity to ask questions and address concerns that arose.

Additionally, the education program was implemented to ensure all nursing staff were up to date with the current protocol and its evidence-based guidance. The staff education was in the form of a presentation and was available to all nursing staff through a facility used education portal. The nursing staff were given 4 weeks to complete the re-education presentation.

Data Collection plan. Data collection occurred at the facility on a facility computer. All data was stored on a facility computer for protection of the participants. Chart review of the EHR for patients that met inclusion and exclusion criteria was began directly after institutional review board (IRB) approval. A data request was obtained through the information technology (IT) department of the facility. The electronic medical record request to IT included patient charts from the SICU, within the previously stated time frames, that had arrived intubated from the OR and were surgical patients. After the patient electronic charts were received from IT a

thorough review was conducted to remove any groups which did not meet criteria. Once all patients were screened for criteria each patient chart was reviewed for collection of data. If, during review, a patient was noted to not meet criteria, that patient was removed from the participant list.

Data Analysis Plan. Statistical analysis was conducted using SPSS version 26 (SPSS, INC., Chicago, IL). Descriptive analysis was used when appropriate to summarize data of the, and between the, two groups. Analysis was tailored to the five main objectives of this proposed project. After the main objectives were analyzed themes that arose from the data were explored for further analysis. The exact data analysis tools used were subject to how the collected data themes and trends presented. The projected data was analyzed after being passed through a two-sample t-test. Confidence intervals of 95% and p-values less than 0.05 were considered significant.

Project Timeline. The IRB approval process began in the summer of 2020 when the PI was enrolled in NUR 918. During the summer course of NUR 918 the PI completed the IRB process with the University of Kentucky Health Care Research Council. During this course the PI received approval from the St. Elizabeth Healthcare Institute of Research. Project approval occurred before August 2020. Beginning in August of 2020 the implementation of staff education and the collection of data began. Final project analysis was completed before January of 2021 and thereafter this final draft was underway. A final project was submitted to the project committee by March of 2021. This finished project is slated for defense in April of 2021.

Resources and Budget

Personnel.

Primary Investigator. The principal investigator (PI) directed the project and was apportion 180 hours of time between executing electronic health record reviews, analyzing data and interpreting results.

Statistician. The statistician was provided by the University of Kentucky College of Nursing. It was expected that there will be no fee for initial consultation but expected the need for further statistical assistance.

Clinical Mentor. The clinical mentor delivered supervision to the PI throughout the progression of the project and allotted 20 hours to the project.

Materials.

Office supplies. Office supplies were provided by the PI and the St. Elizabeth Healthcare Institute of Research. Computers were utilized at the St. Elizabeth facility.

Statistical Software. Statistical software used to analyze the project data was provided by the University of Kentucky.

Feasibility and Sustainability

There was a high feasibility of completing this project by means of the above-mentioned plan. With the implementation of the protocol already complete and the facility operated education portal having been used for many years there was ample time for thorough analysis of the collected data. This left time open to further explore the data for trends and themes that would have been overlooked with a constrained timeline. Furthermore, was expected that upon

completion this project woudl serve as the needed push to not only sustain the protocol but to expand the protocol to other parts of the hospital and even to other hospitals within the same network.

Results

A total of 101 out of 4136 patients admitted to the SICU met inclusion and exclusion criteria. 40 of the 85 patients were from the 2-hour group and 45 from the 30-minute group. 16 patients were from the post education group.

The mean age of the 2-hour group was 61.3 years and 67.8 years of the 30-minute group. This results in a significant p value of 0.021. In the 2-hour group there were 23 males and 17 females. The 30-minute group had 21 males and 24 females. The p value for sex between the two groups is 0.318. The race of participants for the 2-hour group were as follows: Black 8, Caucasian 29, Hispanic 2, Asian 0. The race breakdown for the 30-minute group were: Black 10, Caucasian 33, Hispanic 0, and Asian 2 with a resultant p value between the two of 0.623.

Staff education on patient outcomes

31 SICU nursing staff were educated on the two different SBTs. The education presentation was offered during two SICU staff meetings. All staff, including those not present at the staff meetings, were given access to a digital copy of the presentation which could have been viewed at any time. There was no significant difference between the 30-minute group and the post-education group in SBT length, 2.15 vs 2.11 (p .895), or ventilator hours, 29 vs 28.32 (p .912) (Table 6).

SBT effect on patient outcomes

To look at the perspective difference between the two SBT protocols on patient outcomes the following results were from the 2-hour and 30-minute groups. Results can be found in Table

3. No significant difference was found between the two groups in ICU LOS, hospital LOS, 30-day mortality or 1 year mortality. ICU LOS resulted with a 2-hour median of 5.5 days (4-8.75 inner quartile range) and a 30-minute median of 5 days (3-14.5 inner quartile range) with a p value of 0.93. Hospital LOS 2-hour group had a median of 16 days (12-24 IQR) and the 30-minute group had a median of 18 days (9.5-25.5 IQR) with a p value of 0.46.

