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VENTILATOR ASSOCIATED PROBLEMS - AN UPDATE

Nursing

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ABSTRACT

Ventilator-associated pneumonia (VAP) is a preventable lung infection acquired in mechanically ventilated patients that was not present at the time of intubation. Picture an Intensive care unit where nurses led inter professional team practices evidence based, patient centred care focussed on preserving and restoring their clients physical, functional and neuro cognizant activities. A well developed bundle of practices for the intensive care unit could improve the current practices for an intensive care unit towards the non-infectious environment. Ventilator-associated pneumonia is the most recurrent nosocomial infection encountered in critical care settings. The several packages (ventilator bundles) have been designed to help reduce or eliminate VAP, promote adherence to evidence-based guidelines and thus improve clinical outcomes. When the bundle is executed together incorporates the best available evidences related to the ventilator management in an ICU for adoption in everyday clinical practices.

KEYWORDS

Ventilator-associated pneumonia, Ventilator Bundles, Evidence-Based Guidelines, Quality Improvement, Clinical practice.

INTRODUCTION

Ventilator-associated pneumonia (VAP), a subset of nosocomial pneumonia, is the common infections among intensive care units (ICUs) patients who have been treated with mechanical ventilation for 48 hours or longer. Thus, resulting in the significant increase in hospital costs and length of stay for the patients. Furthermore, VAP is also concomitant with deferred extubation, and increased use of health care resources.

VAP is accountable for 25–42% of all infections that ensue within ICUs and is the second most common healthcare-associated infections. Intubated patients are at threat of developing VAP and the incidence rises with the duration of ventilator support. The incidence of VAP is 22.8% in patients receiving mechanical ventilation. This is widespread in nosocomial pneumonia as 86% patients receive ventilator support. Nevertheless, variation is found depending on criteria used for diagnosis, the type of ICU, hospital resources and study population. The estimated rate of VAP is 1.4 to 5.8 events per 1000 intubated patients since 2000.

Downward trend is more prominent in the United States, probably due to the implementation of ventilator bundles. It has been reported that the VAP mortality rate is between "10% to 40%". Length of stay in the intensive care unit is increased by 5 to 7 days and hospital length of stay 2 to 3 fold in patients with VAP. Hospital costs associated with VAP were estimated 40,000 dollars for each case of VAP. Development of VAP also increases ventilator days, morbidity and mortality.

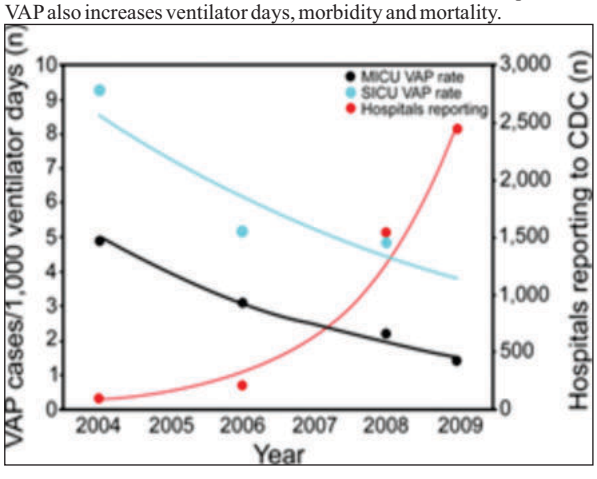
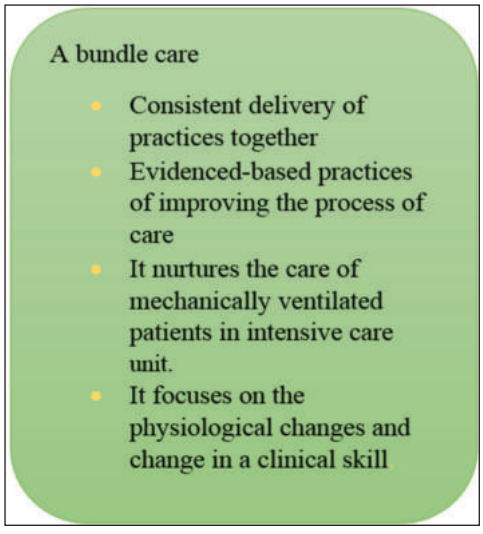


Fig1: *Relationship between ventilator associated pneumonia cases and public reporting of VAP by the Centre's for Disease Control and Prevention(CDC). MICU-Medical ICU, SICU- Surgical ICU.*

Care bundles, are grouping of finest practices with respect to a disease process that individually improve care, but when applied together may result in considerably greater development. The science supporting each bundle component is adequately established that the bundle is considered as best practice.

