Perspectives
Recovery Strategies from the OR to Home

Preventing Ventilator-Associated Death and Injury

Continuing Education for Respiratory Therapists (CRCE)

By John Davies MA, RRT, FAARC

ABSTRACT

In 2002, the Joint Commission (JC) issued a Sentinel Alert on the deaths and injuries related to long-term ventilation. Ventilator-related deaths and injuries are often related to multiple failures that lead to negative outcomes. The majority of the cases occurred in hospital intensive care units followed by long-term care facilities and hospital chronic ventilator units. JC's root cause analysis revealed several contributing factors: inadequate staffing and training, communication breakdown, incomplete patient assessment, and alarm malfunction. According to the AARC, death and injury due to faulty alarms, inadequate alarm systems, alarm misuse, and airway disconnect are avoidable events. In his article, John Davies outlines the strategies to prevent this tragic event.

Unplanned extubation (UE) can be a devastating event for critically ill patients, with potentially life threatening complications including airway trauma, bronchospasm, severe hypoxemia, and cardiac arrest. UE can lead to an increased number of ventilator days, resulting in excessive resource use for patients, and increased risk of litigation for healthcare professionals. Dr. Foster describes methods to protect against UE include education, quality improvement processes, sedation protocols, physical restraints, and tube securing methods.

Mechanical ventilators provide valuable life supporting therapy. However, if proper attention is not paid to their functionality, they have the potential to harm or even contribute to patient deaths. Many factors exist that can influence the patient-related functionality of the ventilator. By identifying these factors, appropriate strategies can be developed to maximize the therapeutic potential while at the same time minimizing the potential for clinical misadventures.

As clinicians, we would like to think that ventilator deaths and injuries are a rare occurrence. Thankfully, for the most part, this is true. Figure 1 illustrates the incidence of ventilator-related events from the years 1995 to 2007, published in a report of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO).[1] Although these events are thankfully rare, the magnitude of the potential effects on patients makes it imperative that steps must be taken to ensure patient safety. Most caregivers have had those "near misses" where one discovers a ventilator alarm improperly set or a ventilator in dire need of maintenance. The potential for harm to a patient could be high if these situations are not corrected. Samore and colleagues reported that a more intensive, organized surveillance system detected higher rates of medical device problems than those reported through traditional voluntary reporting.[2]

How often do ventilator-associated death and injuries actually happen? In 2002, JCAHO issued a Sentinel Event Alert that reported 23 cases related to mechanical ventilators, 19 of which resulted in death, and 4 in coma. Sixty-five percent of these cases were in some way related to malfunction or misuse of an alarm, or reliance on an inappropriately set alarm. Fifty-two percent were caused by a disconnected ventilator tube and 26% by a dislodged endotracheal tube. A small percentage of events were due to incorrect ventilator circuit setup or wrong ventilator settings. Interestingly — and I'm sure the biomedical departments that maintain the ventilators would rejoice — none of the reported cases were due to ventilator malfunction. These clinical misadventures occurred mainly in hospital based intensive care units.[3]

Factors Contributing to Ventilator-Associated Events

Staffing

In 2002, the Joint Commission performed a root cause analysis to identify factors which contributed to the sentinel events mentioned above. The analysis revealed 6 contributing factors: staffing issues, communication breakdown, incomplete patient assessment, equipment issues, caregiver distraction, and cultural issues. The commission found that staffing issues contributed to the majority of

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Supported by an educational grant from Dale Medical Products Inc.

Using an Evidence-Based Framework for Preventing Unplanned Extubation

by Jan Foster, PhD, RN, CNS, CCRN

Unplanned extubation (UE) can be a devastating event for critically ill patients, with potentially life threatening complications including airway trauma, bronchospasm, severe hypoxemia, and cardiac arrest. UE can lead to an increased number of ventilator days, resulting in excessive resource use for patients, and increased risk of litigation for healthcare professionals. Methods to protect against UE include education, quality improvement processes, sedation protocols, physical restraints, and tube securing methods.