The results of 30-day mortality rates for the 2-hour group were 8 out of 40 (20%) and 6 out of 45 (13.3%) with a resulting p value of 0.41. The 1-year mortality rate resulted in 15 of 40 (37.5%) patients for the 2-hour group and 13 out of 45 (28.9%) for the 30-minute group that resulted in a p value of 0.39.

Patient outcomes did have a significant change in the time each patient spent on the ventilator and the time each patient spent on a SBT between the two groups. The 2-hour group had a 59.14 (30.32-97.06) median ventilator hours per patient and the 30-minute group had a 29 (20.14-45.93) median ventilator hours per patient. This resulted in a significant p value of 0.001 for ventilator hours per patient. The 2-hour group had a median SBT hour per patient of 3.42 (2.02-4392) and the 30-minute groups median SBT hour per patient was 2.5 (1.17-3.36). This result carried a significant p value of 0.022 per SBT hours per patient.

Adherence to SBT

SICU adherence to each SBT protocol was validated by results from time of SBT to ABG and time from OR to SBT. The timeframe between SBT and ABG for the 2-hour group per protocol was 2 hours. The results from the 2-hour group are 19 out of 40 (47.5%) with 8 missing data for an ABG. The timeframe between SBT and ABG for the 30-minute group per protocol was 30 minutes. The results from the 30-minute group are 1 out of 45 (.0002%) with 19 missing data for an ABG (Table 7).

There was no specified timeframe in the 2-hour group for patients to be started on SBT. In the 30-minute group the patient was to be placed on SBT ventilator settings upon arrival from the OR as long as other mandatory SBT criteria are met. The results from the 30-minute group were a median of 16.26 minutes (5.1-29.8).

Difference in cost of SBT protocols per patient

The financial cost of invasive mechanical ventilation carries a financial burden for the patient. The cost of mechanical ventilation, per patient, for the 2-hour group had an average of $4186. The cost of mechanical ventilation, per patient, for the 30-minute group had an average of $2466 (Table 8).

Prolonged mechanical ventilation patient factors

For this project, the measure of patient factors correlated with prolonged mechanical ventilation focused on a patient's history of respiratory disease prior to intubation. Patients were categorized as either having or not having a history of respiratory disease. Those patients with a prior history of respiratory disease had a median mechanical ventilation of 63.24 hours. Those patients without a prior history of respiratory disease had a median mechanical ventilation of 54.94 hours. With a resulting p value of 0.85 (Table 9) there was no reason to believe a difference existed in the length of time a patient spends on the ventilator and whether or not the patient had a previous respiratory disease diagnosis.

Discussion

Staff education on patient outcomes

Staff education on SBT protocols showed no significant difference on SBT length or patient ventilator hours before or after SBT protocol education. The staff had already received education on the SBT protocols and had worked through the transition from the original protocol

to the newest protocol. The staff accepted the education as a refresher but, due to their experience with the rapid SBT protocol implementation, appeared to be proficient in their knowledge of the SBT protocols. The education material will be used for new nursing staff in the SICU nursing residency program and any newly hired nurses.

SBT effect on patient outcomes

No significant statistical difference was found between patients in the 2-hour group and 30-minute group with regard to ICU LOS, hospital LOS, 30-day mortality or 1-year mortality. It was difficult to attribute the lack of difference in these measures to the SBTs. There are many confounding variables that play a role in the measures. Although, the lack of a difference did show that the 30-minute SBT protocol was at least as good as the original protocol in these measures. Therefore, the 30-minute SBT protocol was not causing negative patient outcomes in the measures reported.

Results of statistical significance were found between the two groups in the measures of patient ventilator hours and patient SBT hours. Both measures carried a lower statistically significant result in the 30-minute group than in the 2-hour group. This pointed to the fact that the rapid SBT protocol had made improvements in patient outcomes related to hours on a ventilator and how long a patient spent on SBT. Shorter lengths of time on mechanical ventilation have been shown to correlate with lower rates of ventilator induced lung injury, ventilator associated pneumonia, thromboembolism, diaphragmatic muscle atrophy, delirium, gastrointestinal stress ulceration, gastrointestinal hypomotility, fluid retention, inflammation, and others ((Esteban, Anzueto & Frutos, 2003), (Funk et al., 2009), (Levine et al., 2008), (Klompas et al., 2015), (Klompas et al., 2014), (Slutsky & Ranieri, 2013), (Rouby & Brochard, 2007), (Girard et al., 2008), (Goligher et al., 2018), (Martin et al., 1992), (Uchino et al., 2005)).

Adherence to SBT

Rather than comparing adherence to SBT protocols between the groups the results will stand as a validity marker to the adherence to each individual SBT protocol. In the 2-hour group the adherence to protocol resulted in roughly 19 out 40 patients with 8 missing ABG data. This means from the time the patient was documented as being placed into SBT there were 8 patients who did not have a drawn ABG before the patient was extubated. Of the patients who had an ABG drawn 19 were drawn within the protocol specified 2 hours from SBT initiation.