A "bundle" are a cluster of interventions associated with a disease process that, when executed together, results in better outcomes than when implemented individually.



PULLING THE EVIDENCE TOGETHER TO PREVENT VAP: "CRUSHED OUT VAP"

Cuff pressure
Readiness to Extubate
Ulcer (Peptic) Prophylaxis
Sedation Vacation and Weaning
Head End Elevation
Endotracheal/ Subglottic Suctioning
Diet (Enteral Nutrition)
Oral Care
Utilize Hand Hygiene
Thrombolytic Therapy
Ventilator
Associated
Pneumonia

A novel inter-professional bundled approach can be utilized to manage ICU acquired ventilator associated problems.

Cuff Pressure

The endotracheal tube is inserted through the mouth and its distal tip rests above the carina of trachea. Inflation of the cuff is to provide and deliver a positive pressure ventilation without losing tidal volume and prevent aspiration of oral and gastric secretions.

The evidence based study says the replacement of standard polyvinyl chloride cuffs with an ultrathin polyurethane cuff, which decreases the

fluid leakage around the cuff.

Nurses Responsibility

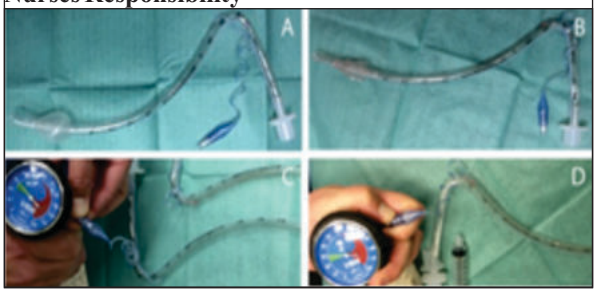
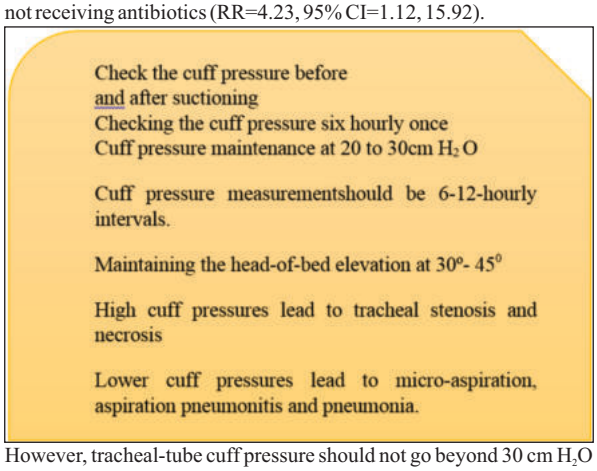


Fig:2 *Comparision of normal and defective endotracheal tubes. (Source: Journal of Anesthesia safety patients)*

The study conducted by Lewis FR, including 83 intubated patients undergoing continuous subglottic secretion drainage SSD), found that patients with persistent intra-cuff pressures below 20 cm H_2O showed a trend towards a higher risk of VAP (relative risk (RR)=2.57, 95% CI = 0.78, 8.03), and a statistically significant risk of VAP among patients not receiving antibiotics (RR=4.23, 95% CI=1.12, 15.92).



However, tracheal-tube cuff pressure should not go beyond 30 cm H_2O to avoid vascular compromise of the trachea, which could result in tracheomalacia and tracheal necrosis.

Readiness To Extubate

The susceptibility to develop VAP is directly associated with duration of mechanical ventilation. Three main strategies are used by clinicians to perform spontaneous breathing trail.The nursing strategies include,

* T-piece trial, in which only supplemental oxygen is supplied which is connected to an endotracheal tube.
* Continuous positive airway pressure (CPAP) trial using CPAP level equal to the previous positive end-expiratory pressure (PEEP) level.
* Invasive ventilation with low level of pressure support (5-8cmH2O) or automatic tube compensation.The criteria for weaning are,

- Respiratory rate < 35breaths/minute
- Good tolerance to spontaneous breathing trials
- Heart rate < 140 /minute or heart rate variability of >20%
- Arterial oxygen saturation >90% or PaO2 > 60 mmHg onFiO2<0.4,80 < Systolic blood pressure < 180 mmHg or <20% change from baseline
- No signs of increased work of breathing or distress

Kress et al. conducted a randomized controlled trial in 128 adult mechanically ventilated patients receiving continuous infusion of sedative agents in a medical intensive care unit. Patients were randomized to receive daily interruption of sedation until awake versus management at the clinician's discretion. Daily interruption resulted in a highly significant reduction in time spent on mechanical ventilation. The duration of mechanical ventilation decrease from 7 days to 4 days (p=0.004).