Background

Unplanned extubation occurs through several ways, including accidental patient self-extubation (ASE), deliberate self-extubation (DSE), and extubation by the caregiver without the involvement of the patient. The overall incidence of UE ranges from 0.3% to 16% in studies reported from the 1980s and 1990s[1-5] with the incidence leveling to 6.6-8.7% in more recent studies.[6,7] The wide variation in UE rates is explained by differences in the definitions and methods of reporting. For example, UE episodes may be calculated according to the number of patients intubated over a period of time. This can be a large figure, resulting in relatively low UE rates compared to the number of days intubated, which may be few. The result is a high rate of UE, even if a limited number of UEs occur. The timing of UE varies in relation to duration of intubation; some patients are more likely to self-extubate within 24 hours of intubation, whereas others do not initiate extubation until the tube has been in place for up to 7 days.[7] Mortality rates are higher, intensive care unit (ICU) and hospital lengths of stay are longer, and infection rates are greater for patients who experience UE.[6,7] As many as 69% of patients experiencing UE may require reintubation which can cause airway trauma, vocal cord damage, aspiration, and bronchospasm.[8] Additionally, during the time between extubation and reintubation, patients may suffer hypoxemia, cardiac dysrhythmias, and other sequelae of oxygen deficit.[9]

Risk factors

Tube securing methods

Many factors increase the risk of UE. One of the most commonly cited factors is ineffective tube securing methods.[10,11] Use of various types of tape, nonstandardized and inadequate taping methods, and stretched and moistened tape have all been associated with UE. Often the tube comes away from the tape during oral care, when the tube is repositioned, and when the patient is turned or positioned for procedures. When fabric ties are used, the material stretches, catches on tubing and catheters, and loses its effectiveness in protecting endotracheal tube placement. Improper length of the endotracheal tube and excess weight and traction of the ventilator tubing also interfere with tube stability.

Agitation

Agitation is another major risk factor for UE. Restlessness, delirium, combativeness, and lack of recent sedative administration contribute to DSE.[12-14] Additionally, agitation is associated with repeated DSEs.[15] Even when no real agitation is observed, low levels of sedation are associated with UE.[16,17] Often, these patients are ready for extubation but the care providers delay in making the decision or delay the weaning and extubation process. The validity of extubation criteria, therefore, warrants evaluation.

Interestingly, control of agitation is not enough to prevent DSE but the type of sedative bears on the likelihood of patients extubating themselves. Studies have shown that patients who self-extubated were more likely to have received benzodiazepines (midazalom and lorazepam).[14,18] Also, continuous intravenous infusion of opiates in higher doses may contribute to DSE.[14]

Restraints

Contrary to conventional wisdom, use of restraint actually contributes to UE. One of the most difficult decisions faced by clinicians when working with agitated, intubated patients is whether or not to physically restrain the patient. The temptation to tie down the hands of a delirious, agitated patient can be irresistible. Logic holds that when a patient's hands are secured, the pulling out of tubes is impossible. However, there is much evidence to dispute this. Studies have shown that 41-91% of patients who self-extubated had wrist restraints in place.[19] Physical restraints may actually increase agitation and restlessness due to the patient's inability to communicate feelings of powerlessness. Such powerlessness, along with altered cognition associated with critical illness, drives patients to behaviors that are beyond reason and DSE is the result. However, as discussed below, there may be situations where restraints are necessary.

Staffing patterns

Various aspects of staffing patterns are linked to UEs. Most happen when nurses are not in the patient's room so one can only speculate whether these incidents are deliberate or accidental.[17,20] Not surprisingly, when nurse workload increases, more UEs take place.[16] With fewer available nurses for a given patient census, nurses will be in patients' rooms less frequently and/or for shorter time periods, and thus increase the risk of DSE. Although many people think the majority of UEs take place at night, for the most part the time of day has no bearing on UEs. Several researchers report that UEs are fairly equally distributed across day and night shifts.[8,10,17,19,21]

Research based strategies for preventing unplanned extubation

Nurses, respiratory therapists, physicians, and other caregivers can prevent UE using a combination of research based methods. Close assessment and careful attention to the tube and patient response beginning with the time of insertion throughout the duration of intubation and ventilator support facilitate tube maintenance and achievement of therapeutic goals. Strategies include tube fixation, attention to emotional and cognitive responses and pain, staff education, and an effective quality improvement program.

