Review Article

Care of the Mechanically Ventilated Patient

"Primum non nocere" "First, do no harm"

"Envision a Healthcare system with no avoidable death and no avoidable harm"

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Abstract

The care of the mechanically ventilated patient is a fundamental component of clinical practice in the intensive care unit (ICU). It is important that care of the mechanically ventilated patient in the ICU is well supported by evidence. Published work relating to the numerous issues of safety and care of the mechanically ventilated patient in the ICU is growing significantly, yet is fragmentary by nature. To establish the evidence supporting practice, a full review of current literature was undertaken using the following steps: Electronic search was done on MEDLINE, CINAHL, EMBASE and Psych-Review databases for articles published between 1970 and 2012. The purpose is to provide a single comprehensive examination of the evidence directly related to the safety and care of the mechanically ventilated patient.

Key Words: Mechanical Ventilation, Patient safety, Patient Assessment, Patient Comfort, Sedation and Pain Management

Introduction

The science of medicine and its relevant medical technologies have never been so rapid and path breaking in its evolution as is witnessed today. The world as we know takes giant strides in creating technologies to cure or alleviate the suffering of mankind. Such gadgets often find their place in either diagnostics or intensive care. Healthcare professionals are often overwhelmed by this massive transfusion of technological advancement and the way it changes the outlook of medicine. While it is important to indulge and endure using these relevant technologies to improve the system of care, it is as important not to forget the basic concepts of human support like safety, comfort and psychosocial support, which help in the resolution of the disease. It is important to remember, that care in these dimensions took medicine to its defining moments in 19th century when care concepts in nursing care came to the fore. Modern day care has to be a combination of both. Pursuant to this concept, this article deliberates about the care concepts in the mechanically ventilated patient.

Patient Safety

An essential strategy for promoting the safety of the mechanically ventilated patient is to use a health assessment framework. The Emergency Care Cycle is one health assessment framework that facilitates a systematic and comprehensive approach to patient assessment. This framework has two components: the Primary survey (see Table 1) which identifies immediate life-threatening events, and the Secondary survey (see Table 2) which often utilizes a head-to-toe systems approach to assess the functional status of each body system[1]. The safety considerations in the care of the mechanically ventilated patient will be discussed using this framework.

Some general patient safety considerations are worth mentioning before we begin. Patients on mechanical ventilation in ICU require continuous observation and monitoring. For this reason a nurse/patient ratio of 1:1 is always recommended[2] (ACCCN, 2005). This ensures that the patient can be closely monitored and that the response to any alarms can be quick[4]. Promoting safety for the ventilated patient also involves keeping emergency equipment (see Table 3) available in the event of accidental extubation or ventilator failure[5]. Routine safety measures utilized when caring for any critically ill patient should apply for the same. These include checking intravenous infusions; ensuring the correct attachment of monitoring devices; checking patient equipment and suitable alarm settings.

Table 1 - Primary Survey

A: Airway	·	Listen to air movement
		Observe rise and fall of the chest
		Check tube is secure and length is correct
B: Breathing	·	Observe chest rise and fall
		Observe patient colour
C: Circulation	·	Check for pulse
		Observe patient colour
D: Disability		Level of consciousness
E: Exposure		Safety of the surroundings
		Preserving patient dignity

Table 2 - Secondary survey

System	Assesment Parameters
Central nervous system	Glasgow coma scale
	Sedation scale
	Level of neuromuscular block
	BIS score
Respiratory system	Airway device
	Tube position
	Cuff pressure monitoring
	Airway Patency
	Obstruction by secretions
	Check humidifier
	Breathing
	Respiratory pattern, frequency
	Adequacy of minute and tidal volume
	Blood gas analysis
	Finger tip pulse oximetry
	Capnography
	Chest X ray
Cardiovascular system	· Blood pressure
	· Pulse rate and rhythm
	· ECG
	CVP monitoring
	Plethysmography
	· Cardiac output monitoring
	DVT signs
Gastrointestinal system	· Presence of bowel sounds
	Abdominal girth
	Bowel sounds
	Examination of nasogastric tube aspirate
	Liver function tests and serum phosphate
General	Core body temperature
	Blood sugar levels
	Patient positioning and risk assessment for bed sores and ulcers
Renal system	Urine output
	Renal function tests