Ulcer (peptic) Prophylaxis

The gram negative bacilli that originate in the duodenum raises gastric pH, promote the development of bacteria in the stomach. The reflux gastric contents and secretions are susceptible to aspirations. Critically intubated patients in an lCU are ability to defend their airway.

Oesophageal reflux and aspirations of gastric contents along the endotracheal tube may cause endo bronchial colonization and pneumonia or even precipitate pneumonia due to decreased bacterial killing in the low acid environment. The nurse's responsibility incudes,

- Check the elevation of bed at 30-45 degree and the position of the gastric tube,
- Measure the amount of feed every 4 hourly, Calculating the required calories of the patient and connect the enteral feeding on time
- Proton pump inhibitors (PPIs) and Histamine 2 receptor agonists (H2RAs) both avert clinically significant GI bleeding by raising the gastric pH.

Sedation Vacation

It has been demonstrated that daily interruption of sedation reduced the duration of ICU stay, mechanical ventilation and incidence of complications, called as Spontaneous Awakening Trail (SAT). The protocols that pairs with spontaneous Breathing trails (SBT) is confirmed to be more effective.

Kress et al. conducted a randomized controlled trial study of spontaneous-awakening trials showed that daily sedation interruptions improved the time to extubation of 64 patients by approximately 2 days which condensed the total admission time to the ICU by 3 days. This study was further reinforced by two separate trials, the Awakening and Breathing Controlled Trial in 2008 titled the “wake up and breathe” protocol and the No Sedation in Intensive Care Unit Patients trial in 2010. Both of these supporting trials investigated the impact of striking a protocol to evaluate and reduce sedation in a planned format and found that spontaneous-breathing trials along with sedation vacations reduced ventilator dependent days and ICU admission days. The care strategies include

- The two primary scales,(Sedation-Agitation Scale (SAS) and the Richmond Agitation-Sedation Scale (RASS) systems utilized to assess the degree of sedation and agitation
- If the patient is getting agitated and is delirious, antipsychotics can be tried
- If anxious, anxiolytics can be tried
- if in pain, low dose fentanyl drip/morphine drip or patch can be administered.

Head End Elevation

The elevation of the headend of bed (HOB) to a semi-recumbent position (30^0- 45^0) is related to decrease the threat of aspiration of aero digestive (e.g. oropharyngeal and gastrointestinal) fluids and to enhance patient's lung volumes and ventilation.

For instance, patients in supine position will have lower spontaneous tidal volumes on pressure support ventilation than those seated in an upright position.

The role of nurse includes,

- Using a mark on the wall that can only be seen if the bed is below a 30-degree angle.
- Elevation of bed at 15- 20^0 during procedure
- Elevation of bed at 30^0 – 45^0after the procedure
- The sacrococcygeal skin contact surface, which increases the risk of pressure sores, so the position can be changed every 2 hourly.

Fig3: *Elevation of head end at 45^0*

Drakulovic et al. conducted a randomized controlled trial in 86 mechanically ventilated patients assigned to semi-recumbent or supine body position. The trial demonstrated that suspected cases of ventilatorassociated pneumonia had an incidence of 34%, while in the semi-recumbent position suspected cases had an incidence of 8% (p=0.003). Similarly, confirmed cases were 23% and 5% respectively (p=0.018).

Endotracheal/ Subglottic Suctioning

Subglottic drainage of potentially contaminated oro-pharyngeal secretions from above the tracheal tube cuff may prevent aspiration, lower airway colonization and hence pneumonia.

John Musceeder (2011) conducted, Subglottic secretion drainage experimental arm of six RCTs and one meta-analysis of nearly 900 patients. The meta-analysis found that subglottic secretion drainage halved the incidence of VAP, particularly during the first week of intubation of patients expected to be ventilated for more than three days. Additionally, duration of ventilation was reduced by almost two days and intensive care unit stay by nearly three days.

