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Ventilator-Associated Pneumonia Bundle Care

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Executive Summary

Ventilator-associated pneumonia (VAP) is one of the most significant nosocomial infections in intensive care units (ICU) worldwide. Patients who have this infection due to lengthy hospital stays face excessive hospital expenditures and are forced to spend more time away from their families than is necessary. VAP is a prominent cause of morbidity and mortality in ICUs, prompting plenty of studies. The most crucial target is its prevention. Understanding how to reduce VAP would help patients live longer, have a better quality of life, and reduce hospital liability. Ventilator-associated pneumonia bundle (VAPB) has been shown in numerous studies to be an effective treatment for VAP prevention. Healthcare professionals are responsible for providing evidence-based care to avoid complications and improve patient outcomes. The recent SARS-CoV-2 pandemic made the condition worse. The admitting diagnosis of many patients in ICU is pneumonia. In the current situation, each health care worker is more responsible for avoiding additional healthcare-associated infections to patients.

Ventilator-associated pneumonia bundle care

Ventilator-associated pneumonia is a nosocomial infection, and it occurs because of poor patient care after intubation and mechanical ventilation. It leads to complications of patients, including death, and increases the health care cost. In order to avoid this hospital-acquired infection, health care providers must understand the importance of following VAP bundle care. Health care professionals are responsible for providing evidence-based care to avoid complications and improve patient outcomes. The project is based on the Ventilator-Associated Pneumonia bundle, and due to COVID-19, nearly all patients were admitted with pneumonia, and the likelihood of receiving a patient with a negative diagnosis was slim to none. Due to this factor, the project's primary aim was to obtain VAP bundle compliance and adherence rate at 100%.

Rationale for the Project

Evidence-based care enhances healthcare quality, patient outcomes, clinician empowerment, and cost-cutting; however, healthcare practitioners must provide evidence-based care to reduce complications and improve patient outcomes (Melnyk & Fineout-Overholt, 2019). VAP is a hospital-acquired infection (Haque, Sartelli, McKimm, & Abu Bakar, 2018), and the objective of the study is to attain the goal of 100% adherence to VAPB protocol and, at the same time, make nurses understand the need to implement the VAPB protocol strictly as VAP infection is one of the more costly and debilitating nosocomial illnesses. VAP diagnosis is challenging because radiological and clinical signs are inaccurate and associated with various respiratory diseases (Timsit, Esaied, Neuville, Bouadma, & Mourvillier, 2017). Many studies proved that VAPB treatment is effective for decreasing the incidence of VAP.

The mortality rate linked to VAP varies between studies; however, VAP results in an additional 12-day hospital stay and a cost increase of nearly $ 40,000 per episode, and approximately 33% of VAP patients die due to the illness (Rodrigues, Fragoso, Beserra, & Ramos, 2016). According to Efrati et al. (2010), VAP is still a common and expensive complication of critical illness, with a pooled relative risk of 9-27 % and fatality rates of 25-50%. The proposed approach for preventing VAP is to use the VAPB protocol at regular intervals and is supported by several studies. If change is not implemented, hospitals must spend additional money on treating VAP because it is a healthcare-associated infection (HCAI).

In 1981, the first Centers for Disease Control and Prevention (CDC) guideline for preventing nosocomial pneumonia was published, which addressed the major infection-control issues associated with hospital-acquired pneumonia ("Guidelines for Preventing Health-Care--Associated Pneumonia, 2003," 2019). The CDC guideline for nosocomial pneumonia prevention was amended and expanded upon in 1994 by the Healthcare Infection Control Practices Advisory Committee (HICPAC) (then known as the Hospital Infection Control Practices Advisory Committee) ("Guidelines for Preventing Health-Care--Associated Pneumonia, 2003," 2019). The Centers for Medicare and Medicaid Services (CMS), as the most prominent national payer of healthcare in the United States, was the first to impose financial disincentives in an attempt to enhance the quality of care through the healthcare-associated conditions (HAC) policy in 2008 (Vaz et al., 2015). CMS halted additional reimbursements to hospitals for costs of care connected with billing codes for certain "preventable events" because of HAC policy (Vaz et al., 2015).