Of the 30-minute group only 1 out of 45 had an ABG drawn within the SBT protocol specified time of 30 minutes. An astounding 19 patients did not have ABG data within 2 hours of the SBT initiation. This could be of many factors and it is important to note that the lack of adherence to this portion of the protocol did not impact the rates of extubation failure. It is possible that circumstances did not allow for the ABG to be drawn on patients. One possible factor is the shortened amount of time between SBT initiation and ABG did not allow for enough resources to complete the task in the given time. The rapid SBT protocol is a standing order set to extubate patients by staff when all criteria are met. The ABG draw may have been overridden by a physician whom decided the ABG result was not necessary for extubation orders.

Cost of SBT

There is a cost advantage benefiting, on average, the individual patient within the 30-minute group over the 2-hour group of $1720. This is a quality improvement advantage for patients as opposed to an outcome performance advantage. Though the quality improvement is a substantial one given the high medical bills each patient incurs through such a complicated and sometimes long hospital stay.

Prolonged mechanical ventilation patient factors

The project addressed whether or not a patient's prior diagnosis of a respiratory disease before intubation correlated to a prolonged mechanical ventilation. Based on the results of the analysis there was no reason to believe a difference exists in the amount of time a patient spent on the ventilator and whether or not that patient had a prior diagnosis of respiratory disease. Patients noted to have a prior diagnosis of respiratory disease had one of the following diagnoses documented in their electronic medical record: COPD, asthma, obstructive lung disease, interstitial lung disease, lung cancer, previous lung surgery, and pulmonary hypertension, pulmonary embolism, lung tumor and diaphragmatic disorders.

Future Implications for Practice

Future implications for practice from this study are based upon the results that patients who were liberated from the ventilator using the 30- minute SBT protocol had significantly shorter ventilator hours and SBT time. A significantly shorter SBT and significantly fewer ventilator hours per patient, with no negative patient outcomes, are highly driven quality outcomes for mechanical ventilation patients. There are not specific benchmarks for the patient population studied here and thus it would be beneficial to find such benchmarks and be able to measure these results against external data.

Results show that staff adherence to the protocols was low. Further education is recommended for the staff on protocol adherence timeliness. It is possible that patient ventilator hours and SBT hours could be even shorter with better protocol staff adherence. An open meeting with staff regarding processes that work well and processes that do not work well which may contribute to the lack of adherence could benefit the protocol in its refinement.

Finally, further research is recommended to better understand the consequences of the rapid SBT protocol. It would benefit the research if, prospectively, there were a uniform documentation templet set for each patient. As you will see in the following section, limitations were met in varied documentation. Prospectively collecting data will also give the researcher the opportunity to collect more data that would otherwise fall off the patient's EMR with retrospective data collection.

Limitations

The single largest limitation of this project was retrospective chart review data collection. The only data that could be collected was that data which was saved into the patient's electronic medical record. Unfortunately, this data was not uniform for all patients. It is inherently dependent on how, and how well, staff documented in the patient's EMR. After the data was collected it had to be scrubbed for missing information that was vital to the project. Those patient charts which had missing vital information were removed from the dataset.

Another limitation to the project was the SARS COV2 pandemic. There was a significant disruption to the routine use of the SICU and the OR throughout the pandemic. This disruption caused months of missing data as well as data that was heavily skewed and unusable for the purposes of this project.

Professional Next Steps

Going forward with this project, the next steps will be to decide if the project needs to be continued. All documentation related to this project will be given to the SICU clinical nurse specialist and manager. If they so chose to carry on the project the steps for prospective data collection are outlined in this manuscript. The education material will continue to be disseminated to the new hires in their orientation program as long a useful.

Summary and Conclusion

This project focused on SICU patients that arrived from the OR intubated. Results from this study demonstrate the potential to significantly reduce the length of SBT and the hours a patient spends on continuous mechanical ventilation. Both are quality driven patient outcomes for the mechanically ventilated patient.

Both the 2-hour and 30-minute SBT protocols demonstrated safety for patients in liberation from mechanical ventilation. Each protocol was efficient in the goal of liberation from mechanical ventilation and had similar ICU LOS, hospital LOS, 30-day mortality rates, and 1-year mortality rates. Education on both protocols were provided to the staff and that education material will be used to educate nurses new to the SICU.

We are encouraged by the evidence that these two measures can be reduced to a minimum and that the outcomes, although not fully recognized here, may be great for patients going forward with this knowledge. Invasive mechanical ventilation is correlated with so many negative patient outcomes that any decrease in the time spent on a ventilator is a win for each and every patient.