Tube securing methods

Securing the tube in order to avoid accidental or self-extubation is key. A commercial tube securing device is superior to tape or twill ties in securing the endotra-

cheal tube.[22] Other advantages to commercial devices include the facilitation of oral care, allowing removal of hypopharyngeal secretions that collect above the endotracheal tube cuff and reducing the incidence of ventilator acquired pneumonia.[23] Lip and facial skin breakdown is averted with a commercial device because repeated applications of adhesive tape are unnecessary. Cleanliness of the tube securing device is maintained with the ability to wipe away secretions, a solution to the problem of moisture and stretching problems associated with tape use. The tube holder fits securely to the face, and supports the weight of the ventilator tubing without causing skin breakdown. Figures 1-3 illustrate an example of a commercially available tube holder. The base of the holder has adhesive backing on one side and is applied directly to the face above the lip; the other side has a hook-and-loop fastener strip (e.g. Velcro®). The neckband has a tube channel that fits over the endotracheal tube. The strap circles the neck and attaches to the hook-and-loop strip on the base, anchoring the tube in place. During oral care, full access of the oral cavity is accessible. This device also provides an easier and safer method of preventing lip necrosis than removing and replacing tape. Because the strap is easily detached and reattached, the device allows for more frequent assessment of the oral cavity and lip and skin assessment. In general, the adhesive backed base requires changing every three days.

Sedation

Many patients who are given endotracheal intubation describe the experience as traumatic, and often experience negative emotions such as fear, frustration, and anger.[24] Their compromised ability to communicate verbally creates feelings of helplessness and powerlessness. Thus, patients must receive some form of sedation "to take the edge off" the experience, even if they are not in pain. Gauging the proper level of sedation is as much an art as a science – oversedation can interfere with successful extubation and undersedation can risk premature removal of the tube by the patient. Clinical practice guidelines have been developed for use in managing sedatives and analgesics in critically ill patients.[25] The algorithm includes assessment of comfort and pain, anxiety and agitation, and delirium, all using validated numeric scales to promote consistency and communication between patients and caregivers. Physical and metabolic causes of obvious discomfort must first be addressed and corrected whenever possible.

Nonpharmacological interventions such as therapeutic touch, presence, verbal support and coaching, along with environmental optimization should be employed initially and throughout the intubation period. Intravenous opiates such as fentanyl, hydromorphone, and morphine are recommended for pain control. Acute agitation may be treated with midazolam, followed by continuous sedation with propofol or lorazepam. The lowest effective doses should be used to guard against the potential of oversedation or development of delirium. Doses should be titrated according to a specified goal agreed upon by the critical care team and quantified by a numerical sedation scale. A daily drug holiday is practiced in many critical care units, which assists the clinician in determining whether or not agitation is declining, warranting a reduction in sedation dosage. Delirium is best treated with haloperidol intravenously as a scheduled drug every six hours (versus "as needed").[25]

Use of Restraints

Wrist restraints may be a marker of inadequate sedation or delirium. Therefore, when initiating wrist restraints, the clinician is urged to step back and reconsider; an assessment for adequacy of sedation and presence of delirium is indicated. Better management of patient behavior with proper medications may preclude application of restraints and prevent a DSE. Clinical practice guidelines have been developed for use of physical restraints in critically ill adult patients.[26] Because of what is known about increased incidence of UEs when physical restraints are in place, and to maximize dignity, comfort, and ethical practice, restraints should be reserved for patients who are at highest risk of injury due to agitation and/or delirium and should be used only as a temporary means of control. Underlying causes of agitation should be addressed and corrected whenever possible. Often, simple measures such as repositioning the patient to relieve chronic back pain, wedged linens or catheter pressure can relieve restlessness and preclude the use of restraints. Sedatives, analgesics, and neuroleptics should be initiated and maintained as needed. Reducing environmental stimulation, encouraging the presence of family members at the bedside, and promoting sleep-wake cycles may mitigate sustained use of restraints.[26]

Figures 1-3. ET Tube Holder (Dale Medical Products)

Education

Staff education is an effective strategy for reducing UEs. One hospital was able to reduce their UE rate by nearly two-thirds in one unit and one-half in another unit.[10, 27] Multiple disciplines such as respiratory therapists, anesthesia personnel, physicians, nurses, and paramedics employed in various hospital units and departments need to participate in the education as they are all involved in intubation and management of the intubated patient. The education program should address tube securing methods such as the procedure for application of the endotracheal tube holder or a standardized taping method. This promotes uniformity among practitioners as patients travel through the hospital from the emergency department, surgery suite, and other units. Sedation, pain, and delirium scales should be part of the program to promote reliability in interpretation of the numerical scoring systems and continuity in goal setting with administration of sedatives, analgesics, and neuroleptics. Earlier recognition and treatment of delirium will also be enhanced with more caregivers skillful in the use of the scoring systems, which will contribute to lower UE rates.