Literature Synthesis

An extensive literature search was conducted on the topic of VAP through the databases of the Cumulative Index to Nursing and Allied Health Literature, PubMed, and the Cochrane Database of Systematic Reviews. Articles written from 2010 and English language are used as the limiters for the search. The keywords used for the search included *head of the bed elevation, oral suction, oral care, sedation vacation, mechanical ventilation, VAP,* and VAPB. The literature review helps assess the effects of maintaining or enforcing the VAP bundle strategy to prevent VAP in mechanically ventilated patients. The effect of VAPB adherence on VAP was searched in the studies, and all studies confirmed that VAPB adherence contributes to lower VAP rates (Balkhy, Al-Thaqafy, Arabi, & El-Saed, 2014; Bird, 2010; Mahmudin et al., 2020). Three quasi-experimental studies were evaluated, both of which looked into the effectiveness of VAPB in preventing VAP cases (Caserta et al., 2012; Eom et al., 2014; Fortaleza, Filho, Silva, Queiroz, & Cavalcante, 2020). According to Eom et al. (2014), VAPB reduced the VAP rate from 57 to seven instances per 1,000 ventilator days after VAPB was introduced. In contrast, Fortaleza et al. (2020) found that the rate decreased from 34.95 to 13.27 in the first ICU and from 36.58 to 12.04 per 1,000 ventilator days in the second ICU after VAPB was introduced. The VAPB is an effective tool to prevent VAP, which is also supported in two other studies. Though one study is methodological (Balkhy et al., 2014) and the other is descriptive (Mahmudin et al., 2020), both found that the VAP rate dropped dramatically from 3.6 to 1.0 and from 10.2 to 3.4 cases per 1,000 ventilator days, respectively.

A single randomized control trial by Shahabi, Yousefi, Yazdannik and Alikiaii (2016) investigated the impact of a daily sedation interruption regimen on the early occurrence of VAP in patients receiving mechanical ventilation in critical care units. The incidence rate of VAP in

the intervention and control groups was 0% against 15% on the third day of the intervention, 12.5% compared 50% on the fourth day, and 27.7% versus 55.3% on the fifth day of intervention (Shahabi et al., 2016). Infusion of a daily sedation vacation protocol dramatically reduced the occurrence of VAP in patients receiving intravenous sedation, according to the findings of this study. Shahabi et al. (2016) noted that VAP is one of the most prevalent and hazardous side effects of mechanical ventilation. The main components of the VAPB included were head of the bed (HOB) elevation and daily sedation vacation (Balkhy et al., 2014; Caserta et al., 2012; Eom et al., 2014; Bird, 2010; Mahmudin et al., 2020; Fortaleza et al., 2020). Oral care was one VAPB component in many studies (Balkhy, et al., 2014; Caserta et al., 2012; Eom et al., 2014; Mahmudin et al., 2020; Fortaleza et al., 2020). Peptic ulcer prophylaxis and deep vein thrombosis prophylaxis were also added in some studies as VAPB components (Balkhy et al., 2014; Eom et al., 2014; Bird et al., 2010).