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List of Tables

Table 1. Study Measures

Measures	Description	Level of Measurement	Data Source
Chief Complaint	Chief Complaint of admitted patient	Ordinal	Medical Record
VAP	Patient develops a ventilator associated pneumonia after extubation protocol	Ordinal	Medical Record
History of Respiratory disease	Yes or No. Does the patient have a diagnosed history of a respiratory disease	Ordinal	Medical Record
Sex	Sex of patient	Ordinal	Medical Record
Age	Patients age	Nominal	Medical Record
Weight	Weight of patient in pounds	Nominal	Medical Record
BMI	Patient body mass index	Nominal	Medical Record
Temperature	Patient temperature	Nominal	Medical Record
Respiratory Rate	Patient Respiratory Rate	Nominal	Medical Record
Heart Rate	Patient Heart Rate	Nominal	Medical Record
MAP	Patient Mean Arterial Pressure	Nominal	Medical Record
Oxygen Saturation	Patient oxygen saturation	Nominal	Medical Record
FIO2	Fraction of inspired oxygen	Nominal	Medical Record
WBC	White blood cell count	Nominal	Medical Record
RBC	Red blood cell count	Nominal	Medical Record
Hematocrit	Patient hematocrit	Nominal	Medical Record
Sodium	Serum sodium	Nominal	Medical Record
Potassium	Serum potassium	Nominal	Medical Record
Glucose	Serum glucose	Nominal	Medical Record
BUN	Serum blood urea nitrogen	Nominal	Medical Record
Creatinine	Serum creatinine	Nominal	Medical Record
Albumin	Serum albumin	Nominal	Medical Record
Total bilirubin	Serum Total bilirubin	Nominal	Medical Record
HCO3	Arterial bicarbonate	Nominal	Medical Record
pH	Arterial pH	Nominal	Medical Record
pCO2	Arterial carbon dioxide	Nominal	Medical Record
pO2	Arterial oxygen	Nominal	Medical Record
Lactate	Serum lactate	Nominal	Medical Record
Intubated	Is the patient Intubated: Yes or No	Nominal	Medical Record
ICU Length of Stay	Number of days patient stent in ICU after extubation protocol	Nominal	Medical Record
Hospital Length of Stay	Number of days patient spent in hospital after extubation protocol	Nominal	Medical Record
Ventilator hours	Hours patient spends intubated after extubation protocol	Nominal	Medical Record
PaO2/FIO2	Ratio calculated from the partial arterial pressure of oxygen in blood divided by the fraction of inspired oxygen	Nominal	Medical Record
Extubation failure	Patient who fails to pass SBT	Ordinal	Medical Record
Reintubation	Patients who need reintubated within 72 hours of extubation	Ordinal	Medical Record
Weaning Time	The amount of time each patient spends weaning from continuous mechanical ventilation	Nominal	Medical Record

RASS	Richmond Agitation Sedation Scale	Ordinal	Medical Record
Unexpected Extubation	Occurrence of extubation that is not planned	Ordinal	Medical Record
Arterial pH	Arterial blood pH drawn during SBT as dictated by protocol	Nominal	Medical Record
Compliance with Ventilator setting	Time from admission to SICU until placed on Protocol ventilator settings	Ordinal	Medical Record
Compliance with extubation criteria	Time from meeting extubation criteria to extubation	Ordinal	Medical Record
SICU cost per day	Amount of money billed for patient stay in SICU per day	Nominal	Medical Record
Cost of mechanical ventilation	Amount of money billed for patient continuous mechanical ventilation	Nominal	Medical Record
APACHE III	Acute Physiology Age Chronic Health Evaluation III	Nominal	Medical Record
APS	Acute Physiology Score	Nominal	Medical Record
GCS	Glascow Coma Scale	Nominal	Medical Record
Charlson comorbidity index	Functional measurement of patient comorbidity	Nominal	Medical Record
Barthel index	Functional capacity measurement	Nominal	Medical Record
SOFA	Sequential Organ Failure Assessment	Nominal	Medical Record
International Study Group mechanical ventilation classification	Classification of patients by reason for mechanical ventilation	Ordinal	Medical Record
Nutrition	Patient nutritional statues	Ordinal	Medical Record

Table 2. Demographics

	2-hour (2018) (n = 40) mean (SD) or n (%)	30-minute (2019) (n = 45) mean (SD) or n (%)	*p*
Age	61.3 (13.9)	67.8 (12.1)	.021
Sex			.318
Male	23 (57.5%)	21 (46.7%)	
Female	17 (42.5%)	24 (53.3%)	
BMI	30.54 (9.3)	29.72 (8.1)	.662
History of respiratory disease			.898
Yes	21 (52.5%)	23 (51.1%)	
No	19 (47.5%)	22 (48.9%)	

Table 3. Patient Outcomes

	2-hour (2018) n=40 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)	*p*
ICU LOS	5.5 (4 – 8.75)	5 (3-14.5)	.93
Hospital LOS	16 (12-24)	18 (9.5-25.5)	.46
30-day mortality after discharge	8 (20%)	6 (13.3)	.41
1-year mortality after discharge	15 (37.5%)	13 (28.9%)	.39
Patient Ventilator hours	59.14 (30.32-97.06)	29.00 (20.14-45.93)	.001
SBT hours	3.42 (2.02-4.92)	2.15 (1.17-3.36)	.022

Table 4. Extubation Failure

	2-hour (2018) n=40 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)	*p*
Extubation failure	2 (5%)	2 (4.4%)	.904
Unplanned Extubation	1 (2.5%)	3 (6.7%)	.365