Quality improvement and risk management

Vigilant assessment of UE rates to-

gether with identification of associated factors is critical to improving patient outcomes with mechanical ventilation.[27] In the author's own experience, variance reports of UE incidents have been found without details surrounding the event. Reasons for this may be explained by the fact that no one witnessed the patient self-extubate, there was no follow-up investigation, reporting tools were unavailable, and there was no formal quality program to address the issue. A database to include all UEs and extenuating circumstances is vital for evaluating processes and outcomes when caring for mechanically ventilated patients. Once the issues are identified, evidence-based interventions can then be implemented with follow-up re-evaluation to determine successes and areas needing further attention.

Conclusion

Unplanned extubation is a serious concern in the ICU. Implementation of research based approaches can assist the caregiver in the identification of patients at risk for DSE, and incorporation of methods that prevent all types of UEs. A comprehensive plan that includes tube stabilizing techniques, recognition and treatment of agitation and delirium, proper use of restraints, staff education, and a rigorous quality improvement program are all effective means of reducing the incidence of UE. Because many patients are undersedated at the time of DSE and do not require reintubation, better ways of determining readiness for extubation are needed; this is an area ripe for research. In the meantime, clinicians have access to research based strategies that provide multiple methods for preventing UE and the potentially catastrophic outcomes.

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the sentinel events. Causes cited were inadequate orientation and training process (thought to contribute in 87% of cases) and insufficient staffing levels (35% of cases).[3] Certainly, lack of training and orientation with regard to ventilator operation can breed unfamiliarity with the machine, as well as lack of recognition of when a patient may need more ventilatory support. Inadequate training could also potentially lead to barotrauma and ventilator-induced lung injury (VILI) through the use of excessive pressures and/or volumes by inexperienced users. Thus, it is imperative that clinicians be trained not only on the equipment, but also be made aware of the safe limits of ventilation. An in depth discussion of VILI is out of the scope of this paper.

Communication

The second most common factor contributing to ventilator injury and/or death was communication breakdown. In this domain, the Joint Commission determined that in 70% of the cases the communication breakdown was among staff members, such as respiratory therapists and nurses. [3] If a proper shift report is not given — especially to the night shift where staffing levels and surveillance capabilities are often reduced — then valuable information may be omitted. An example of this would be neglecting to inform the oncoming staff member that a patient has had frequent nuisance alarms requiring re-adjustment of settings outside normal standards. In this situation, a decompensation in respiratory status might not be detected before a serious situation occurs. Nurses are integral members of the multidisciplinary team and need to be informed about alarms and parameters that need immediate attention. If nurses are not told what to focus on, there is the potentially dangerous possibility of them interpreting a harmful alarm as a nuisance alarm.

The other area of communication breakdown is between the patient and family. Increased apprehension in family members can often be sensed by the patient. Ongoing family discussions with the care team serve to inform and comfort, thus reducing anxiety levels. If these discussions do not occur, the family is bound to be more anxious and nervous. This could lead to a rise in the patient's anxiety level, exacerbated by the clinical environment with all the extra lights and alarms. This could ultimately lead to an unplanned

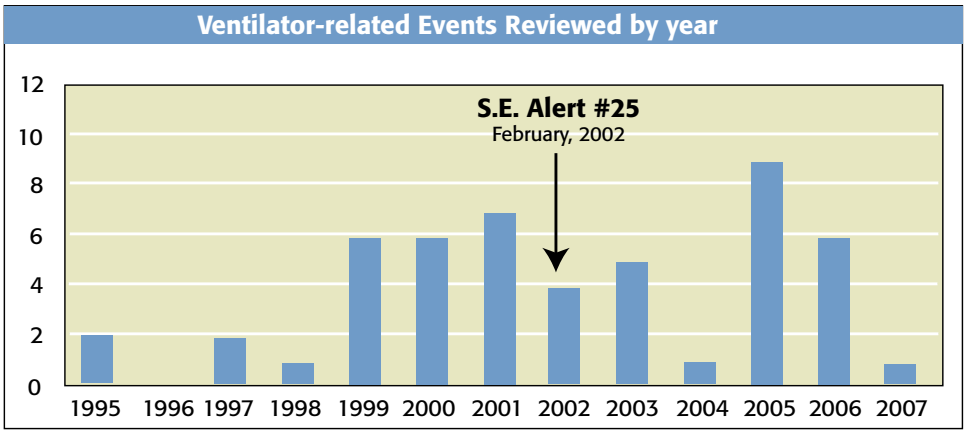

Figure 1. Ventilator-Related Events Reviewed by Year. Used with permission from JCAHO.[1]

patient-initiated extubation.