In a cohort study, VAP incidence dropped from 12.9/1000 ventilator-days (a rate of 16 cases per 100 patients) to 9.28/1000 ventilator-days (a rate of 11 cases per 100 patients) following the VAPB intervention period (p 0.05) (Rello et al., 2013). A single-blind prospective randomized clinical trial(Hassankhani, Akbarzadeh, Lakdizaji, Najafi, & Mamaghani, 2017) evaluated the effects of 60° semi-recumbent position on preventing VAP and respiratory parameters in mechanically ventilated patients. Significant decrease in VAP occurrence and improvement in some mechanical respiratory parameters, including tidal volume and pulmonary compliance, were noted with the HOB elevation of 60 degrees (Hassankhani et al., 2017). A prospective, interventional, and multicenter study was conducted by (Álvarez-Lerma et al., 2018) and found that implementing a bundle of measures to prevent VAP was associated with a highly significant reduction of VAP from 9.83 episodes during the baseline period to 4.34 episodes per

1,000 days of mechanical ventilation in the last three months of the intervention period. (Güner & Kutlutürkan, 2021) conducted a prospective, randomized, controlled trial and investigated the impact of semi-recumbent position at 30° and 45°on the development of VAP compared with a HOB elevation to <30°. The frequency of VAP was significantly lower in the 45° compared with the <30° study arm (P = .022) (Güner & Kutlutürkan, 2021).

Even though there is a clear link between the following VAPB protocol and lowering VAP, implementing or enforcing VAP is challenging too. Atashi, Yousefi, Mahjobipoor, & Yazdannik (2018) discussed three crucial categories of obstacles to preventing VAP in a single qualitative/descriptive study: nurses' limited technical ability, unpleasant environmental variables, and passive human resource management. However, proper funding, adequate staffing levels, and contextually relevant evidence-based guidelines are essential to successful VAP prevention.

Project Stakeholders

The stakeholders in this project included the patients, family members, doctors, especially pulmonologists, staff nurses, critical care charge nurses, members from the respiratory, radiology department, infectious control and prevention nurse, members from hospital supply department, and hospital administration. Stakeholder support is crucial so that evidence-based change can occur in the hospital, leading to positive outcomes. When implementing evidence-based change, it is crucial to think about the preferences of patients and stakeholders because their support is crucial to the initiative's success (Melnyk & Fineout-Overholt, 2019). Timely notification about the project's progress to the critical care director and director of the respiratory department was crucial. Charge nurses were other resource personnel for this project; they took additional responsibility to assess the VAPB compliance checklist in

each shift. Nurses and respiratory technicians worked for hand in hand for the success of this project. All ventilated patients underwent chest radiographs in the morning every day, and members from the radiology department were additional resource personnel. The pulmonologist's support was crucial in this journey to diagnose and confirm patients' problems. The hospital's supply department was responsible for providing enough materials, especially mouth care kits and suction materials. Approval from hospital administration was necessary for the implementation of the project.

Incorporating patient preferences for healthcare into the method of care and scientific decision-making is an essential function of patient-centered care, adheres to moral standards of respect and autonomy, and in many cases, contributes to better health outcomes (Street, Elwyn, & Epstein, 2012). Communication is critical in patient-provider relationships. It is critical to inform the patient and their family members about the VAPB intervention and why it is performed. The provider must give tailored care based on the patient's needs and unique medical history (Melnyk & Fineout-Overholt, 2019). When presenting treatment plans or possibilities and the full extent to which the patient will be affected by treatment, healthcare providers must evaluate the advantages of embracing patient values and requirements (Siminoff, 2013).

In the case of ventilated patients, an affected person cannot voice their worries and may be bodily or cognitively incapable of letting their providers recognize their options. In such circumstances, it was up to the nurse or physician to successfully communicate with the afflicted person's family about what methods or actions might be done to move forward. Healthcare providers must ease the tensions of anxious family members when their loved ones are mechanically ventilated and are showing signs of severe discomfort. For example, when sedation has ceased, the patient will become increasingly agitated and uncomfortable, which may be

troubling for the family members to witness in the room. A proper explanation should be given to walk the family members through the process to know what to expect next. This phase is particularly critical for establishing trust and rapport with patients and those who care for them.

Implementation Plan

The evidence-based project selected was the implementation of the revised VAPB for the prevention of VAP. The change project was selected, and the PICOT question was developed in January 2020, but implementation started only in September 2021. First secured approval from the hospital, and the current project implemented at Dallas Regional Medical Center's (DRMC) 14 bedded surgical intensive care unit (SICU).

