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Ventilator Associated Pneumonia: Reducing the Risk during Covid-19 Pandemic

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Abstract

Novel corona virus, known as COVID-19, was identified in the United States (U.S.) in January 2020. Within two months, patients testing positive for COVID-19 were overwhelming U.S. hospitals in major cities. Many of these patients were presenting with severe acute respiratory syndrome (SARS) requiring critical care and mechanical ventilation to support respiratory function. A complication of mechanical ventilation is ventilator associated pneumonia (VAP). Orem's, 2001, theories and the American Association of Critical-Care Nurses (AACN) Synergy Model for Patient Care, 2000, provide information that explains the need for and how to individualize nursing care to achieve quality outcomes. Evidence of effective strategies to prevent VAP is available. Planning and executing implementation must include inter professional team which should be led by an expert nurse familiar with critical care and VAP prevention. Bedside nurses are the change agents who will be most affected by this planned change, thus should be proportionally involved in the process. Change and process theory and evidence suggest that a process be mapped out including thorough assessment, goal setting, planning, implementation, and evaluation to facilitate quality improvement. Education, policy and protocol development, incorporation of the VAP bundle (a combination of care techniques demonstrated to prevent or reduce the incidence VAP), "ventilator care kit", monitoring, and evaluation are key to successful sustainability of this initiative. Implementation of a VAP prevention program for care of mechanically ventilated patients has never been more important than during the current COVID-19 pandemic when patients assaulted with this viral infection fight for their lives.

Keywords: COVID-19, Severe Acute Respiratory Syndrome (SARS), Ventilator Associated Pneumonia (VAP), Orem, AACN Synergy Model for Patient Care, VAP Bundle, Root-cause-analysis, Change theory, Critical Care Quality, Optimal Patient Outcomes.

Background

The novel corona virus was transported to the United States via human hosts and began shedding and spreading virus to people in the cities where this unwanted visitor arrived. The exact date of arrival is not known, but the first confirmed case was at the end of January 21, 2020 in a person in Washington State [1]. On September 4, 2020 over six million cases have been confirmed with more than 189,000 American deaths reported.

"An epic Covid is another Covid that has not been recently distinguished. The virus causing corona virus disease 2019 (COVID-19) Corona virus disease 2019 (COVID-19) is a respiratory illness that can spread from person to person. …COVID-19 is a new disease, caused by a novel (or new) corona virus that has not previously been seen in humans" (CDC, What is a novel corona virus? 2020).

Severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), was "identified as the source of a pneumonia outbreak in Wuhan, China," and in the United States in late 2019 [2]." "Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by a corona virus. SARS was first reported in Asia in February 2003 and spread…to countries in North America, South America, Europe, and Asia before the SARS worldwide flare-up of 2003 was contained" (CDC, SARS, 2020). Since 2004, there have not been any known cases of SARS reported anywhere in the world until the pneumonia reported in China in 2019 (CDC, SARS, 2020).

"Given how common the disease is becoming, as in prior major severe acute respiratory infection outbreaks—SARS (severe acute respiratory syndrome), MERS (Middle East respiratory syndrome), avian influenza A(H7N9), and flu A(H1N1)pdm09—basic consideration will be a fundamental part of the worldwide reaction to this rising disease" [3].

Severe Acute Respiratory Syndrome (SARS) associated with the novel corona virus, known as Covid-19 has resulted in extreme rates of hospitalizations and admissions to critical care units in every country where an outbreak occurred and is occurring. Those Covid-19 patients with SARS often require mechanical ventilation to support respiratory function as a life-saving treatment measure. A serious complication of mechanical ventilation is known as ventilator associated pneumonia or VAP.

Ventilator Associate Pneumonia and COVID-19

Ventilator Associated Pneumonia (VAP) is a hospital acquired lung infection noted in patients who require mechanical ventilation to support respiratory function [4]. VAP can develop within 48 hours or longer after intubation, insertion of a tracheotomy or endotracheal tube creating a direct connection to major airways which facilitates effective mechanical ventilation [5]. Intubation interferes with normal anatomical function by placement of a foreign object, tube, into the pharynx and/or trachea. Direct impact of endotracheal tube placement results in a reduction "in local host defenses. …mucosal injury can lessen mucociliary work, while upper aviation route safeguards are