Unplanned extubations (UE's) are very real, serious, and potentially fatal events. Any patient with an endotracheal tube is at risk for a UE. Factors which increase the risk of UE include poor endotracheal tube securing, lack of appropriate intravenous sedation, and improper patient position. Certainly the less secure the endotracheal tube is, the greater the risk of an UE. Intravenous sedation can be a tricky situation. As a clinician, you want the patient to be sufficiently awake when it is time for them to participate in spontaneous breathing trials. However, you also want adequate pain control so you don't have patient-ventilator dyssynchrony. Despite being a somewhat infrequent event, UE's have been associated with prolonged mechanical ventilation, ICU and hospital stay.[4] Also, hospital survivors who have UE's during their ICU stay are more likely to require continued care than to do well enough to go directly home. (Figure 2)

Patient Assessment

The next category cited by the Joint Commission was incomplete patient assessment, 30% of which was due to poor room design that limited observation of patients. This situation is especially true in areas containing computerized tomography (CT) and magnetic resonance imaging (MRI) scanners, where staff usually has to observe patients from another room. Also, many emergency department rooms are not as conducive to patient and ventilator observation as an ICU room. Delayed or no response to an alarm and lack of recognition of a monitor change comprised 22% and 13% of incomplete patient assessments, respectively. Another hindrance to patient assessment is the placement of a patient into the prone position, either as a measure to increase oxygenation, or for facilitating a bedside procedure. When a patient is in the prone position (lying face down), adequate securing of the endotracheal tube becomes much more important and difficult. In the prone position, gravity can cause the tube to slip out. Also, the patient's saliva is likely flow out of the patient's mouth onto the tube making it more difficult to keep secured. Moreover, there is more chance of the tube becoming kinked underneath the patient. A kinked endotracheal tube will hinder and may even prevent tidal volume delivery.

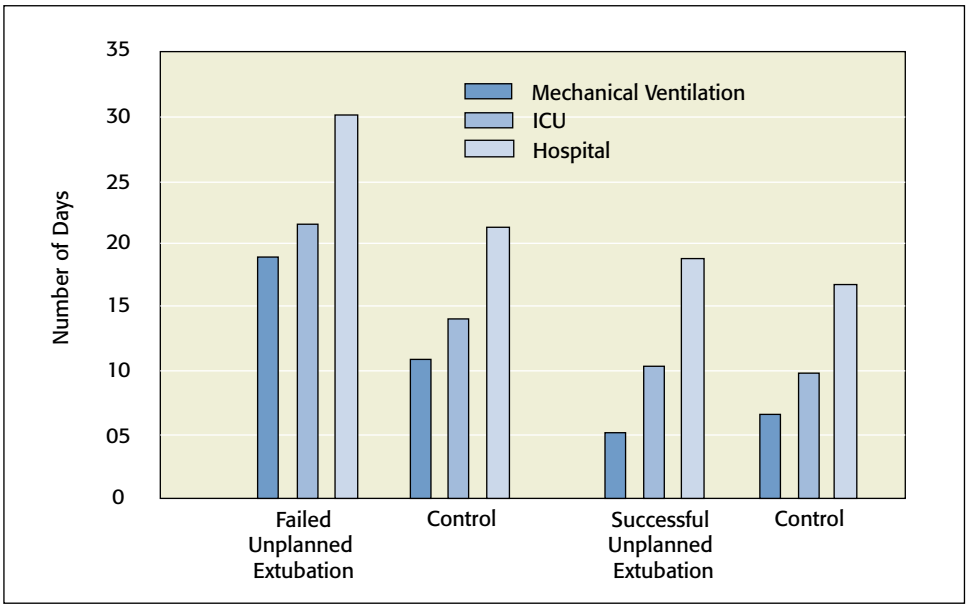

Figure 2. Comparison of duration of mechanical ventilation, ICU stay, and hospital length of stay for failed unplanned extubations, successful unplanned extubations, and their respective matched controls. Used with permission from Epstein et al. 2000.[4]