VAP is defined as an infection of the lung parenchyma that occurs at least 48 hours after hospital admission (Timsit et al., 2017). Initially, the plan was to select ventilated patients with no pneumonia at the time of intubation. However, the condition changed, and due to COVID-19, almost all patients were diagnosed with pneumonia at the time of admission. There was no possibility to get patients with no pneumonia at the time of admission. Numerous studies have demonstrated the usefulness of the VAPB so the goal for this initiative is to attain 100 percent VAPB compliance that ultimately prevents VAP.

SICU receives all ventilated patients admitted to the hospital. Only ventilated patients in the SICU were included in the current project. The proposed VAPB includes daily sedation vacation, assessment for readiness to extubate, HOB elevation at least 30 degrees or more (unless contraindicated), gastric ulcer prophylaxis, deep vein thrombosis prophylaxis, cuff pressure control (cuff pressure assessment at least once in a shift), oral care, and oral suction every four hours.

COVID-19 prolonged intubation days and endotracheal tube (ETT) cuff leak and reintubation are in place, even though there are very few numbers. To avoid this unwanted dangerous situation, advocated for adding cuff pressure monitoring at least once in a shift. In many studies, cuff pressure assessment was one of the VAPB components that allowed for proper care and increased patients' long-term health (Mahmudin et al., 2020; Rello et al., 2013). This addition was made due to extreme necessity since the pandemic began, changing how clinicians care for patients.

The study period was for four weeks, from October 17 to November 13, 2021. Each assigned nurse or respiratory therapist was responsible for providing recommended VAPB care to the patient and recording it in electronic health records (EHR). Nurses and respiratory technicians must work hand in hand for the success of this project. Inter-professional collaboration is frequently utilized to solve a wide range of challenges and complex situations when two or more professions collaborate to achieve a common goal (Green & Johnson, 2015). The hospital uses epic software for EHR, including VAP on the property list. Each nurse and respiratory therapist could add VAP to the property list on the flow sheet. Staff members were responsible for clearing their worklist hourly, which also helped implement the VAPB every four hours.

Some of the essential elements needed for successful organizational change management include frequent and effective communication, fostering a team culture, identifying and empowering champions, and providing feedback and positive reinforcement (Gesme & Wiseman, 2010). All health practitioners involved in this project received clear verbal or nonverbal information regarding the project at regular intervals about the project's plan, progress, and success. Charge nurses were aware to check VAPB compliance in each shift. Any successful

organizational change plan relies on effective communication (Melnyk & Fineout-Overholt, 2019).

Evidence-based nursing is intended to standardize health care practices to the latest and the best science available in order to minimize variations in care and avoid unanticipated health outcomes (Correa-de-Araujo, 2016). Each element of the VAPB serves to keep critically ill, mechanically ventilated patients safe while hospitalized.

Timetable/Flowchart

VAP is a preventable illness that compromises the lives of patients in critical care units globally. EBP change project timelines are highly varied, and multiple project components may overlap or occur at the same time (Melnyk & Fineout-Overholt, 2019). The plan for the current project started on January 13, 2020. The PICOT question was developed in the previous semesters and gained approval from the critical care director. Research and relevant clinical information were established and gathered pertinent to the patient population, and data was acquired to support the need for evidence-based change. Once the evidence was obtained, a synthesis table was created.

During the first week, approval was gained from the critical care director at the facility to obtain the data required for the project. Week two through five consisted of collecting current VAPB compliance rates starting from September 5 to October 2. As *w*eek three through four progressed, staff and stakeholder engagement was encouraged from October 3 through the 9th. Critical care meetings and selection team leaders occurred from October 10 through the 16th. During week five, practice recommendations required for the Evidence-Based practice were formulated from September 12 through September 18. The following week consisted of meetings amongst team leaders to create visual reminders and posters to engage staff and properly follow

VAPB care. The following week, Stakeholder's approval was gained. During this period, team leaders put forth efforts to type and place placards for every computer in the ICU and reminder stickers on the computer monitors. Before this occurred, a meeting was held so that all team members were aware and individual roles and expectations were set, given proper education.