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circumvented and the viability of hack is diminished" [6]. Indirect impact may result in "an enhanced capacity of tracheobronchial cells to bind gram-negative bacteria, an effect that favors airway colonization and pneumonia. Airway injury "can create binding sites for microbes in the storm cellar film of the bronchial tree and the incitement of the discharge of bodily fluid, which at that point deteriorates and can make expected locales for bacterial adherence" (, p. 523). Devices such as endotracheal tubes, tracheostomy tubes provide sanctuary for bacteria which can multiply. COVID-19 patients have "disease-associated impairments" which impair normal human defense mechanisms and adds to the impairments caused using an artificial airway [6]. The insertion of the endotracheal tube or tracheotomy tube also provides a means for oral and gastric secretions to enter the lower airways [7].

VAP results from the invasion of microorganisms into the lower airways. VAP is a complication that ventilated patients may experience. Critically ill patients experiencing VAP are known to have a greater length of hospital stay, increased risk of mortality, and increased hospital costs [8]. VAP rates range from one to four cases per 1000 ventilator days [8]. There is a ≥30% attributed mortality rate in VAP treatment failures and an average increase of seven to 11 days critical care units with and increased cost of approximately $39,000 per patient [8-10].

Covid-19 patients admitted to hospitals with severe respiratory distress syndrome require mechanical ventilation. Mechanical ventilation requires the insertion of an endotracheal or tracheostomy tube increasing the risk for VAP as a complication for these COVID-19 patients. Nurses and other critical care healthcare providers must deliver effective, evidence-based quality care to assure survival of this high-risk population.

This paper provides information to promote quality evidence-based practice to COVID-19 patients requiring mechanical ventilation using theory, modeling, and planned change with successful use of prevention strategies that have demonstrated promising results.

Theory-based Evidence for Care of COVID-19 Patients Experiencing VAP

Theory is often over-looked, ignored, when considering care of the critically ill. Technique and skills of care and treatment are often the focus of nurses and healthcare practitioners. However, nursing care continues to be the performance of skilled reasoned actions which mandates a professional duty to advocate for effective, quality care.

Theory and theoretical models are beneficial for improving effective techniques to decrease incidences of VAP and improve quality care. Orem's, 2001, self-care deficit theory describes requirements of holistic human functioning known as requisites and basic conditioning factors, that are synonymous with determinants and social determinants of health. These requisites and basic conditioning factors are essentials that nurses must consider if they are to provide quality care. Universal self-care requisites (air, food, water, elimination, activity/rest, social/solitude, normalcy, and hazards) and developmental self-care requisites (having abilities support life and development from birth through stages of adulthood, and provide needed self-care to prevent and/or manage challenges that threaten normal development) provide an essential list of factors the people must successfully address to maintain health and well-being [11].

The health and well-being of care for the critically ill is a challenge. Nurses are responsible for assisting critically ill patients in meeting their self-care requisites through use of their nursing knowledge and skill which Orem in 2001 identified as nurse agency. Patients relying on mechanical ventilation are unable to perform requisite behaviors on their own. This inability to address universal and developmental requisites requires nurses to provide wholly compensatory care, care to maintain function and support life. Nurses must provide care to compensate for all self-care activities a person normally does for self. This is especially true for those COVID-19 patients who are provided sedation or paralytic drugs during mechanical ventilation.

"The American Association of Critical-care Nurses (AACN) Synergy Model for Patient Care is a patient-fixated model that centers around enhancing quiet consideration by coordinating the qualities of the patient with the skills of the attendant" . This model is in perfect alignment with Orem's nursing theories.

AACN's Synergy Model for Patient Care, developed in 1996, is a conceptual framework that aligns patient needs with nurse competencies. This framework promotes a shift in nursing assessment skills from a medical model to a nurse competency framework. Like Orem's, 2001, theories, the principal idea is that patient need, or self-care deficits, drive the competencies required for care delivery. Orem's, 2001, theories posit that knowledge of patient need or self-care deficits aligned to nurse agency or ability creates synergy for achievement of optimal care outcomes. Table 1 presents the eight patient characteristics and eight nurse competencies identified in AACN's Synergy Model for Patient Care. All competencies and characteristics are essential, but importance changes depending on patient need. "Collaboration results when the necessities and attributes of a patient, clinical unit or framework are coordinated with a medical caretaker's abilities" [12].