Equipment Issues

Some of the reported sentinel events were related to equipment. These included alarms that were turned off or set incorrectly (22%), no alarm for certain disconnects (22%), alarms not being audible in all areas (22%), alarms not tested for functionality prior to being placed on the patient (13%) and restraint failure leading to unplanned extubation (13%). Obviously, the lack of an effective alarm system will not alert caregivers to a change in patient status and the delay can have disastrous consequences for the patient. Patients in isolation rooms are at risk of having their ventilator alarms not being heard unless specific steps are taken, such as amplifying existing alarm systems.[5] Another potentially harmful situation is not setting the disconnect alarm correctly. Take the example of a patient receiving high ventilatory support (either high delivered pressure or volume targets) with the disconnect alarm set too low. If the endotracheal tube becomes disconnected and sits on the patient's chest, the resistance of the patient's chest may cause the flow to be high enough to generate pressures exceeding the low inspiratory alarm setting. In this case, the patient would be disconnected from the ventilator but no disconnect alarm would sound. Restraint failure is also a very significant possibility, again with disastrous results. If a patient gets a hand free, they will often go directly to the endotracheal tube and pull it out. Even though the tube may be appropriately secured, it is no match for a patient's hand.

Distraction and Cultural Factors

It was found that distraction due to environmental noise contributed to 22% of the ventilator-associated events. Noise can be from many sources but the two main culprits are loud machinery, such as a high frequency oscillator, and so called "nuisance" alarms. Nuisance alarms are those which occur frequently and usually do not affect the patient's outcome. Chambrin and colleagues discovered that the level of hemodynamic monitoring in the ICU setting is conducive to a large

number of false alarms.[6] In their study, alarms sounded every 37 minutes, 37.8% of which were ventilator alarms. A common cause of false alarms is a coughing patient or one who is anxious with a high respiratory rate and in need of sedation. A common response is to repeatedly silence the alarms or reset them to a wider range. This is the easiest solution but certainly not the safest. Ultimately, the clinical cause of false alarms should be addressed. A more dangerous situation is one in which a patient undergoes a procedure at the bedside. In some situations, drapes may be placed over the face and endotracheal tube. Much emphasis is placed on the procedure itself and less on the patient. This could lead to excessive silencing of alarms and lack of patient observation. To take this situation further, imagine a patient who is undergoing a surgical procedure involving cauterization. If the patient is receiving mechanical ventilation with high fractional inspired oxygen concentrations (FiO2) and becomes disconnected while active cauterization is taking place, there is a high potential for fire due to the oxygen enriched environment.

Cultural factors

Cultural factors were implicated in 13% of ventilator-associated events. The Joint Commission cited hierarchy and intimidation as relevant cultural factors. In areas where the core team model is used, therapists who have become comfortable in their particular domain tend to be more resistant to venturing into other patient care areas where help may be needed. Also, if a therapist has to perform in a care area outside their core domain, they may be unfamiliar with the setting and not be as attuned to the alarm sounds. Intimidation can occur in situations where a superior, such as a physician, supervisor or team leader, makes an inappropriate decision but will not tolerate a challenge to their authority. If a therapist is intimidated, they may not pursue other avenues to get the situation corrected.

Prevention Strategies

Virtually all injury and death from mechanical ventilators are preventable. Therefore, identifying risks and developing strategies to reduce these risks are paramount for patient safety. The risk factors revolve mainly around clinical staff and equipment, although location and acoustics may play a role in being able to hear alarms. Among staff-related issues are inadequate orientation, lack of ongoing training, insufficient staffing, communication breakdown, incomplete patient assessment and inadvertent extubation. Equipment-related issues include alarms being off or set incorrectly, lack of alarms for disconnects, alarms not being audible in all areas, and restraint failure. Certainly restraint failure can lead directly to inadvertent extubation.

Although life sustaining medical equipment such as mechanical ventilators are valuable tools, they are just that – tools. In essence, they are an extension of the clinician. The clinician must perform the proper calibration procedures, set the ventilation mode and all related parameters, set the alarms at appropriate levels, and ensure that the ventilator is in a suitable location.

Calibration of a ventilator is the first step in ensuring safe, therapeutic mechanical ventilation. The newer generation mechanical ventilators have more intricate and sophisticated senor arrays. Calibration generally takes place first by the ventilator, as in a self test of the internal circuitry, then by the clinician, who is required to perform a number of tests on the circuit related sensors (e.g. flow and volume readings, leak tests and circuit compliance calibration). In many cases the clinician has the option of skipping one or all of the tests with the exception of the ventilator self-test. If the clinician opts to skip the tests, then the risk of incorrect number and graphics displays increases. In the worst case scenario, the ventilator would display higher than actual tidal delivered volume and/or FiO2. The clinician would be lulled into a false sense of security and not be as quick to respond to a patient's clinical compromise because the "numbers all look good". Also if a leak test is not performed and the circuit indeed does have a leak, the patient may not receive the tidal volume that is being delivered from the ventilator. Most newer ventilators have a built in leak compensation function. However, the compensation function may just support the flow in the circuit without ensuring delivery to the patient. So, flow could be moving past the exhalation sensor without the patient receiving it. The tidal volume display could appear normal, with the actual patient tidal volume being different. If this situation goes unnoticed, it could force the patient to work harder to get the sufficient tidal volume and again could lead to hemodynamic decompensation. So, while these procedures may be somewhat time consuming, they are important to ensure proper ventilator function.