Weeks eight through 11 consisted of implementing a revised formulation for VAPB. Team leaders collected daily compliance data reflecting VAPB adherence. The consecutive week used for final data collection analyzes pre and post-intervention figures for VAP adherence in the unit. The data was then shared with stakeholders, followed by disseminating the evidence. During next month's critical care meeting, there will be more face-to-face communication with nursing professionals. This meeting will be four different sections for all staff from the day and night shifts. Roundtable presentations offer the opportunity to share specific information with a group but also to allow the group to discuss the practical application of the content outcomes (Melnyk & Fineout-Overholt, 2019). Once this meeting is over, information about the evidence will send it as a message to the critical care group. Another option is to disseminate the findings to the hospital board, including all healthcare professionals involved in critical-care patient care.

Data Collection Methods

From the conception phase to the conclusion phase, good research technique design is critical, and computers play an essential role from the beginning to the finish of a study, particularly for data collection, data storage, and data administration ((Kulkarni, 2016). DRMC uses epic software, which is very helpful for collecting data regarding the components of the VAPB.

The current evidence-based project was the implementation of a revised VAPB at regular intervals in SICU. After providing care to the patient, staff recorded the event into the electronic

health record (EHR). A checklist was also used for assessing VAPB compliance. Head of the bed elevation, oral suction, and oral care was checked every four hours and considered done if checked "yes" all six times. Peptic ulcer disease prophylaxis and deep venous thrombosis prophylaxis, assessment of readiness to extubate, sedation vacations were verified if completed or not daily. Cuff pressure assessment was done at least once in a shift. The case is not in compliance with the bundle if even one element is missing. For example, the SICU has 14 beds. If there are 14 ventilated patients, and ten patients have all bundle elements completed, 71 percent (10 divided by 14 multiplied by 100) are compliant with the ventilator bundle. If all 14 patients had all bundle elements completed, compliance would be 100 percent. The entire bundle is considered compliant only if all items were compliant, and it is considered non-compliant if any item was not performed (Bird, 2010).

Charts of mechanically ventilated patients were reviewed daily to assess the VAPB compliance rate. SICU always has free charge nurses, and they agreed to check it to make the project a success. The critical care charge nurses kept track of the number of days patients spent on a ventilator and VAPB compliance daily and recorded it on a checklist. A *ventilator day* is defined as a calendar day for which the patient is charged for mechanical ventilation (Bird, 2010). The formula for calculating VAPB per 1000 ventilator days was in place ("Ventilator Bundle Compliance | IHI - Institute for Healthcare Improvement," n.d.). The formula for calculating VAPB compliance is (number of SICU patients on mechanical ventilation who received all ventilator bundle elements) / (total number of SICU patients on mechanical ventilation on a given day of the week of the sample) and multiply by 100 to obtain percentage ("Ventilator Bundle Compliance | IHI - Institute for Healthcare Improvement," n.d.).

VAPB compliance rates of every Saturday during pre-and post-intervention were used to compare the rate and success of the project. The weekly data collection was displayed using a bar graph. The pre-implementation was comprehensively evaluated in the same SICU for the previous four weeks' VAPB compliance rates.

Nurses intervened in this process when monitoring if non-compliance with a bundle element was detected and regular feedback on compliance was provided to the ICU teams (Eom et al., 2014). The hospital approved all study procedures. Outcome data were collected daily to determine whether 100 % adherence was followed for the VAPB implementation and the result posted on the notice board in the critical care unit. These results helped all staff members understand what is going on and where the missing is happening.

