Examining the Evidence to Guide Practice: Challenging Practice Habits

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Nurses are the largest segment of the nation's health care workforce, which makes nurses vital to the translation of evidence-based practice as a practice norm. Critical care nurses are in a position to critically appraise and apply best evidence in daily practice to improve patients' outcomes. It is important for critical care nurses to continually evaluate their current practice to ensure that they are applying the current best evidence rather than practicing on the basis of tradition. This article is based on a presentation at the 2013 National Teaching Institute of the American Association of Critical-Care Nurses. Four practice interventions that are within the realm of nursing are critiqued on the basis of current best evidence: (1) turning critically ill patients, (2) sleep promotion in the intensive care unit, (3) feeding tube management in infants and children, and (4) prevention of venothromboembolism . . . again. The related beliefs, current evidence, and implications for practice associated with each topic are described. (*Critical Care Nurse*. 2014;34[2]:28-30,32-46)

In 2001, the Institute of Medicine challenged all health care professionals to decrease variation in practice through adoption of practice interventions based on best evidence to improve patients' outcomes.[1] Current reviews of clinical practice suggest that only 10% to 15% of clinicians consistently implement evidence-based care[2] and indicate that it may take up to 2 decades for original research to be put into routine clinical practice.[3] It is well established that evidence-based practice (EBP) is associated with higher quality care and better outcomes for patients than care that is steeped in tradition.[4] Yet at times, clinicians continue to practice on the basis of tradition.[5]

CNE Continuing Nursing Education

This article has been designated for CNE credit. A closed-book, multiple-choice examination follows this article, which tests your knowledge of the following objectives:

1. Articulate the benefits of implementing evidence-based practice
2. Differentiate between evidence-based practice and nursing care that is steeped in tradition
3. Distinguish strong evidence from lower levels of evidence that are used to guide practice

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Nurses are the largest segment of the nation's health care workforce practicing on the front lines with patients,[6] making nurses vital to the translation of EBP as a practice norm. Nurses are in a position to critically evaluate and apply the evidence in daily practice to improve patients' outcomes. Nurses need to stop using practice interventions that are based solely on tradition.[5] Details of essential steps used to critically evaluate and apply the evidence into practice have been outlined in previous articles about interventions in critical care nursing practice that may not be based on current best evidence.[7-10] As health care professionals, each of us is responsible for exploring new knowledge to guide practice, diffusing evidence into practice, and working with our critical care team to develop a process for effective dissemination and adoption of best evidence as part of daily practice.[11] One essential step in examining the evidence is evaluating the strength of the evidence so that strong evidence (ie, research-based recommendations) is preferentially considered over lower levels of evidence (ie, opinion papers).[12]

This article explores current evidence on 4 interventions within the nursing practice domain and asks nurses to review and apply best evidence to guide practice. The topics addressed are (1) turning critically ill patients, (2) sleep disruption in the intensive care unit (ICU), (3) feeding tube management in infants and children, and (4) prevention of venothromboembolism. Current evidence and implications for practice associated with each topic are described.

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Turning Patients Every 2 Hours

There are many "stories" about the origin of turning patients every 2 hours, and nursing textbooks dating back to the early 1900s instructed nurses to remove pressure on extremities by repositioning patients as frequently as every hour.[13] Repositioning is the act of turning or actively shifting body weight to relieve pressure from an underlying surface.[14-16] Turning patients every 2 hours is the accepted standard for practice. What is the evidence supporting the practice of turning patients every 2 hours?

Reviewing the Evidence

Should patients be turned at least every 2 hours? The short answer is yes. Although turning the patient every 2 hours is an expected standard in caring for an immobile patient, the research science supporting turning frequency is limited.[14,17-19] However, nonresearch evidence such as expert opinions and professional standards of care support turning every 2 hours as an important intervention to reduce complications from immobility.[19,20] Turning as an intervention has 2 functions: mobilize the body (ie, promote cardiovascular tone, prevent venous stasis, improve muscle strength and pulmonary function, and enhance mentation) and relieve pressure (ie, prevent pressure-associated skin breakdown [pressure ulcers]). In a clinical article from 1967 titled "The Hazards of Immobility," Olson et al[21] review the adverse effects of immobility on body systems and include turning and early mobility as essential nurse-driven interventions to prevent poor outcomes for patients. In a more current review of the evidence, Johnson and Meyenburg[22] articulate the physiological support for turning immobilized patients to optimize perfusion and ventilation.