Table 3 - Emergency equipment and safety checks

Essential equipment at bedside
- Self inflating manual resuscitation bag with appropriately sized face mask
- High flow suction unit with yankeur sucker and endotracheal suction catheters

Additional equipment readily accessible at bedside
- Intubation equipment
- Oxygen-wall and portable supplies
- Battery operated suction unit

Safety checks
- All equipment is present, readily accessible and in full working order
- The ventilator is connected where possible to an uninterrupted power supply
- Intravenous infusions are being delivered according to a current order with the correct rate, composition, time of expiry, point of administration, etc.
- Patient equipment is functioning properly and safe alarm limits are set
- Monitoring devices are connected appropriately and safe alarm limits are set

Patient Comfort

It is essential for critical care personnel to deliver high quality care to the critically ill patient using relevant technologies but equally important is incorporating psychosocial care measures[5]. This balance is often one of the largest challenges facing the persons involved in the critical care environment. A good foundation for standardized quality care would presume a thorough patient assessment and a comprehensive equipment safety check was undertaken. Following patient assessment and safety checks, consideration of crucial care interventions to improve patient comfort, safety and well being needs to be addressed. For this reason, physicians and nurses involved in critical care are expected to determine the unique interventions that will positively impact on outcome of the mechanically ventilated patient and assist in the patient's progression toward desired goals.

The advancement of patient comfort through focused procedural care interventions is an integral component of expert care in the ICU. The nature of critical care medicine brings a plethora of unique patient physiological and psychological challenges. A delicate balance is needed to shift between the skills required in the use of technical equipment and the caring role of the intensivist and nurse who use their ability to observe, protect, relate to their patients as valued people and provide care that is centered on comfort[6]. A humane approach to understand the patient's environment and the provision of comfort measures to minimize and, where possible, normalize the patient's routines go a long way to reducing the mechanically ventilated patient's psychological stress. This article emphasizes on several patient comfort measures including: positioning; eye care, mouth care and washing; management of stressors; sedation and pain management.

Patient positioning

Positioning can improve patient comfort and also address the physiological aims of improving oxygen transport (reducing V/Q mismatch), reducing the work of breathing and easing myocardial workload[7]. Specific examples include: supine, semi-recumbent, side lying and prone. There is a lot of evidence supporting the semi-recumbent positioning of ventilated patients, with the head of the bed (HOB) elevated from 30° to 45°, reducing the incidence of ventilator acquired pneumonia (VAP)[8].

The degree of HOB and the time spent on supine position are identified risk factors for aspiration of gastric contents[9] and the development of VAP as a consequence. A seminal prospective, randomized, clinical trial conducted by Drakulovic et al.[10] compared continuous semi-recumbence (45° elevation) to no elevation in the early mechanical ventilation period and found a significantly greater incidence of VAP in patients without elevation of the head of the bed. Grap et al.[11] found that VAP was more likely to develop in patients with high Acute Physiology and Chronic Health Evaluation (APACHE) II scores who spent more time initially with the head of the bed less than 30°. Due diligence must be given to specific patient problems such as head injury and acute lung injury while considering elevation of HOB. In such circumstances, individual patient assessment should be done and practice guidelines should be based on related evidence.

Mouth care

There appears to be a wide disparity in use of oral hygiene and comfort measures in the ventilated patient. Swabs (foam sticks) and toothbrushes are commonly used for mechanical cleansing while there is a variety in the choice of cleansing agents such as: commercial mouthwashes, chlorhexidine, hydrogen peroxide, sodium bicarbonate, and fluoride[12]. Evidence currently supports the use of a soft bristled toothbrush and rinsing of the oral cavity[13]. Stiefel et al.[14] compared the condition of the mucous membranes, teeth and tongue of eight ICU patients before and after tooth brushing and found that toothbrushes were effective in

improving oral hygeine. However, there is a limitation in this study; dental plaque variation was not reported nor was a link made to VAP.

Although chlorhexidine has been used in oral hygiene protocols for oncology patients[15] its efficacy has not been established in the critically ill patient population. However, it is noted to benefit adjunct plaque removal and suppress potential pathogenic organisms[16].

Timing and frequency of oral care has been reported at 2, 3, 4 and 12 hourly intervals[13]. A review article by O'Reilly suggested that oral care at two and four hourly intervals improved oral health.[12] However, not providing oral care for extended periods reversed previous benefits. It is now recommended that oral care be established and maintained in individualized manner[12].