Regular ventilator maintenance is also paramount in preventing malfunction and subsequent patient injury and/or death. As with any other piece of machinery, equipment that does not receive regular maintenance checks and regular upgrades will be more prone to failure. In most hospital settings, this is the duty of the Biomedical Department, but ventilator maintenance checks should be included under respiratory monitoring. Ultimately, maintenance should be a shared responsibility between the respiratory therapist and the biomedical department.

As noted, ventilator-associated injury and death can be prevented in almost all cases. However, it does require that institutions take steps to optimize prevention. First, professionals who are responsible for the application, adjustment and monitoring of ventilators, alarm systems and artificial airways should undergo competency testing. This should involve ongoing review and improvement of orientation and training programs with job-specific, ventilator safety-related content as well as competency checks. Second, a system should be in place to ensure ventilator and monitoring system performance before and during patient application. All devices and systems should be maintained according to manufacturers' specifications. This includes both biomedical and respiratory surveillance. There should be regular preventative maintenance and testing of all alarm systems with emphasis on making sure that alarms are sufficiently audible at all working distances, and through background ICU noise. This would also require an examination and updating of alarm response procedures. A system also needs to be in place to ensure all gas delivery systems are properly maintained. Interruption in the oxygen delivery to a ventilator could have catastrophic results. Newer generation ventilators automatically switch over to air is the oxygen supply fails. However, if the patient requires an FiO2 of 1.0 and this situation occurs, the patient would only be receiving an FiO2 of 0.21. Third, protocols for the application, maintenance

Figure 3. Dale Stabilock Endotracheal Tube Holder. (Dale Medical Products, Inc.)

Figure 4. Thomas Endotracheal Tube Holder. Laerdal Medical.

and discontinuation of mechanical ventilation should be in place and updated in a timely fashion. Also, a tracking system would help identify, analyze and hopefully prevent future ventilator-related incidents that result in serious injury or death. However, this requires that adequate staffing and regular team training be in place. A mechanism to track the outcomes of all ventilator patients would also be extremely helpful. Fourth, direct observation of the ventilator-dependent patient is preferable to remote alarm setups. This may require redesigning rooms or units to improve patient observation. Fifth, a careful evaluation of the endotracheal tube securing protocol should be undertaken with respect to both the devices as well as respiratory therapist observation and documentation. Endotracheal tube position should be noted and documented in conjunction with regular respiratory therapy monitoring checks. Repositioning of the tube should be done on a regular basis. Newer securing devices that are more efficient are now available. (See Figures 3-5.) Certainly, their capacity for securing must be weighed against financial costs.

Finally, ongoing continuing education with regard to ventilators should be a requirement of all respiratory care departments. This should be targeted at the interdisciplinary team as well as respiratory therapists. Continuing education will not only increase the knowledge base, but will also serve to heighten clinical awareness with respect to patents receiving mechanical ventilation.

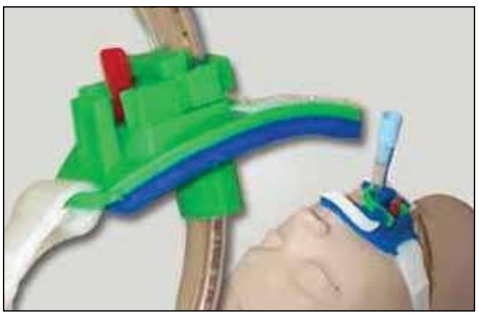

Figure 5. Grip-ET Endotracheal Tube Holder. Para Products, Inc.

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4. Describe strategies for prevention of unplanned extubation.