It has been reported that people naturally shift their body position about every 12 minutes.[23] Sensory cues prompt repositioning or shifting of body weight; thus, when individuals either cannot respond to the sensory cues because of critical illness or lack the cues because of neurological injury, the person is dependent on others for turning.[15,18,19,22]

Studies specifically examining the effects of turning every 2 hours were initially conducted in healthy adults[24,25] and later in hospitalized older adults.[26] More recent research[27-29] and several Cochrane reviews[30,31] have explored the frequency of turning, specialty bed support surfaces, and the development of pressure ulcers. Because of differences in study designs, conclusive decisions cannot be drawn from the evidence.[14,17,30] However, clinical practice implications based on research, review papers, and expert opinion suggest the following: patients at higher risk of complications from immobility could benefit from use of specialty bed support surfaces rather than the standard ICU bed,[16,29-31] heels should always be suspended,[14,19] and increased acuity of a patient should drive turning frequency, which may include small shifts in weight and/or hourly repositioning.[14,19,20,30-33]

Although results of some studies suggest that turning frequency may be reduced (leaving the patient in the same position for longer than 2 hours) for select patients when specialty bed support surfaces are used,[16,27] current national practice guidelines recommend that, at a minimum, regardless of bed surface, the nurse should consistently assess the patient's risk for pressure-related skin injury and turn the patient at least every 2 hours.[19,20,32] The science on turning patients who are on special bed surfaces continues to be examined.[16,27,29] Many types of support surfaces are available (eg, low air loss, air fluidized, fluid-filled, foam, fluid immersion), and specific indications are beyond the scope of this discussion. Readers are referred to the National Pressure Ulcer Advisory Panel (www.npuap.org) for upcoming information on this organization's efforts to standardize support surface technology. What is supported in the evidence is that even if specialized bed support surfaces are used, repositioning remains a necessary intervention to prevent pressure ulcers from developing.[14,16,19,20,27,29,30,34]

Evidence on the effectiveness of continuous lateral rotation therapy and skin outcomes is lacking. Continuous lateral rotation therapy is for pulmonary indications (eg, deteriorating ratio of PaO_2 to fraction of inspired oxygen, acute pulmonary injury).[22,35-37] Research is needed to explore the effectiveness of continuous lateral rotation therapy and skin pressure reduction. Manufacturers' guidelines suggest that current hospital standards for skin assessment should be followed when continuous lateral rotation therapy is used for pulmonary indications.[35]

Several challenges in meeting frequent turning standards have been reported.[14,38-41] Challenges include patients' hemodynamic instability, patients' obesity, lack of equipment and peers to reposition patients effectively, and time.[14,21,38-41] No reports explain why critically ill patients are not repositioned every 2 hours, but the challenge remains for nurses to turn patients frequently as recommended in national guidelines. Turning is considered an essential intervention to mitigate complications of immobility[18] and prevent pressure ulcers.[15,19,20,32] Although the research science is limited, the overall evidence and national guidelines support that turning every 2 hours is an essential intervention to prevent poor outcomes for patients. More importantly, the frequency of turning may need to be increased, depending on the patient's acuity.[14,15,18-20,33]

Turning critically ill patients is the first step to mobilizing patients. The American Association of Critical-Care Nurses (AACN) early progressive mobility protocol incorporates turning as a first step in the collective effort to get patients mobile and reduce the hazards of immobility.

Implications for Practice

It is not clear from research studies whether there is an optimal turning frequency, especially for critically ill patients. Research science on the optimal turning schedule continues to be examined. However, clinical evidence is cited in national guidelines and expert opinions to recommend frequent turning (defined as every 2 hours) of immobile patients.[14,15,18-20,30-33] Increased frequency of turning should be driven by the nurse's assessment of the patient's risk for pressure ulcer injury (ie, Braden risk score).[19,31] Nurses should strive to turn patients every 2 hours; however, if hemodynamic instability is a concern or the Braden risk score is low, more frequent weight shifts are indicated to relieve pressure and prevent adverse outcomes for patients.[14,17-20,32,33] Critical care nurses are in an ideal position to advocate for the use of support surface therapies if warranted by the severity of the patient's illness and associated immobility. Frequent turning along with good skin care practices, providing nutritional support, and encouraging early mobility are evidence-based nurse-driven interventions to optimize patients' outcomes.[14,17,19,20,29-33] Turning every 2 hours is a practice standard that reduces complications of immobility and is an important intervention for preventing pressure ulcers. Patients may need to be turned more often than every 2 hours, depending on the patient's severity of illness and driven by nursing assessment.[14,17,19,20,29-33]

Turning patients every 2 hours is essential to prevent poor outcomes; in fact, some patients may need to be turned more often, depending on the severity of the illness.