Table 5. Blood Test Results

	2-hour (2018) n=40 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)	*p*
Arterial pH	25 (64.1%)	24 (64.9%)	.945
Arterial carbon dioxide	30 (76.9%)	21 (56.8%)	.061
Arterial oxygen	10 (25.6%)	5 (13.5%)	.184
Arterial bicarbonate	17 (43.6%)	10 (27.0%)	.132
Total arterial cabon dioxide	21 (53.8%)	14 (37.8%)	.162
Base excess	21 (53.8%)	15 (40.5%)	.246
Arterial oxygen	30 (76.9%)	26 (70.3%)	.510
P/F ratio	18 (46.2%)	12 (32.4%)	.221
Sodium	28 (70.0%)	32 (71.1%)	.911
Potassium	27 (67.5%)	33 (73.3%)	.556
Chloride	27 (67.5%)	31 (68.9%)	.891
CO2	26 (65.0%)	21 (46.7%)	.090
Calcium	6 (15.0%)	10 (22.2%)	.395
Blood Glucose	32 (80.0%)	43 (95.6%)	.026
BUN	20 (50.0%)	18 (40.0%)	.355
Serum Creatinine	12 (30.0%)	20 (44.4%)	.170
GFR Afr Am	15 (38.5%)	23 (51.1%)	.245
GFR Non Afr Am	15 (38.5%)	27 (60.0%)	.049
Anion Gap	35 (94.6%)	37 (86.0%)	.204
White Blood Cells	20 (50%)	37 (82%)	.002
Red Blood Cells	39 (97.5%)	44 (97.78%)	.932
Hemoglobin	40 (100%)	42 (93.33%)	.096
Hematocrit	39 (97.5%)	43 (95.56%)	.627
Mean Corpuscular Volume	3 (7.69%)	3 (6.67%)	.856
mean corpuscular hemoglobin	2 (5.13%)	4 (8.89%)	.505
mean corpuscular hemoglobin concentration	3 (7.69%)	6 (13.33%)	.405
red cell distribution width	21 (52.5%)	24 (53.33%)	.939
Platelets	23 (57.5%)	17 (37.78%)	.069
Mean Platelet Volume	12 (32.43%)	6 (13.33%)	.038

Table 6. Staff Education

	Post Education n=16 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)	*p*
Patient Ventilator hours	28.32 (19.73-39.39)	29.00 (20.14-45.93)	.912
SBT hours	2.11 (1.09-3.42)	2.15 (1.17-3.36)	.895

Table 7. Adherence to Protocol

	2-hour (2018) n=40 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)
OR to SBT	N/A	16.26 (5.1-29.8)
SBT to ABG	19 (47.5%); 8 missing	1 (.0002%); 19 missing

Table 8. Costs

	2-hour (2018) n=40 median (IQR) or n (%)	30-minute (2019) n=45 median (IQR) or n (%)
MV Cost per patient	4186	2466

Table 9. Prolonged Mechanical Ventilation

	History of Respiratory Disease n=42 median (IQR) or n (%)	No History of Respiratory Disease n=43 median (IQR) or n (%)	*p*
Ventilator Hours	63.24 (31.84-89.52)	54.94 (29.77-91.65)	.851

List of Figures

St. Elizabeth HEALTHCARE	**Respiratory Care** Clinical Policy/Procedure
Title: **Continuous Mechanical Ventilation Management for Surgical Intensive Care Unit**	
Approved By: **Irfan Budhani, MD, Medical Director of Respiratory Care Department** **Responsible Party: Thomas Cahill, Director, Respiratory Care**	Page: 1 of 3 Policy No.: RCD CP 400-034 Originated: 12/14/2018 Revised: Reviewed:
Interdisciplinary Review: **Surgical Intensivist, Dr. Linz**	

POLICY: The Respiratory Care Department (RCD) practices respiratory therapy based on the best evidence available in the peer reviewed medical literature. Respiratory Care practices respiratory therapy within the scope of practice described in the Kentucky Respiratory Care Practice Act KRS 314A. Respiratory Care performs respiratory therapy guided by written procedures for discontinuation of Continuous Mechanical Ventilation (CMV) in the Surgical Intensive Care Unit (SICU) for post-operative patients.

RCD discontinues continuous ventilators, upon physician's orders, following predetermined criteria defined in the Spontaneous Breathing Trial (SBT).

PURPOSE: Provides guidelines to Respiratory Care Practitioners (RCP) to place the patient on initial CMV settings and perform Spontaneous Breathing Trial. (SBT)

DEFINITONS: To remove patient from continuous mechanical ventilation (CMV) in an orderly manner by using evidence based guidelines. Ventilator discontinuance is a critical procedure that is based upon sequential assessments of cardio-pulmonary status.

SETTING: Acute care hospital, Surgical Intensive Care Unit

INDICATIONS:

1. Patients requiring continuous mechanical ventilation (CMV) that are post-operative surgical patients who are appropriate for a rapid weaning protocol.

ASSESSMENT OF NEED: Patient meets criteria for continuation from CMV post operatively.

ASSESSMENT of OUTCOME: Patient successfully removed from CMV support.