Orem's, 2001, theories and AACN's Synergy Model for Patient Care affirm the idea that quality nursing care provision by competent nurses who assess and meet patient needs will achieve quality outcomes [13]. This notion is crucial when making a case for changing bedside care delivery. Frontline nurses, those working at the bedside delivering care, drive change and innovation in healthcare because they are the

Eight Patient Characteristics	Eight Nurse Competencies
Resiliency	Clinical Judgement
Vulnerability	Advocacy and Moral Agency
Stability	Caring Practices
Complexity	Collaboration
Resource availability	Systems Thinking
Participation in care	Response to Diversity
Participation in decision making	Facilitation of Learning
Predictability	Clinical Inquiry

Table 1: Patient Characteristics and Nurse Characteristics of AACN's Synergy Model for Patient Care.

Note: Patient Characteristics and Nurse Competencies are those identified in AACNs, Appendix C: the synergy model. In: Standards for Acute and Critical Care Nursing Practice. Aliso Viejo, CA: American Association of Critical-care Nurses 2000: 47-55.

critical decision makers caring for the critically ill, 24 hours a day, seven days a week.

Making the Case for Change

Nursing care provided to those critically ill COVID-19 patients requires highly competent nurses to prevent complications that can further limit a patient's ability to meet their self-care requisites, air, food, water, elimination, activity/rest, social/solitude, remaining free from hazards, and progression toward normalcy [11]. Competent care provision requires nurses to continually incorporate the best research evidence into practice. This dynamic state of the nursing profession is often unappreciated but has been recognized during the COVID-19 pandemic as these front-line care givers fought for the lives of their patients while adapting practice as new information regarding the deadly virus became known. Nurses working in critical care units across the world take care of the very ill and delivery of the best care is required to prevent hospital-acquired infection or injuries, such as VAP in normal conditions.

Patient that do experience VAP or other hospital-acquired conditions experience escalation in critical status, extended length of hospital stay, and associated increases in morbidity and mortality risk rates with proportional financial ramifications [14]. Multiple studies have analyzed interventions to prevent VAP. [15] Found interventions that included care techniques and skills known as the VAP bundle, a staff of protocol for use of this bundle, and policies developed to address to incorporate the VAP bundle into care delivery were shown to prevent patient infections (2013). Effective educational interventions must include staff in decision-making, and in development and delivery of education, and in evaluation of the plan. When frontline nurses are involved in decision-making regarding changes at the bedside these nurses become change agents who drive improved patient and fiscal outcomes. Consistent compliance and adherence to policy, protocols, or guidelines is facilitated by nurses' positive attitudes toward the specified interventions [16]. The nurses, change agents, can facilitate change or create barriers to a change or incorporation of a change into practice.

Frontline nurses who are change agents are using process tools to determine the causative factors of issues in care delivery. One such apparatus, root cause analysis (RCA), has been used to determine potential reasons for medical clinic obtained conditions [17]. Examination of components associated with the issue or phenomena of interest reveals findings the guide's teams to determine strategies to improve care and enhance prevention [18]. RCA is part of the continuous quality improvement process and is a problem-solving tool intended to identify all contributing factors that when addressed with acceptable practice change can eliminate threats [18]. Once completed, RCA results are used to identify the essentials including the need for learning and the development of focused educational information for staff working in the critical care [18].

Root cause analysis (RCA) includes fishbone diagramming visually depict or categorize the cause and effect aspects of the issue which may include personnel, policies, equipment, and other associated components [18]. The 5 Why technique, asking why each identified aspect causing or contributing to an issue or problem, the process until all potential causes or contributing factors are identified and diagramed [19]. This technique, used in RCA and in the analysis phase of "Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology, is a way to determine details about causes of issues or problems [19]. The apparatus "doesn't include information division, theory testing, relapse or other progressed factual devices, and as a rule can be finished without an information assortment plan" [19]. Continually asking why the issue occurs and recording all relational aspects facilitates better understanding of the issue or problem and can reveal preference for information transmission and form which is critical to assure necessary action is taken in proper sequence to address or prevent the issue or problem [18]. Research completed by [20], demonstrated that "accurate, easily accessed information at the bedside is needed for providing safe patient-centered care" (p. 442). Information in checklist form in patient's room or are immediately accessible to staff is a visual reminder to complete interventions such as the VAP bundle thus increasing compliance and decreasing incidence of this complication. [11] was a proponent of using tools like check lists to reinforce learning and guide care while providing nurse education. Such provisional support increases the availability of resources and intervenes in expanding health care system factors, environmental factors, and health states detailed in Orem's theory [11]. Ongoing analysis and evaluation of these resources leads to protocol refinement and policy revision, which ensures quality care and improved health outcomes when caring for the critically ill.