Hygiene

Effective nursing measures to meet the ventilated patients basic hygiene needs and to improve comfort are an integral part of expert critical care nursing practice.

Eye care

Mechanically ventilated patients who are unconscious and/or sedated are a high-risk group dependent on eye care to maintain their eye integrity. These patients are at risk to develop abrasions, corneal dehydration and infection as a result of loss or impairement of basic eye protective measures, such as the blink reflex[17]. Individual assessment to determine eye care needs is essential in this group of patients. As per current practice, majority of ICU's perform eye care every 2 hours to prevent corneal abrasions, dehydration and infection. Methods of eye care include eye drops, taping, normal saline irrigation, paraffin-based gauze, ointments, gels and polyethylene[17]. One randomized controlled study found that polyethylene covers (cling wrap) are as effective as hypromellose drops and lacri-lube ointment in reducing the incidence of corneal damage in mechanically ventilated patients[18]. A systematic review recommends the following: eye care be provided to all ICU patients; ointments and drops are more effective in reducing corneal abrasion than no treatment; and polyethylene covers are more effective in reducing corneal abrasion than ointment and drop[19]

Management of stressors

Significant focused research in the area of psychosocial care of the ventilated patient is happening over the past few decades. There is a recognized interface between the critical care environment and the patients experience of the stress. It has been reported that a considerable number of ventilated patients' experience sleep deprivation, nightmares, communication difficulties and feelings of isolation and loneliness.

Communication stressors

Difficulties in communication are a source of great stress for mechanically ventilated patients, it often leads to feelings of vulnerability and powerlessness[20,21]. Ashworth's seminal observational study of ICU nurse - patient communication interactions concluded that communication in the ICU occurred most frequently in conjunction with physical or procedural care. Recent literature suggests communication is focussed on care interventions and that nurses identify numerous barriers in communicating with the mechanically ventilated patients under their care. These include: heavy workload; focus on technological or physical care[22]; difficulty in lip reading; patients inability to write; patient personality[23]; and lack of education regarding communication. Despite the general belief that communication[20] with mechanically ventilated patients is an important aspect and an integral part of quality care, evidence still suggests that communication is neither effectively nor consistently managed[24]. Though communication with the mechanically ventilated patient is a challenging aspect of nursing care there are behaviors and devices, which can assist in the process. The intensivist and nurse's use of positive body language, friendly gestures, eye contact and use of simple questions with a yes/no response has been reported to reduce patient distress[23]. Other useful strategies reported include, the involvement of familiar people, such as family members, and the use of specific staff who are familiar with the patient[21]. Lip reading and pen and paper are still the most commonly used communication tools. Other devices suggested are word or picture charts, alphabet boards and rewritable magnetic boards.

Sleep disturbance

Sleep disturbance is a significant problem and a significant stressor for mechanically ventilated patients in the ICU. Critically ill patients have reported high incidence of fragmented sleep[25]. There is profound debate in the literature in regard to sedation in the ventilated patient; whether it is a solution or part of the problem[26]. Active promotion of sleep is not always possible in the unstable critically ill patient; nurses have to individualize care for each patient by planning sleep promoting interventions. The common causes include; environmental noise (including alarms, equipment, telephones and talking), lighting, discomfort, stress and pain[26]. Sleep deprivation can as a consequence produce; suppression of the immune system leading to an impaired capacity to combat infection and impaired wound healing; weak upper airway musculature and delayed weaning from mechanical ventilation[26]. Further, visual hallucinations and delirium can result.[27] Preparing the ventilated patient for sleep can be a challenge for the critical care staff. It is often recommended that critical care personnel should reduce environmental noise and cluster care into short episodes to enable periods of uninterrupted rest for the patient[25]. Many studies recommend the following care interventions: timely silencing of equipment alarms; pre-emptive silencing of ventilator alarms prior to suctioning; dimmed lighting; minimizing lights turned on at night; positioning the patient comfortably; considering the ICU room temperature; clustering of care, where possible, to promote periods of uninterrupted sleep; avoiding care interventions that

are commonly performed at night as part of their practice routines (for example; patient bedcare between 2 and 4 a.m. or ECG recording at 5 a.m.)[26] The implementation of such care is based policy and expert ICU care, recognizing that it is an important pre-requisite to promote the re-establishment of the ventilated patients diurnal rhythms.