RESOURCES:

1. **Personnel:** Registered or Certified Respiratory Therapist (RRT) / (CRT)
2. **Equipment and Supplies:**
    a. Stethoscope
    b. Mechanical Ventilator

FREQUENCY: Daily

PROCEDURE: See flow chart below

1. Place patient on Continuous Mechanical Ventilator upon arrival from the Operating Room (OR).
2. Initial Ventilator Settings Include:
   A. Mode: CPAP/Pressure Support
   B. PS 0- 8 cmH20
   C. Peep: 5 cmH20
   D. FI02: titrate to keep SP02 > 92%
   a. Maintain parameters for a PH of 7.30-7.45, PC02 30- 45
   b. Head of bed >30 degrees
   c. Monitor hemodynamics MAP >60-65mm Hg
   d. Monitor patient and obtain ABG sample 30 minutes

3. Assess if patient meets criteria to wean from CMV. The following assessment needs to be completed:
   a. Responds to verbal stimuli
   b. Hemodynamically stable (MAP >60-65
   c. FI02 40%
   d. No arrhythmias

4. **Extubate the patient when they meet the following criteria**:
   a. RR < 30
   b. Maintains adequate MV, Spontaneous TV of ≥ 4ml/kg
   c. Patient can lift head off pillow
   d. RSBI (F/VT) < 105
   e. HDS
   f. ABG parameters 7.30-7.45
   g. Consider humidified high f low O2
5. **Failure to wean includes the**:
   a. Apnea > 30 seconds
   b. New arrhythmias
   c. Accessory muscle use and/or RR > 30
   d. MAP <60mm Hg

e. If patient does not meet the criteria to extubate but can maintain adequate MV, lift head off pillow, responds to commands, re-attempt the SBT.

f. If patient does not get extubated within 24 hours. The patient should follow the ***RCD-SBT protocol referenced CP 400-031. Please refer to Algorithm A.***

MONITORING:

1. Respiratory Therapist to monitor patient during wean initiation
2. Refer to the Spontaneous Breathing Trial (SBT) weaning protocol algorithm attached.

DOCUMENTATION: Document the outcomes (Pre-and Post) of the SBT in EMR and the patient's progress notes. Document Patient/Family Education in the EMR.

INFECTION CONTROL:

1. All staff members must practice BSI precautions.
2. Aseptic technique must be practiced by all staff members when assembling, changing and applying these therapies
3. Changes of equipment and supplies associated with diagnostic procedures are described in the Department's **INFECTION CONTROL GUIDELINES** which can be found in the **SAFETY MANUAL**

ACTION FOR ADVERSE REACTION: Contact physician of weaning failure & document the failure criteria in EMR flow sheet and progress notes.

REFERENCES:

1. Ouellette DR, Patel S Girad TD, Morris PE., Schmidt GA, Burns SM, Epstein SK, Esteban A.. Liberation from Mechanical Ventilation: An Official American College of Chest Physicians/ American Thoracic Society Clinical Guideline, ***CHEST* (2016).**