The American Association of Critical-care Nurses (AACN) declares that mortality with VAP [without the confluence of Covid-19] is significant and requires attention [21]. Ventilator associated pneumonia (VAP) is a common and life-threatening nosocomial, hospital acquired, infection which is associated with a myriad of physiologic and economic consequences, not to mention demand and impact on nurses, other caregivers, and families [22]. The addition of the complication of VAP in the critical ill COVID-19 patient is the perfect storm, increasing the risk for significant disability including death. [22]. looked at the incidence of VAP in patients supported by mechanical ventilation (2017). One group of patients received routine care provision using standard precautions while another group of patients received comprehensive VAP prevention strategies, VAP bundle (2017). Significant decrease in VAP incidences was noted in the implementation group receiving the VAP bundle (2017). These results support previous findings of the effectiveness of use of VAP bundle in effectively decreasing or preventing VAP (2017).

The implementation of the VAP bundle has demonstrated effectiveness in addressing and decreasing the deadly complication of VAP. Implementation of this effective strategy is required to assure Covid-19 patients a fighting chance for recovery.

The Planned Change

Implementation science lends structure to planned change [23]. Change theories, in general, address fulfilling long-term goals using a series of planned steps while considering different perspectives of proposed change [23]. Consideration of perspective is key to effective change. Those personnel impacted by or responsible for the change must be included in the change process to a proportionate degree. Thus, goal setting must be a dynamic process to focuses efforts and create common ground for optimal implementation with all stakeholders involved or impacted by the change [23]. The inter professional care team should develop long-term goal to reduce the incidence of or prevent VAP for mechanically ventilated Covid-19 patients. Other goals must address maintaining consistent practice, streamlining documentation, and evaluating the efficacy of implementation of the program and interventions within the VAP bundle. The priority is the delivery of quality care which must drive the VAP prevention strategy. Using a VAP checklist in a paper or electronic format will aid, care delivery standardization, and documentation. Recommended bundle of nursing interventions for the prevention of ventilator-associated pneumonia are presented in Table 2, Ventilator Associated Pneumonia Prevention Checklist.

Daily	Scheduled and Routine Care
Cleanse ventilator	HCG bath for patient per policy
Ventilator circuits inspected (change only if needed)	-
Chlorhexidine (.12%) rinse with oral care	Oral care Q 4 hours
Fresh suction/oral care supplies (and as needed)	Manage oral secretions
Attempt mobilization	Repositioning Q 4 hours
Preform tube care (ET or Trach and as needed)	Manage oral secretions
Manage gastric reflux	Head of bed elevated 30-45 degrees (if tolerated)
Wear appropriate PPE for all care	-

Table 2: Ventilator Associated Pneumonia Prevention Checklist.

Note: Adapted from sources of the American Association of Critical-Care Nurses and Hellyer TP, Ewan V, Wilson P & Simpson AJ (2016). The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. Journal of the Intensive Care Society 17: 238–243.

Havelock's change theory, originally developed in 1973, aptly applies to modern preventative protocol implementation efforts like the VAP bundle for preventing VAP in COVID-19 patients. Havelock's theory proposed planned and purposeful change through a rational problem-solving process while considering the perspectives of all involved; stakeholders who are asked to change or facilitate the change, as well as those benefitting from the change must be involved [17]. The six phases of change in Havelock's change model include: 1) building a relationship, 2) identifying the problem, 3) acquiring relevant resources, 4) goal setting and choosing the best solution, 5) gaining acceptance, and 6) stabilizing the innovation and generating self-renewal for sustainability [17]. Havelock's model is aligned well with implementation of a VAP prevention program incorporating the use of VAP bundle strategies. This theory stresses the importance of successfully creating a healthy work environment while identifying problems, utilizing resources, and finding solutions by building trusting relationships and true collaboration of the interprofessional unit practice team [24].