Promoting Sleep in the ICU

Sleep is an essential function, as many physiological changes that contribute to growth and the maintenance of homeostasis occur during sleep. However, the ICU environment is not very conducive to enhancing sleep in critically ill patients.[42] The combination of ICU patient care routines (eg, frequent laboratory tests, invasive procedures, fully supportive care), the ICU environment (eg, equipment, alarms, light), and frequent visitation (providers and family) contributes in many ways to sleep disruption for ICU patients.[43-47] Regardless of the cause of sleep disruption, the consequences of lack of sleep include worsening symptoms, physical and cognitive dysfunction, mood instability, and fatigue.[42,43,45,46] This situation raises the question: Why are we, as critical care nurses, disrupting the sleep of patients who are at most risk for complications related to lack of sleep? As much as possible, nurses need to restructure their work flow and environment to maximize sleep of critically ill patients.

Reviewing the Evidence

To explore traditions in practice that interfere with sleep, we must first understand the physiology of sleep. The suprachiasmatic nucleus, located in the hypothalamus, regulates sleep through complex interactions of neurotransmitters in the suprachiasmatic nucleus stimulated by light entering the retina, melatonin, and neural pathways, creating circadian rhythms and our sleep-wake cycle.[44] Normal sleep architecture consists of 2 key phases; non–rapid eye movement (NREM) and rapid eye movement (REM) sleep. NREM sleep has 3 stages; stage N1 (light sleep), stage N2 (moderate sleep), and stage N3 (deep sleep or slow wave sleep). REM sleep, the fourth stage, is considered the most restorative and valuable stage of sleep.[48] Most people spend 75% to 80% of their sleep time in NREM sleep, and 20% to 25% in REM sleep, and will cycle through these 2 phases about 4 to 6 times throughout the night, spending 90 to 100 minutes per cycle.[45,48] Thus interrupting a patient's sleep every 60 minutes prevents a patient from achieving true restful sleep.[45,46]

Sleep and sedation differ markedly. Sleep is a natural and essential biological process, whereas sedation is not natural and does not support normal sleep patterns.

Several methods can be used to measure sleep (eg, polysomnography, electroencephalography, bispectral index, actigraphy)[45,46,49] in combination with or without direct observation and patients' self-reports. Limitations in the use of sleep assessment technology and communication challenges with critically ill patients contribute to the difficulty of measuring sleep in ICU patients.[49] What is known about sleep is that patients in the ICU have fragmented sleep, often experiencing multiple sleep-wake cycles that fail to reach N3 or restorative REM stage sleep.[43,44,50,51]

The connection between sleep deprivation and delirium has particular importance in the ICU practice environment.[43,44,52,53] Many ICU patients are at risk of experiencing both sleep deprivation and delirium, especially elderly patients and/or patients receiving mechanical ventilation.[53] Delirium has been independently associated with increased mortality, greater long-term cognitive impairment, and increased health care costs.[53-56] Although the causal relationship between sleep deprivation and delirium continues to be researched, what is known is that both conditions share similar mechanisms, risk factors, and symptoms.[44,45,52-54] Circadian rhythm disturbances, effects of sedating and analgesic agents, and inattention occur with both delirium and sleep deprivation.[44,45,52,54-57] Although the overall magnitude that sleep disruption has in relation to delirium is unknown, current evidence supports that optimizing sleep is an important intervention for reducing the incidence of delirium.[45,54,56] Last, lack of quality sleep can result in other psychological disturbances such as depressive symptoms, fatigue, anxiety, and stress.[58,59]

Lack of sleep adversely affects the immune system, resulting in catabolic states and cytokine dysfunction.[44,60] Much of the evidence has been studied in animal models; the relationship between sleep deprivation and immune function in humans is less clear.[44,61] Research examining the impact of sleep deprivation on humans indicates that cytokines, the key messengers of the immune system and cellular immunity, can be disrupted.[52] The immune system has its own circadian rhythm that is dependent on cytokine-induced feedback loops between the suprachiasmatic nucleus and peripheral clocks.[60] Specific cytokines are associated with sleep: cytokines that enhance sleep (interleukins 1, 2, 8, and 18, tumor necrosis factor-α, interferon-γ), cytokines that inhibit sleep (interleukins 4, 10, 13, transforming growth factor-β), and cytokines that have a mixed influence on sleep (interleukin 6, interferon-α).[60] Cytokines rely on T cells for their production. When the immune system is under stress, T-cell production can be compromised, cytokine production decreases, and normal sleep patterns are affected. Sleep deprivation may also create a shift in immune activity away from humoral immunity and toward cell-mediated immunity, creating an imbalance in immune function.[60,62] This imbalance can place already compromised critically ill patients at further risk. Last, sleep deprivation stimulates the release of hormonal mediators (eg, cortisol and catecholamines), which can intensify the stress response seen during critical illness.[44,63]