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1. **In 2002, JCAHO issued a Sentinel Event Alert that reported 23 cases of death or injury related to mechanical ventilators. Which of the following were identified as a cause of this?**
   a. Ventilator alarm malfunction or misuse
   b. Disconnected ventilator tubing
   c. Ventilator malfunction
   d. A & B
2. **Factors which contributed to the sentinel events include all of the following except:**
   a. Incomplete patient assessment
   b. Clinician distraction
   c. Family Intervention
   d. Communication breakdown
3. **Which of the following has the potential to the increase the risk of an unplanned extubation?**
   a. Improper patient position
   b. Lack of appropriate sedation
   c Inproper tube securement
   d. All of the above
4. **When you encounter repeated "nuisance" alarms what action should you take to alleviate the situation?**
   a. Keep pushing alarm silence
   b. Expand the alarm ranges on the ventilator
   c. Determine the cause
   d. B + C
5. **Equipment issues that could increase the risk of death or injury include which of the following?**
   a. Alarms not tested for functionality prior to the ventilator being placed on the patient
   b. Inability of the caregiver to hear the alarm (volume too low or ventilator location)
   c. Alarms set incorrectly
   d. All of the above
6. **Which of the following staffing issues contributed to the reported sentinel events?**
   a. Inadequate orientation
   b. Inadequate ongoing training
   c. Quality assurance initiatives that interfere with the workload
   d. A & B
7. **Strategies to prevent death and/or injury from the ventilator should include:**
   a. Optimizing the orientation program
   b. Examining staffing levels and workload distribution
   c. Emphasis on interdisciplinary communication
   d. All of the above
8. **What is/are advantage(s) to utilization of an endotracheal tube securing device?**
   a. Ease of oral hygiene, reduction in lip necrosis
   b. Families are better able to participate in hygiene measures
   c. Reduces oral and skin infections
   d. Facilitates communication, reduces discomfort
9. **Use of physical restraints reduces the risk of unplanned extubation.**
   a. True
   b. False
10. **Most patients who self-extubate do not require re-intubation.**
    a. True
    b. False
11. **What are the key benefits to an education program designed to reduce unplanned extubations?**
    a. Nurses can earn necessary education contact hours
    b. Respiratory therapists can learn from nurses
    c. Consistency in endotracheal tube securing methods
    d. Reduced dosages of sedatives
12. **What should be done when a patient self-extubates?**
    a. Immediately reintubate and draw arterial blood gases
    b. Administer a topical anesthetic into the vocal cords
    c. Evaluate the sedation level
    d. Investigate extenuating circumstances and enter into a database
13. **How is delirium best treated in critically ill patients to prevent extubation?**
    a. Administration of haloperidol intravenously
    b. Application of physical restraints
    c. Assessment with a select sedation scale
    d. Providing a bedside sitter
14. **When securing an endotracheal tube, what is an important consideration?**
    a. Using consistent length of cloth ties
    b. A device that supports the weight of the ventilator tubing
    c. The ability to remove adhesive from the face on a daily basis
    d. A device that provides nasogastric suction

What is the highest degree you have earned (circle one) ? 1. Diploma 2. Associate 3. Bachelor's 4. Master's 5. Doctorate

Indicate to what degree you met the objectives for this program: Using 1 = strongly disagree to 6 = strongly agree rating scale, please circle the number that best reflects the extent of your agreement to each statement.

	Strongly Disagree					Strongly Agree
1. Identify the prevalence of obesity	1	2	3	4	5	6
2. List surgical options available in managing issues of redundant skin	1	2	3	4	5	6
3. Outline pre-, intra- and post-operative care for patients having reconstructive surgery	1	2	3	4	5	6
4. Discuss the evidence for performing a tracheotomy on a mechanically ventilated patient earlier, rather than later in the course of ventilation, as it relates to outcomes and liberation from mechanical ventilation.	1	2	3	4	5	6
5. Explain the differences between the two types of tracheostomy procedure percutaneous dilation and open surgical	1	2	3	4	5	6

Name & Credentials _____
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City _____ State _____ Zip _____
Phone _____ Fax _____
Email Address _____
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Mark your answers with an X in the box next to the correct answer

	A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	9	☐	☐	☐	☐
2	☐	☐	☐	☐	10	☐	☐	☐	☐
3	☐	☐	☐	☐	11	☐	☐	☐	☐
4	☐	☐	☐	☐	12	☐	☐	☐	☐
5	☐	☐	☐	☐	13	☐	☐	☐	☐
6	☐	☐	☐	☐	14	☐	☐	☐	☐
7	☐	☐	☐	☐	15	☐	☐	☐	☐
8	☐	☐	☐	☐	16	☐	☐	☐	☐

How long did it take you to complete this home-study program? _____

What other areas would you like to cover through home study?

_____

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