Cost/Benefit Discussion

The current project does not add any additional cost to the hospital's budget because of multiple reasons. All products used were already included in the unit budget; therefore, the expenses remained the same. SICU required sufficient staffing; the nurse-to-patient ratio usually was 1:2 in SICU, although in some cases, such as patients with an impella or IABP, the ratio was 1:1. There was no modification to the number of staff required for this project. According to (Fratantoro, 2013) a study conducted by researchers from Brigham and Women's Hospital and Harvard Medical School reveals that VAP accounts for 31.6% of total healthcare-associated infections, and the United States (US) healthcare system spends $40,144 per patient to treat VAP. Comprehensive nurse intervention can reduce the time spent on mechanical ventilation and in the hospital, avoid VAP, alleviate patients' negative emotions, and improve their quality of life as well as nursing satisfaction (Fan, Chu, Jiang, & Du, 2021). Patient healthcare costs will be reduced due to the reduced length of stay in the hospital due to VAP prevention.

Discussion of Results

Health outcome measures are used to assess clinical practice changes, aid in healthcare decision-making, and develop new policies or practice standards (Melnyk & Fineout-Overholt, 2019). The VAPB compliance rate was required to ensure that all patients received effective treatment in the hospital. In total, there were 194 ventilator days included in the study. Throughout the study period, there was an overall rise in compliance with the bundle in SICU. The VAPB compliance rate in each week during the pre-intervention period was 69.2%, 55.5%, 70%, and 71.4%, whereas, in the post-intervention period, it rose to 83.3%, 88.8%, 100%, and 90% consecutively. Overall compliance with the VAP bundle increased from 66.5% to 90.5% within the SICU. During the VAPB implementation period, VAPB compliance reached 100 % on several days, but on other days it was not. The main reason was that because of COVID- 19, many patients' oxygen requirements and positive end-expiratory pressure (PEEP) were very high, and sedation vacation was impossible. There was no possibility to compare the effect of VAPB for the occurrence of VAP due to pandemic because almost all patients' diagnosis was pneumonia at the time of admission.

Conclusions/Recommendations

Due to lengthy hospital stays, VAP patients face astronomical hospital expenditures and are forced to spend more time away from their families than is necessary. There are some recommendations for this project. Understanding how VAP can be reduced would help patients live longer, have a better quality of life, and reduce hospital liability. Once the pandemic is over, more research is needed to confirm the effectiveness of VAPB for the prevention of VAP. Research studies have shown positive effects of using the VAPB for the prevention of VAP. Therefore, adhering to a VAPB at regular intervals in the critical care unit is recommended to

improve patient outcomes and save money for both the patient and the hospital. Health education played an integral role in maintaining compliance rates for VAPB, while in-service education and continuation of learning will allow for VAP rates to stay low or remain close to zero. Strict adherence to VAPB needs to become the standard of practice that helps enforce a patient safety culture for all healthcare workers.

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Appendix A

Evidence Synthesis Table

Studies	Design	Sample	Intervention	Outcome
A	Methodological	*N*= 1003	HOBE DSV PUP DVTP OC OS	VBC increased VAPR decreased VUR increased
B	Qualitative descriptive	*N*= 23	Nurses perception about barriers for VAPB intervention	Barriers present
C	Single-blind clinical trial study	*N*= 100	DSV	VAPR decreased
D	Quasi-experimental	*N*= 196 ICU beds	HOBE PUP DVTP OC	VBC increased VAPR decreased
E	Cohort	*N*= 4000	HOBE EA DSV PUP DVTP	TBC increased VAPR decreased
F	Descriptive		HOBE OC AS PUP CPC	VBC increased VAPR decreased