Feelings of isolation and loneliness

Hupcey undertook a study of 45 critically ill adult patients who were in ICU for a minimum of three days and found that the ventilated patients need to feel safe is paramount.[28] Feelings of isolation, loneliness, and fear and anxiety have a negative impact on patient perceptions of safety.

Critical care personnel can use numerous interventions to reduce patients' perception of isolation and loneliness. Orientation with respect to day and time can be achieved through repeated communication and large clocks which faces in view for the patient. Placing objects familiar to the patient, such as family pictures, around the bed space can personalize the ICU environment. For long-term mechanically ventilated patients, planning their day with ''trips to the outside'' is another mechanism to reduce isolation. The authors emphazize that though the impact on workload from this intervention is huge, the positive benefits of such a practice to patient and staff is substantial.

It is accepted that families have a positive impact on the patient's outcome in the ICU[29]. Stressors such as social isolation and others in the ICU may contribute to ventilated patients sense of dependency and increase acute confusion and distress[30]. Evidence suggests that, social interaction, in the form of family presence, can be beneficial to the mechanically ventilated patient[31]. Family-centric approach is a philosophy of care that acknowledges the family unit as the fundamental focus of all health care interventions[32]. In the ICU this translates to, the consideration of the mechanically ventilated patient in the context of their family and the assessment of individual family needs to plan and implement the interventions necessary to improve outcomes for patients and their families. Measures such as encouraging the family to be with the patient, communicating to the patient and holding their hand are of great benefit to the patient and family.

Pain management

Patients recalling experience to pain during their time in intensive care are almost everywhere[39]. Furthermore, nurses underestimate patients pain[34]. Pain has many deleterious effects; therefore it is imperative to view pain as the fifth vital sign when undertaking assessment[38].

It is widely accepted in practice that an individual's self-report of pain is the most accurate[33] (ANZCA, 2005). In many mechanically ventilated patients it is not possible to verbalize because of endotracheal intubation, and there is significant impairment of non-verbal communication caused by such factors as sedation[34]. Therefore, tools selected should be appropriate to the individual, and all methods deemed likely to gather the required information should be used[35] (ANZCA, 2005). Methods include the use of assessment tools, and behavioral and physiological signs[35]. Several assessment tools have been used for critically ill patients, though there is limited validation of tools in this population. Tools for the assessment in intensity of pain include the visual analogue scale and the numeric rating scale[34]. Tools developed specifically for critically ill patients and requiring further validation include the adult non-verbal pain scale[36], pain assessment and intervention notation tool[35], both use behavioural and physiological data and the behavioral pain scale[37].

Both behavioral and physiological indicators may inform pain assessment of the mechanically ventilated patient. Physiological indicators are the least reliable in this regard. Significant pain may be present with no change in behavioral or physiological parameters[35]. Other factors, which may contribute to pain assessment, include the presence of wounds, procedures to be undertaken, and proxy assessment data from family members, poorly correlated with self-reports[36]. An analgesia plan with clear objectives needs to be established and communicated to all care providers[34] . Documentation is vital for effective communication and optimal management of pain; so, pain assessment and response to interventions must be clearly documented[38].

Sedation Management

Pain management and sedation are bonded inextricably[40]. Continuous iv sedation prolongs mechanical ventilation time[41]. Daily sedation vacations to reassess requirements reduce ventilation time, length in intensive care and complications such as VAP[42]. Likewise, the use of protocols/guidelines with clear goals has demonstrated a reduction in ventilation time, medication side effects, morbidity, length of stay in ICU and costs[43]. Therefore, protocols incorporating daily sedation vacations should be used.

Pain and other correctable causes of distress need to be addressed prior to meeting sedation requirements. Commonly used in clinical practice, the Ramsay Scale is a six-point numerical scale of motor response derived on the basis of depth of sedation[44]. There is limitation in discrimination of quality and degree of sedation[34]. The Riker Sedation-Agitation Scale (SAS) is a seven-point scale that illustrates behaviour from unrousable through to dangerous agitation[45]. The Richmond Agitation-Sedation Scale (RASS) is a 10-point scale that illustrates patient behaviour from unrousable to combative[46]. Both the SAS and RASS have been validated in critical care populations. Both uses tools such as observation, response to voice; and if no response to voice, response to physical stimulation[34]. Many tools have been developed for critical care populations, but probably the best is yet to come[46]. Apart from this, tools such as Minnesota Sedation Assessment Tool, Adaptation to the Intensive Care, Motor Activity Assessment Scale, Adaptation to the Intensive Care Environment instrument and the Vancouver Interactive and Calmness Scale are used in some centers[46].