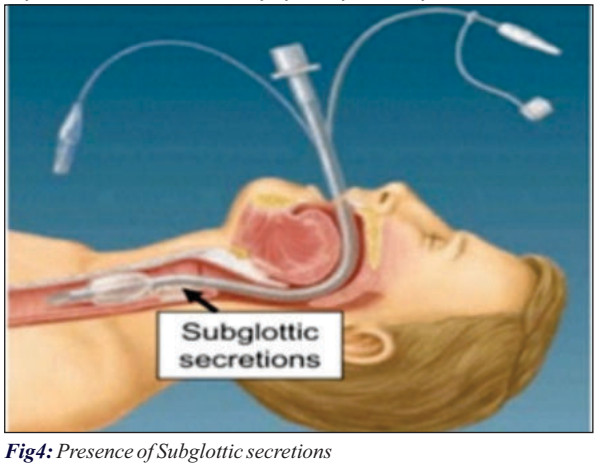


Fig4: *Presence of Subglottic secretions*

The nurse's responsibility includes,

- Maintain adequate cuff pressure
- Insert the catheter into the ET tube gently by using aseptic technique and then perform subglottic suctioning
- Use separate suction catheter for oral suctioning
- Drain ventilator condensate regularly without opening circuit
- Discard suction tube directly after one single use
- Measure the amount and characteristics of secretion.

Diet (Enteral Nutrition)

In Critically ill patient, enteral nutrition is the preferred route and should be started within 24 to 48. The specific reasons for providing early enteral nutrition are to maintain gut integrity, modulate stress and the systemic immune response, and to attenuate disease severity.

While starting feedinga nurse should know that the,

- less gut permeability,diminished activation,
- release of inflammatory cytokines (i.e. tumour necrosis factor [TNF and systemic endotoxemia)].
- measure gastric residuals every 4 hours in critically ill patients.
- Gastric residual volume ranges from 200-500 mL, should raise concern and lead to the implementation of measures to reduce risk of aspiration.
- Check the gastric volume before suctioning and any other procedure.

Early enteral nutrition is associated with a reduction in infectious complications, reduced length of stay and mortality when compared to delayed initiation.

Fig5: *Enteral feeding bag set on double hook IV stand*

Ibrahim et al used a prospective, controlled, clinical trial method to compare 2 strategies of feeding (early and late feeding). Patients in the early-feeding group were scheduled to receive their estimated total daily enteral nutritional requirements starting on day one of mechanical ventilation. Patients in the late-feeding group were scheduled to receive 20% of their predictable daily enteral nutritional requirements during the first 4 days of mechanical ventilation, followed by their full estimated daily enteral nutritional requirements beginning on day 5 of mechanical ventilation. The results showed that patients in the early-feeding group had a statistically larger prevalence of VAP (49.3% vs. 30.7%).

Oral Care

Prolonged mouth opening due to intubation reduces saliva flow, increase in oral bacteria, and obstruction by the endotracheal tube can reduce accessibility for oral care.

Chlorhexidine is a broad spectrum antibacterial agent that has been used extensively as an oral rinse to control dental plaque and to prevent and treat gingivitis.

- Position a patient in a semi recumbent
- Maintain the cuff pressure at 20-30cm of H_2O before oral care.
- Apply chlorhexidine 0.12%,Scrub along teeth, tongue and gum line using small circular motions
- Clean the mouth with a clean swab
- Apply water soluble jelly to patients' lips

Fig6: *Oral care with chlorohexdine* 0.12% - 2%

Utilize Hand Hygiene

In the rouse of the growing burden of health care associated infections (HCAIs), the increasing severity of illness and complexity of treatment, superimposed by multi-drug resistant pathogen infections, health care practitioners are reversing back to the fundamentals of infection preventions by simple measures like hand hygiene.

The essential elements to implement hand hygiene are:

- Verify the availability of alcohol-based hand rub at the point of patient care
- access to a safe, continuous water supply and soap and towels;
- training and education of health-care professionals;
- monitoring of hand hygiene practice and performance feedback;
- reminders in the workplace; and
- the creation of a hand hygiene safety culture with the participation of both individual health care workers and senior hospital managers.

Fig8: *Eight Steps To Clean Hands*

Thrombolytic Therapy

Deep vein thrombosis (DVT) is formation or presence of a thrombus in deep veins when patient is immobilised.The nursing measures to prevent DVT includes,

- Low-molecular heparin,weight - subcutaneously once daily or unfractionated heparin: 5000 units subcutaneously every 8 to 12 hours.
- Intermittent pneumatic compression (IPC) sleeves and anti-embolism stockings (AES).
- Elevation of the lower limb
- Use of knee-high compression stockings providing 30 to 40 mm Hg pressure is recommended

Fig9: *DVT Pumps Are Compression Pumps Which Is Designed To Prevent People From Getting Deep Vein Thrombosis (DVT).*

CONCLUSION

A bundle care is a small set of evidence based preventive practices, when implemented collectively helps in the prevention of a health care associated infections. In recent years many advancements have been developed to prevent the ventilator associated problems. The advancements need to be updated among health care professionals in respect to the diagnosis and prevention of VAP.

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