Appendix A: Continued

Evidence Synthesis Table

			ETS EOC	
G	Quasi-experimental	*N*= 1000 PD	HOBE OC CPC Keep breathing circuit below bed height DSV	VAPR decreased HCAI decreased
H	Quasi-experimental	*N*= 2200 patients annually	HOBE DSV EA PUP DVTP OC CASS	VAPR decreased
I	Cohort study	*N*= 3845 VD	No circuit change DSV Hand hygiene OC CPC	VAPR decreased ICU LOS Duration of MV
J	Single-blind prospective randomized clinical trial	*N*= 25	HOBE 45^{O} HOBE 60^{O}	VAPR decreased
K	Cohort study	*N*= 171, 237 ICU admissions	Education Hand hygiene CPC OC HOBE Reduce DMV	VAPR decreased
L	Prospective, randomized, controlled	*N*= 60	HOBE <30^{o} HOBE 30^{o} HOBE 45^{o}	Percentage of VAP is low

Appendix A: Continued

Evidence Synthesis Table

Legend: A = Balkhy et al., 2014, B = Atashi et al., 2017, C = Shahabi et al., 2017, D = Eom et al., 2014, E = Bird et al., 2010, F = Mahmudin et al., 2020, G = Fortaleza et al., 2020, H = Caserta et al., 2012, I = Rello et al., (2013), J = Hassankhani et al., 2017, K = Álvarez-Lerma et al., 2018, L = Güner & Kutlutürkan, 2021.

AS - assessment of sedation, CASS – continuous aspiration of subglottic secretion, CPC - cuff pressure control, DMV- duration of mechanical ventilation, DSV- daily sedation vacation, DVTP - deep vein thrombosis prophylaxis, , EA – extubation assessment, EOC - emptying of condensate, ETS – endotracheal tube suctioning, HCAI - healthcare associated infections, HOBE – head of bed elevation, ICU- Intensive care unit, OC- oral care, OS – oral suction, PD - patient days, PUP - peptic ulcer prophylaxis, TBC - total bundle compliance, VAPB - ventilator associated pneumonia bundle VAPR – ventilator associated pneumonia rate, VBC – ventilator bundle compliance bundle compliance, VD- ventilator days, VUR- ventilator utilization ratio.

Appendix B

Outcomes Table: Effect of ventilator-associated pneumonia bundle for the prevention of ventilator-associated pneumonia

	A	B	C ♦	D ♦	E	F	G ♦	H	I	J	K	L
VBC	↑			↑	↑	↑						
VAPR	↓	NE	↓	↓	* ↓	↓	↓	↓	↓	↓	↓	↓

Legend: A = Balkhy et al., 2014, B = Atashi et al., 2017, C = Shahabi et al., 2017, D = Eom et al., 2014, E = Bird et al., 2010, F = Mahmudin et al., 2020, G = Fortaleza et al., 2020, H = Caserta et al., 2012, I = Rello et al., 2013, J = Hassankhani et al., 2017, K = Álvarez-Lerma et al., 2018, L = Güner & Kutlutürkan, 2021. NE-not evaluated, VAPR - ventilator associated pneumonia rate, VBC - – ventilator bundle compliance