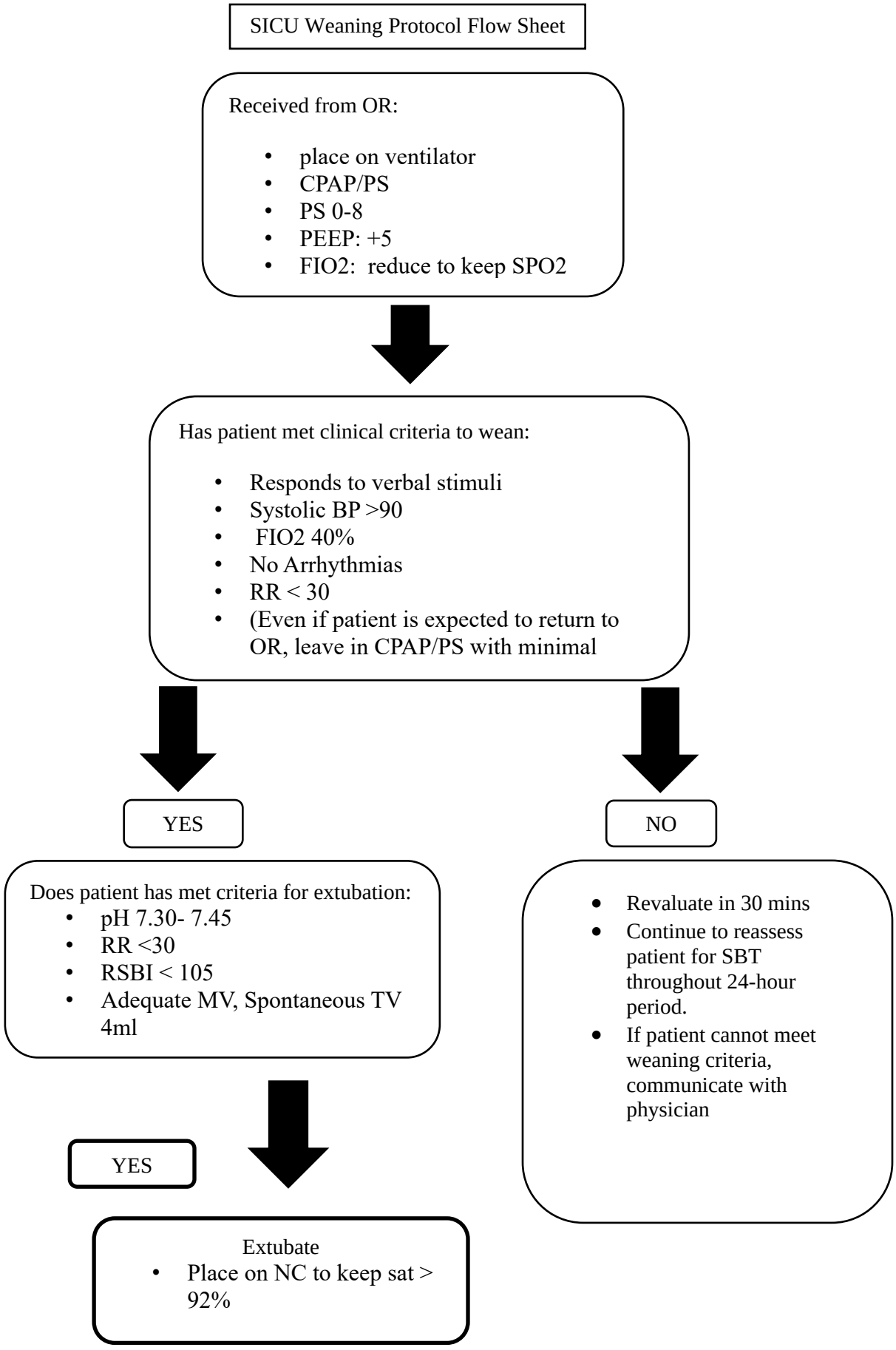
SICU Weaning Protocol Flow Sheet
Received from OR:
• place on ventilator
• CPAP/PS
• PS 0-8
• PEEP: +5
• FIO2: reduce to keep SPO2
Has patient met clinical criteria to wean:
• Responds to verbal stimuli
• Systolic BP >90
• FIO2 40%
• No Arrhythmias
• RR < 30
• (Even if patient is expected to return to OR, leave in CPAP/PS with minimal
YES
NO
Does patient has met criteria for extubation:
• pH 7.30- 7.45
• RR <30
• RSBI < 105
• Adequate MV, Spontaneous TV 4ml
• Revaluate in 30 mins
• Continue to reassess patient for SBT throughout 24-hour period.
• If patient cannot meet weaning criteria, communicate with physician
YES
Extubate
• Place on NC to keep sat > 92%

Figure 2. Original SBT protocol.

St. Elizabeth HEALTHCARE	**Respiratory Care** Clinical Policy/Procedure
Title: **SPONTANEOUS BREATHING TRIAL (SBT)**	
Approved By: **Irfan Budhani, MD, Medical Director of Respiratory Care Department** **Responsible Party: Thomas Cahill, Director, Respiratory Care**	Page: 1 of 5 Policy No.: RCD CP 400-031 Originated: May 1977 Revised: 2-29-08, 9-18 -09, 10-25-11, 3-1-15,6-13-16,01/25/2016 Reviewed:
Interdisciplinary Review: **Director of Physical Therapy, Director of Critical Care, Director of Intensive Care**	

POLICY: The Respiratory Care Department (RCD) practices respiratory therapy based on the best evidence available in the peer reviewed medical literature. Respiratory Care practices respiratory therapy within the scope of practice described in the Kentucky Respiratory Care Practice Act KRS 314A. Respiratory Care performs respiratory therapy guided by written procedures for discontinuation of Continuous Mechanical Ventilation (CMV).

RCD discontinues continuous ventilators, upon physician's orders, following predetermined criteria defined in the Spontaneous Breathing Trial (SBT).

PURPOSE: Provides guidelines to Respiratory Care Practitioners (RCP) to perform the daily Spontaneous Breathing Trial. (SBT)

DEFINITONS: To remove patient from continuous mechanical ventilation (CMV) in an orderly manner by using evidence based guidelines. Ventilator discontinuance is a critical procedure that is based upon sequential assessments of cardio-pulmonary status and cardio-pulmonary reserve.

SETTING: Acute care hospital

INDICATIONS:

2. Patients requiring continuous mechanical ventilation (CMV).

CONTRA-INDICATIONS:

1. Use of vasopressors (*unless ordered by MD)*
2. Inadequate oxygenation:
    i. P/F ratio <150
    ii. Sa02 <88% on FIO2>50%
    iii. PEEP >8 cmH20
    iv. pH <7.3
    v. RR>35
3. Inadequate spontaneous inspiratory effort
4. Evidence of myocardial ischemia in past 24 hours
5. Increased ICP
6. Receiving neuromuscular blockers

ASSESSMENT OF NEED: Patient meets criteria for discontinuation from CMV.

ASSESSMENT of OUTCOME: Patient successfully removed from CMV support.