The Ventilator Care Bundle

The Institute of Healthcare Improvement[46] (IHI) has come up with this very significant initiative. The IHI Ventilator Bundle is a series of interventions related to ventilator care that, when implemented together, will achieve significantly better outcomes than when implemented individually.

The key components of the IHI Ventilator Bundle are:

1. Elevation of the Head of the Bed
2. Daily "Sedation Vacations" and Assessment of Readiness to Extubate
3. Peptic Ulcer Disease Prophylaxis
4. Deep Venous Thrombosis Prophylaxis
5. Daily Oral Care with Chlorhexidine

By using these series of interventions, the most lethal and among the most common of all hospital-associated infections — dropped by more than 70 percent. The findings, published online in the journal Infection Control and Hospital Epidemiology, show how a relatively simple series of steps, coupled with an education program and a work environment that promotes patient safety, can save tens of thousands of lives and millions of dollars in health care costs.

Such pneumonias kill an estimated 36,000 Americans each year. There is no near exact figure for India, but I guess it must be reasonably higher. "Far too many patients continue to suffer preventable harm from these respirator-linked pneumonias," says study lead author Sean M. Berenholtz from the Johns Hopkins University School of Medicine. "Health care organizations need to be held accountable for ensuring that patients get safe and effective treatments to prevent these infections. Broad use of this intervention could prevent the vast majority of those 36,000 deaths."

ICU Process Measures

Head of bed elevation

Bottom Line: In mechanically ventilated patients, HOB elevation > 30 degrees reduces the frequency and risk for nosocomial pneumonia compared to supine position. Elevating HOB > 30 degrees is a simple no cost intervention that will improve outcomes in our patients.

Appropriate DVT prophylaxis

Bottom Line: In critically ill patients, thromboprophylaxis is effective for preventing deep venous thrombosis (DVT). However, the method of prophylaxis proven in one group cannot necessarily generalize to other patients, and multiple types of thromboprophylaxis appear to be effective. Nonetheless there is agreement that patients who are critically ill or mechanically ventilated are at high risk for DVT and should receive thromboprophylaxis.

Appropriate PUD prophylaxis

Bottom Line: In mechanically ventilated patients, the use of PUD prophylaxis reduces the risk of upper GI bleeding. The specific therapy may be less important. Multiple therapies for PUD prophylaxis are effective.

Appropriate sedation

Bottom Line: Daily interruptions of sedative drug infusions decrease the duration of mechanical ventilation and length of stay in the ICU.

Appropriate glucose control

Bottom Line: Intensive insulin therapy to maintain blood glucose <110 mg per deciliter reduces morbidity and mortality among the critically ill patients.

Assessment of readiness to extubate

Bottom Line: Daily screening of the respiratory function followed by trials of spontaneous breathing can reduce the duration of mechanical ventilation, and decrease complications and costs of ICU care.

Summary

The mechanically ventilated patient presents many challenges to the intensivist. Care and management of the critically ill mechanically ventilated patient is demanding and necessitates an expert understanding of technological issues underpinned with a patient focused approach. From the discussion above it is clear that while mechanical ventilation is a necessary therapeutic intervention for many patients, it brings with it an array of potential or actual complications that present further challenges for the critically ill patient. It is evident that there are many areas of care that would benefit from further research. Future research should determine the most effective strategies to provide comfort to the patient through alleviation of common stressors such as communication issues, sleep disturbance, isolation, and pain and sedation management.

To support the use of evidence in the practice, the concept of a 'Ventilator Care Bundle' had been utilized in the United States and the United Kingdom. The bundle includes four interventions which have sound evidence to support their effectiveness in improving outcomes for the mechanically ventilated patient: elevation of the head of the bed; management of sedation including daily 'sedation vacations'; peptic ulcer prophylaxis; deep vein thrombosis prophylaxis[46] (Institute for Healthcare, in press). The concept of Care Bundles provides a mechanism for highlighting best practice in a particular area to clinicians. If implemented effectively, Care Bundles support the provision of minimum standards of care for all patients in a subgroup[47] and provide indicators to measure the quality of care provided[48]. The utilization of a care bundle for the ventilated patient could also serve as a quality improvement process and a mechanism of ensuring evidenced-based practice[49] .

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