Other factors that contribute to sleep deprivation include environmental factors (light and noise), sedation, ventilators, and nursing interventions. When one considers environmental factors, the noises most commonly reported to be disruptive to patients include staff conversations, alarms, overhead pages, telephones, televisions, and family.[44,47,51,64-67] The Environmental Protection Agency recommends maximum hospital noise levels to be 45 decibels (dB) during the day and 35 dB at night.[68] The average ICU routinely has a noise level of 80 dB, which contributes to sleep disruption.[43,45,69] Bundled interventions to reduce noise or implementing mechanisms to isolate noise, such as offering patients earplugs, should be considered to address excessive environmental noise in the ICU.[65-67] Research indicates that light may disrupt sleep because of its role in circadian rhythm and melatonin release,[70] but patients report that noise and patient care activities are more disruptive to sleep, especially when patients are more alert.[43,70-72]

Similarities between sleep and sedation include reduced responsiveness, reduced muscle tone, respiratory depression, and temperature deregulation.[49,50] However, sleep and sedation differ markedly. Sleep is a natural and essential biological process, with cyclical sleep architecture contributing to physiological restoration, whereas sedation is not natural and does not support normal sleep patterns.[50] Sleep can be reversed by external stimuli, whereas sedation cannot, and norepinephrine release is decreased during sleep but continues to be released during sedation.[50] Sedation also may adversely affect sleep. γ-Aminobutyric acid agonists (ie, benzodiazepines and propofol) increase patients' total sleep time but reduce their REM sleep, and α_2 agonists (ie, dexmedetomidine) increase the patient's slow wave sleep (N3) and may reduce the incidence of delirium.[50] Sedation may increase the total sleep time, but the lack of normal sleep architecture, reduction in REM sleep, and disorganization of circadian rhythmicity and sleep-wake regulation contribute to sleep deprivation.[49] Other medications that can impair sleep include antipsychotic agents, β-blockers, proton pump inhibitors, H_2 blockers, antibiotics, antidepressants, corticosteroids, vasopressors, and antiasthmatic agents.[45] Additionally, some medications such as sedatives, nicotine, alcohol, and opiates can create withdrawal insomnia.[45]

Mechanical ventilation disrupts sleep in many ways. Discomfort of the endotracheal tube, uncomfortable set respiratory rates, ventilator alarms, reduced total REM sleep, and dyssynchrony with the ventilator all contribute to sleep disruption.[44,46,47,51,73] Studies that explored the relationship between sleep and ventilator mode showed that sleep was less fragmented with assist-control ventilation or pressure-controlled ventilation than in pressure support mode.[73-75]

Nurses play a vital role in improving their patient's sleep and limiting sleep disruption. However, nurses can be limited by preconceived notions of what a sleeping patient looks like. A study of nursing perceptions of sleep in the ICU found that most nurses (>80%) considered the patient to be sleeping if the patient's eyes were closed and the heart rate, respiratory rate, and blood pressure were decreased.[76] Nurses in that study[76] also believed that the average ICU patient slept moderately well and that noise was the predominant factor affecting sleep. Another study[77] of nursing care showed that a mean of 42.6 care interactions occurred at night, with 62% of baths occurring between the hours of 9 PM and 6 AM, limiting overall sleep time. Nurses should question unit practices that encourage bathing patients during optimal sleep times, consider clustering care, limit unnecessary conversations at the bedside, and manage alarms. Critical care nurses can optimize the sleep environment by restructuring work-flow habits.

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Implications for Practice

Critically ill patients in the ICU can experience significant sleep disruption, reduced REM sleep, and increased arousals and awakenings.[43,44,50,52,78,79] This fragmented