RESOURCES:

3. **Personnel:** Registered or Certified Respiratory Therapist (RRT) / (CRT)
4. **Equipment and Supplies:**
    a. Stethoscope

FREQUENCY: Daily

PROCEDURE: See flow chart below

1. **PATIENT SAFETY:** Using two methods, excluding room number, ensure positive identification of the patient
2. Raise HOB to 30 degrees unless contraindicated.
3. Registered Nurse (RN) will initiate the Spontaneous Awakening Trial (SAT) - (Sedation Vacation)

    SAT Failure Criteria Assessment

    a. RASS ≥ 3
    b. Respiratory rate >35/min
    c. SpO2 < 88% on > 50% FiO2 or below titrate range
    d. Acute cardiac arrhythmia
    e. ICP > 20mmHg

    OR

    Two or more signs of respiratory distress:

    1. Heart rate increase ≥ 20 bpm above baseline or HR <55 bpm
    2. Use of accessory muscles
    3. Abdominal paradox
    4. Diaphoresis
    5. Marked dyspnea

4. If patient tolerates the SAT, the Respiratory Therapist is to perform SBT. The patient should be placed in an inspiratory pressure augmented weaning mode. Specifically a Pressure Support (PS) at 5-8 cm/H2O with CPAP 0-5 cmH20. (Tube Compensation can also be considered as an alternative mode for initial weaning.)

5. Monitor and assess the patient's progress between 1-2 hours. This time frame is excluded from the cardiac surgery recovery unit (CSR).
6. Mobility level 2 reference ***ACLIN-M-04*** policy states that a patient can wean and be placed in chair position. This should be completed twice a day up to an hour as the patient tolerates. This

is a collaborative effort between the Registered Nurse (RN) and RT. An increase in mobility level of 3 is only contraindicated if a patient plans to be extubated. If the patient meets criteria for extubation, communicate with the Physical Therapist (PT) assigned to the ICU about increasing the mobility level of the patient, or having the physician place the order if they have not been consulted.

7. Obtain ABG within 1- 2 hours on initiation of SBT.
8. **Assess for SBT FAILURE CRITERIA:**
   a. New Arrhythmias
   b. Apnea >45 seconds
   c. Inability to maintain SpO2 >88% (or titrate parameters) with FiO2 <50%
   d. RR >35 for ≥ 5 minutes
   e. Systolic BP decrease 15mm/Hg or 20mm/Hg increase
   f. ICP > 20

OR

Two or more signs of respiratory distress

- Tachycardia ≥ increase HR by 20 bpm
- Bradycardia <55 bpm
- Abdominal paradox/use of accessory muscles/diaphoresis
- Abrupt change in mental status

9. Contact physician with ABG results and respiratory assessment for extubation orders. If a patient is at high risk for re-intubation or extubation failure, an order and communication to the physician for NIV post- extubation should be recommended. High risk patients include:
   a. patients that have failed more than one SBT
   b. weak cough
   c. More than one co-morbid condition (e.g. CHF, COPD, age, severity of illness)
10. Patients that are high risk for postextubation stridor from laryngeal edema should have a cuff leak test completed. Risk factors include:
   a. Prolonged Intubation
   b. Traumatic intubation
11. To perform the cuff leak test the Respiratory Therapist should :
   a. A cuff leak should present normal airflow around the ETT after the cuff of the ETT has been deflated.
   b. The Respiratory Therapist should suction the mouth and upper airway prior to deflating the cuff.
   c. To perform the cuff leak test the Respiratory Therapist should deflate the ETT and listen for air movement around the ETT while using their stethoscope over the upper trachea.
   d. Notify the physician if any evidence of stridor or absence of airflow.
   e. If patient fails cuff leak test systemic steroids should be ordered for administration at least 4 hours before extubation. Please communicate with the Registered Nurse (RN) about the patient prior to extubation that they are at high risk for postextubation stridor. So this can shared
   f. If Stridor does occur, consider recommending Cool Aerosol with supplemental oxygen or nebulized racemic epinephrine.

g. Refer to Spontaneous Breathing Trial (SBT) weaning protocol algorithm attached.

MONITORING: Respiratory Therapist to monitor patient during wean initiation.

DOCUMENTATION: Document the outcomes (Pre and Post) SBT in EMR and the patient's progress notes. Document Patient/Family Education in the EMR

INFECTION CONTROL:

1. All staff members must practice BSI precautions.
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ACTION FOR ADVERSE REACTION: Contact physician of weaning failure & document the failure criteria in EMR flow sheet and progress notes.

REFERENCES:

1. Girard et al. (2008). Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): A randomized controlled trial. *Lancet, 371*(1), 126-134.
2. Ouellette DR, Patel S Girad TD, Morris PE., Schmidt GA, Burns SM, Epstein SK, Esteban A.. Liberation from Mechanical Ventilation: An Official American College of Chest Physicians/ American Thoracic Society Clinical Guideline, *CHEST* (2016).
3. Michele Balas, Eduard Vasilevski, Kendra Schmidt, Joseph Sisson, Marlene Cohen, William Burke. Effectiveness and Safety of the Awakening and Breathing Coordination, Delirium Monitoring/Management, and Early Exercise/Mobility (ABCDE) Bundle. *Critical Care Medicine*. (2014)
4. AARC Clinical Practice Guideline, Removal of the Endotracheal Tube. (1995)

SBT Algorithm