* = statistically significant findings

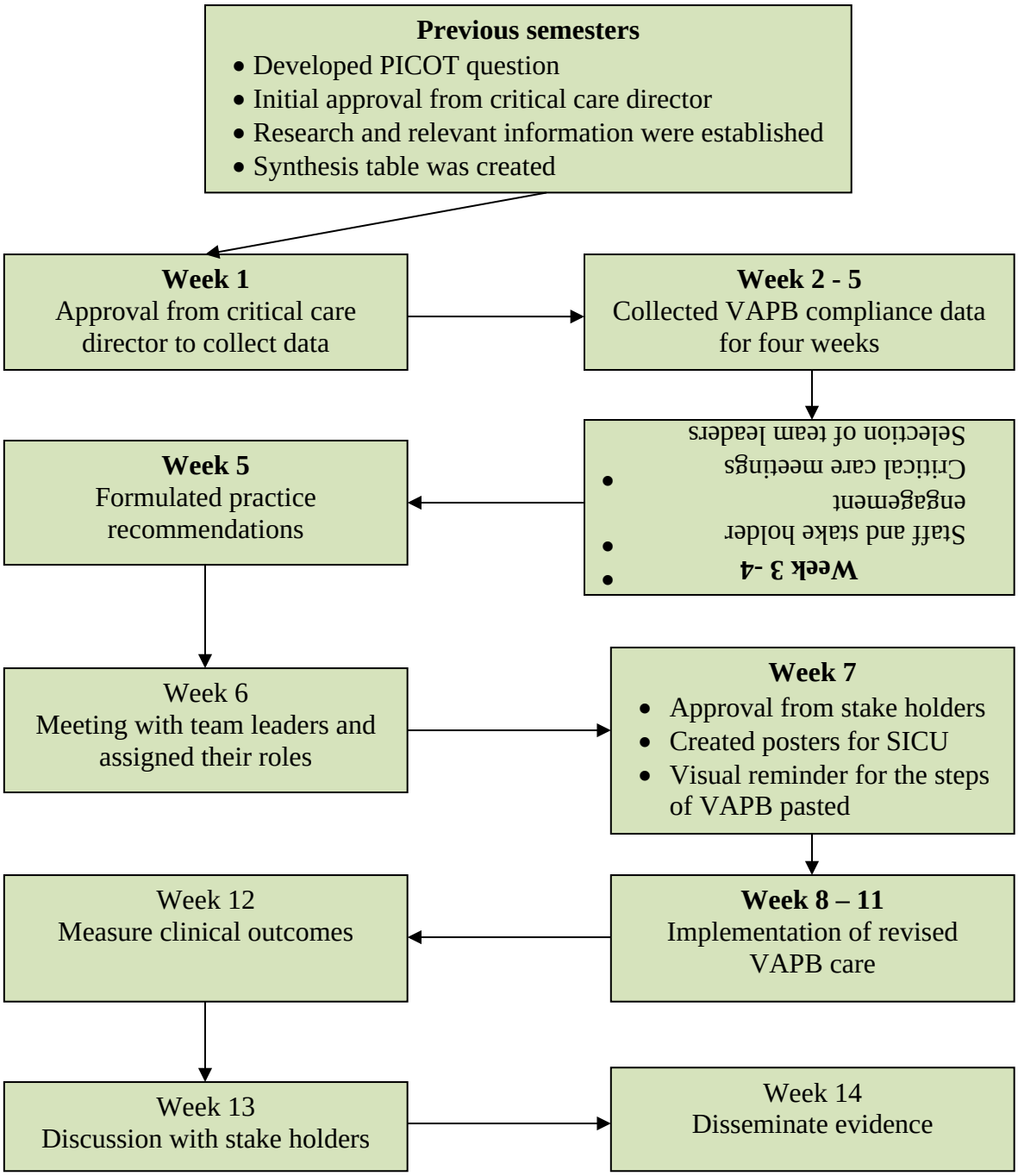
♦ = higher level evidence

VAPR – ventilator-associated pneumonia

VBC - ventilator bundle compliance

Appendix B

Flowchart



Appendix C

Instrument

Checklist for VAPB compliance

Serial number	VAPB elements	Bed number													
		1	2	3	5	5	7	8	9	10	11	11	12	14	15
1	Daily assessment of readiness to extubate, yes/no														
2	Daily sedation vacation, yes/no														
3	Daily peptic ulcer disease prophylaxis yes/no														
4	Deep vein thrombosis prophylaxis, yes/no														
5	Cuff pressure assessment, yes/no														
6	*S*emi-recumbent position (more than 30 degrees)														
7	Oral suction every four hours, yes/no														
8	Oral care every four hours, yes/no														

Appendix D

Outcome

Percentage of VAPB compliance rate