The American Association of Critical-care Nurses has compiled best evidence from qualitative studies, controlled studies, case-reports, peer reviews, and more supporting the use of VAP prevention strategies contained in their helpful and effective resource the Pulmonary Management pocket-guide which includes VAP bundle specifics [21].This process for change is supported by [9], who stressed implementation of an evidence-based practice VAP prevention program should include seven steps. The implementation of the program begins with an inter professional task force to address VAP, includes education for staff about hospital-acquired infections, incorporates evidence-based interventions in education and practice materials, ensures policies regarding VAP are developed and implemented, develop documentation standards, determine unit compliance with the VAP bundle, and incorporate education into orientation [9].

The inter professional teams should include members of critical care unit nursing staff, physicians, respiratory therapists, risk/quality management. Critical care staff nurses are the direct patient care professionals who must perform the interventions that prevent VAP. Inter professional unit practice teams led by nursing staff ensure nursing's sustained engagement in quality care process improvement over time. The inter professional team commits to prioritizing peer review by performing regular compliance rounds, monitoring compliance with provision of VAP bundle, ensuring availability of resources, and ongoing investigation of occurrences of VAP.

It is noted that nurses are on the front line in preventing hospital-acquired infections such as VAP through provision of meticulous oral care, supportive respiratory care with Respiratory Therapists, positioning, and initiating steps that lead to successful rapid extubation [25],. Dental plaque buildup and oral bacteria growth, reproduction occurs five times in each 24-hour period, contribute to the occurrence of VAP, the nurse must perform meticulous oral hygiene for incubated patients as noted in the VAP bundle [26] .Compounding bacteria growth is the potential for aspiration. Fifty percent of healthy adults' aspirate in their sleep [26]. Intubation provides a direct pathway into the lungs and if the mechanically ventilated patient is receiving sedation or paralytic medications, which most are, then VAP is sure to occur if not intentionally prevented [26].

When implementingVAP prevention strategiesone must address barriers, limitations, and facilitating factors. Barriers to successful implementation of a VAP prevention program are identified as low quality of work and a poor organizational culture [27]. The difficult nature of the care required by thesemedically complex patients, such as the critically ill COVID-19 patient, lack of educational resources or opportunities, and limited skilled staff are quality work life barriers many critical care nurses experience [24]. Potential barriers regarding organizational culture consistently exhibited in various critical care units are lack of encouragement and poor interprofessional relationships [24]. Some barriers to VAP prevention stem from unhealthy work environments and contribute to the occurrence of VAP. Limited resources, staff shortages and lack of VAP and prevention knowledge are evidence of unhealthy work environment barriers [21,28]. Staff shortages, namely the number of nursing care hours and nurse skill level is correlational to patient safety [21]. It is crucial to evaluate the risks that insufficient nurse staffing pose to complicated patients [21,29]. Addressing these barriers on a unit can be accomplished by providing education for all critical care nursing staff and other members of the inter professional team, increased nurse to patient ratios, consideration of nurse competency and skill level when developing work schedules, providing laminated checklists that are in patient rooms, and implementing the use of a specific ventilator supply kit, which includes all necessary items for intentional oral hygiene and essential care [21,29]. The overall goal of these actions is to increase knowledge of and compliance with quality care initiatives, standardize practice, improve nurses' time management, improve the unit culture and work life, and ultimately reduce the incidence VAP and other complications.

Patient care units develop their own culture over time which can result in barriers. This is true of critical care units, but these units with high-technical equipment and monitoring systems also have factors that facilitate quality improvement [24]. Facilitating factors present in a healthy work environment often seen within the critical care units are positive, supportive attitudes, readiness for change and to learn, knowledgeable and skilled resources, readily available technology, and willing participation to improve outcomes [24]. Technology use to expedite training and supports reliable protocol documentation

promotes the prevention of and reduces the incidence of VAP [30]. Technological availability varies in most critical care units, but most critical care units have greater technological capabilities than general medical/surgical patient care areas. Using the available technology aligned with staffs' readiness to learn about the use of the equipment in the VAP prevention kit to complete the VAP bundle will increase staff satisfaction with the care they provide as well as improve health outcomes for their patients. In the ideal critical care unit, there is an inter professional team of nurses, physicians, and respiratory therapists available 24 hours a day, seven days a week to allow collaboration and provide care. [31], noted a positive interaction between the nurse work environment and critical care physician staffing on VAP. When there is an adequate amount of skilled health professionals, there is an increased likelihood for optimal care to prevent VAP [31]. This study also noted that inter professional collaboration between the nurses and physicians staffing the critical care units in the study played an important role in VAP rates (2016).

The most effective way to prevent VAP is to educate current and future nurses and the entire inter professional team about the VAP prevention program, including policies, protocol, tools, VAP bundle, "ventilator care kit", evaluation components for process improvement [32,33], demonstrated significant improvement in nursing student VAP knowledge after completing an educational program. Provision of ongoing education is effective, both in school and in professional settings beyond licensure. When nursing schools implement VAP prevention education into the critical care courses of their respective programs, they prepare more effective graduate nurses who will provide benefit to the critical care patients in their care and to the units and organizations where they work. When organizations provide professional development for nursing staff and other members of inter professional team, competency and skill are reinforced, new practices are introduced and the risk of patient harm is mitigated, including the prevention of VAP development.

Action Plan & Evaluation

Nurses are expert process engineers; it is included in every standard of practice. A comprehensive assessment needs to be completed by inter professional team led by an expert nurses or nurses. Nurses must be intimately involved in the process because they are the change agents who will be incorporating the care strategies into their day-to-day practice. Goal setting should precede planning. Education efforts should create information regarding caused and means to prevent VAP and be available for a various levels of healthcare providers in easily accessible formats, video, audio, hard copy, and other electronic modes. Annual competencies regarding VAP prevention should be assessed to facilitate sustained improvement in addressing VAP.

Tools to facilitate VAP prevention include a laminated intervention checklist of the VAP bundle and "ventilator care kit"in each patient care room where mechanical ventilators are used. This will provide a reminder for bedside nurses of the actions needed to reduce VAP while providing appropriate resources conveniently available in the room to facilitate use. An online evidence-based education refresher should be available to all staff. The refresher should be a succinct professional presentation that provides key information, background and significance of VAP, current institutional and benchmark statistics, expected national target of no VAP, elements in the VAP bundle, documentation tools, and inter-unit/institutional resources readily available to reduce VAP risk. A laminated copy of the VAP bundle could also be posted in each critical care patient room as a reminder to staff and to promote adherence. Lamination will permit reuse, nurses can use dry erase markers to check off completed bundle tasks each shift worked and allows for appropriate disinfecting after discharge and prior to admission of a new patient.

The "ventilator care kit" can save nurses time by optimally containing everything needed to perform meticulous oral hygiene every four hours during each shift. Recommended hygiene routineincludes: Chlorhexidine oral solution (used every 12 hours), mouth swabs, suction toothbrushes, suction supplies (both rigid and flexible suction catheters), normal saline, ambu bag, tube stabilizer of choice (twill tape, cath secure tube tamer, or other), and dressing supplies [34]. The supplies in the "ventilator care kit"should be available in unit supplies but can put in a "ventilator care kit" when a patient is placed on mechanical ventilator. These supplies are to be used on all patients and would require no additional cost. Assembling the supplies for the "ventilator care kit"and having them available in a supply or ventilator room should be included in the protocol and either supply staff or ancillary staff can be educated on maintaining supply stock levels. Supply levels in each kit are calculated to provide needed care for a 24-hour period or the designated period between stocking and re-stocking.

Budgeting should include costs of developing and providing educational materials in video, audio, and electronic forms, printed educational materials, and laminated checklists. Costs will vary depending on the number of rooms in each unit. "Ventilator care kit" assembly will require a container that has compartments that can be stocked with supplies for providing the VAP bundle. Time for expert nurses to lead the inter professional team, develop policies and protocols, and provide education should also be included in the budgeting process .Increasing safety, patient outcomes, and reducing hospital costs justifies the request to cover budgetary demands of implementing the VAP prevention program. The hospital is responsible for costs related to a case of VAP since it is not usually covered by Medicare or other third-party payors [35]. Implementation costs to implement and maintain the VAP prevention program are offset by the institutional costs of nosocomial/hospital acquired VAP cases. If the VAP prevention program can save one life, it is worth the expense.

Policy development will be a work product of inter professional team and must consider all aspects of care provision as the guiding document of the VAP prevention program as quality care and improvement initiative. Policy should provide a background and definitions, general statements about the VAP prevention program, the goal of zero VAP cases. The policy or policies should address associated requirements, care requirements and standards, unit specification, supply specification, and associated responsibilities. Policy review should be included in the protocol for the VAP prevention program as this must be a dynamic process and review with appropriate updates occurring as specified.

Evaluation is instrumental in any planned change and should begin with the planning and inclusive of all implementation strategies [17]. To facilitate evaluation, base-line data should be collected in all areas where evaluation strategies will be implemented. Evaluation of different interventions included in the VAP prevention program can be evaluated in a variety of ways such as surveys, documented observation, and critical care unit data review and analysis. Timing of evaluation and duration between evaluation cycles must be included in the implementation plan and as with other program components, must be reviewed and revised as appropriate. The inter-professional group will decide assessment type and stretch for assessing VAP anticipation program segments. Obtaining staff perceptions of the VAP prevention program is important. These front-line workers are the professionals

responsible for care delivery. Depending on inter professional team recommendation; survey could be sent to all critical care unit staff six to twelve months post-program implementation. Survey items would include items that assess knowledge of VAP, VAP bundle, VAP "ventilator care kit", VAP protocol, policies, and thoughts and feelings about the program, implementation, and evaluation. The survey instrument should also include an open-ended section for nurses to offer suggestions, comments, and voice concerns. Compliance rounding is another form of evaluation and should be a component of unit policy regarding the VAP prevention program. Compliance rounding should be listed as a professional responsibility for both nurses and respiratory therapist and should be conducted at regular intervals. This evaluation segment is an activity that should be designated to all nursing staff who works on the critical care unit. It functions as a reinforcement of the VAP prevention program and leads to standard practice ensuring effective quality care delivery. Data about cases of VAP should be analyzed at six- and twelve-month intervals. All VAP cases will continue to be examined using RCA by inter professional team will review data and revise, policy, program, and protocols as needed. Comparison to base-line data, the number of VAP cases prior to implementation will additionally be used to determine if this plan is effective in creating a positive change, negative change, or no change at all. Planning effective evaluation for change to improve quality must be included in program planning and development. Evaluation strategies are critical interventions as important as the provision of the VAP bundle care provision to the critically ill COVID-19 mechanically ventilated patient. Planned evaluation is central for continuous quality improvement and elemental in implementation of a VAP prevention program in mechanically ventilated COVID-19 patients.

Evidence and resources are readily available and a blueprint for implementing a VAP prevention program has been provided. The Institute for Healthcare Improvement (IHI) reminds us quality improvement is not simply a short-term limited fix, but rather a long-term commitment to those served by the organization (IHI, 2018). It takes time, teamwork, resources, perseverance, vigilance, and education, ongoing evaluation which may require modification of processes, protocols, and policies.

Ventilator Associated Pneumonia (VAP) is a preventable, life-threatening nosocomial, hospital acquired infection. COVID-19 patients are high risk for contracting VAP because of the severe acute respiratory syndrome (SARS) that triggers respiratory failure requiring intubation and mechanical ventilation to sustain life. Critical care unit nurses are pivotal in preventing VAP as they are the primary front-line care provider working to prevent these infections.

Evidence has shown that specific interventions included in the VAP bundle can prevent a patient from developing VAP, but often this requires change [36]. To facilitate the change process an interprofessional team led by expert nurses should be brought together to act to prevent VAP within each organization where COVID-19 patients requiring mechanical ventilation are receiving care.

This article brings together theory, change process and models, best evidence, and process components to implement an effective VAP prevention program to improve the quality of care delivery, produce improved patient outcomes such as reducing morbidity, mortality, and potentially eliminating VAP. The collaborative plan presented provides implementation steps which include educational elements, tools for care provision such as the VAP bundle in-room checklist and "ventilator care kit" providing equipment and cues for each nurse providing care. The inter professional team working to implement a VAP prevention program requires collaboration and communication. This teamwork improves working relationships on critical care units and enhances organizational partnerships which are ingredients that contribute to development of a healthy work environment. Implementation of a VAP prevention program must be an inclusive inter professional process. When done correctly, it can have far reaching effects on patients, families, nurses, other inter professional team members, and organizational culture [37-39].

Conclusion

The COVID-19 pandemic has presented challenges to healthcare professionals' and organizations throughout the world. These challenges have forced us to revitalize collaborative efforts to prevent life-threatening complications such as VAP in COVID-19 ventilator dependent patients. Implementation of VAP prevention programs have saved lives through the hard work and commitment of front-line nurses, physicians, respiratory therapist, and countless other healthcare team members whose continued commitment shoulders this important work.

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