Table 1 Factors that influence sleep and suggested nursing interventions

Factors that influence sleep	Interventions
Environmental factors	Reduce environmental noise (alarms, equipment, television, telephones, overhead pages, conversation)[43-45,51,64,67,69] Reduce light exposure during sleep time; dim lights[43,51,67] Provide patient and their family members with education about sleep promotion Consider ear plugs to reduce environmental noise[65,66]
Delirium	Regularly assess patients for delirium by using a valid and reliable tool[56] Promote a consistent sleep/wake cycle[53,56] Provide reorientation as needed[56] Provide hearing, vision, and communication tools as needed Implement nurse-driven early mobility protocols
Mechanical ventilation	Assess for endotracheal tube discomfort[44] Limit dyssynchrony with the ventilator[44,75] Consider assist-control ventilation versus pressure support modes[73,74]
Medications	Assess for medications that impair sleep: antipsychotics, β-blockers, proton pump inhibitors, H_2 blockers, antibiotics, antidepressants, corticosteroids, vasopressors, antiasthmatics, benzodiazepines, γ-aminobutyric acid agonists[45] Assess for medications that can cause withdrawal insomnia: sedatives, nicotine, alcohol, opiates[45]
Sleep/wake cycle	Ask the patient and/or family what the patient's regular sleep/wake cycle is to adapt care Promote consistent sleep and awake periods Encouraging activity helps with sleep hygiene[81]
Sedation	Limit use of sedatives when possible to promote improved sleep architecture[53,56,57] Limit the use of benzodiazepines[56,57] Assess the patient for signs of sleep deprivation and/or delirium[53,56,57]
Complementary therapies	Use massage, music, acupressure, and/or aromatherapy to enhance relaxation[82,83]
Nursing care interactions	Assess the patient for sleep deprivation even if the patient appears to be sleeping (eg, eyes closed, vital signs stable)[76] Cluster care when possible[67] Consider care schedules that optimize sleep/wake cycle (eg, bathing time, procedures, vital signs) Consider using nurse-driven sleep protocols[76,82]

sleep puts patients at risk for impaired recovery and other complications like delirium.[50,53] Nurses can improve the patient's sleep cycle through modifications of the environment (eg, reduce noise and light), clustering care to minimize sleep disruptions, limiting sedation, optimizing mechanical ventilation modes that enhance sleep, and assessing for the presence of signs of delirium.[47,51,65,80] Early mobility may also enhance sleep.[81] Complementary therapies such as massage, music, aromatherapy, and acupressure enhance relaxation and may reduce activation of the sympathetic nervous system, thereby enhancing sleep.[45,82,83] Last, development of nurse-driven sleep protocols can provide consistent medical and nonmedical interventions that promote sleep. Table 1 provides a list of factors that can influence sleep and suggested interventions to enhance sleep. Clinicians should be vigilant about sleep enhancement through patient-centered approaches that enhance optimal ICU recovery.

Best Methods to Prevent Harm When Inserting Feeding Tubes and Verifying Placement in Infants and Children

Insertion and maintenance of a nasogastric tube or orogastric tube is a common nursing practice in critically ill neonates and children. In 2005, the AACN published a practice alert[84] on verification of feeding tube placement; the practice alert was revised in 2009.[85] The alerts provided evidence-based recommendations for expected practice; however, only 2 citations supporting these documents were from pediatric publications. To ensure optimal outcomes for children, nurses must use age-specific evidence, when it exists, to guide practice rather than extrapolating from evidence in adults.

The reported incidence of gastric tube misplacements in neonates ranges from 38% to 61%[86,87] and from 20.9% to 43.5% in infants and children.[88-90] Feeding through a tube in which any of the orifices are in the respiratory tract or esophagus can result in aspiration and related sequelae such as pneumonia.[91-93] When a feeding tube intended to be positioned in the stomach is inadvertently positioned past the pylorus and the child is fed complex formulas requiring gastric enzymes for complete digestion, malabsorption can occur, leading to inadequate weight gain, diarrhea, and dumping syndrome.[94,95] Reported complications of malpositioned feeding tubes in infants and children include pneumothorax,[96] hydropneumothorax,[97] esophageal perforation,[98,99] urinary bladder perforation,[99] and death.[100,101]

Ensuring safe and effective feeding via nasogastric tubes requires the nurse to initially insert the tube to the correct place and periodically confirm that the tube remains in the intended location. Even if a nasogastric tube is positioned correctly upon insertion and secured, the distal tip can migrate forward or backward from its original position.[102-104] Because nasogastric tubes can be misplaced on insertion or subsequent to initial placement, 2 related traditions in practice will be discussed. The first is associated with morphological measurement used to predict insertion length. The second is the use of auscultation and other singular bedside methods to verify placement of nasogastric tubes.

Reviewing the Evidence: Predicting Insertion Length

Current practices for predicting insertion length and verifying placement vary. A 2008 survey of children's hospitals reported variability in insertion and verification procedures.[105] Respondents reported using auscultation, gastric pH, aspirate color, length of external tubing, and radiography as verification methods. Several hospitals reported using only a single method to verify placement. A 2013 survey of 15 California neonatal ICUs also demonstrated variability in insertion and verification procedures (Jonathan Duncan, e-mail communication, January 17, 2013). Radiography, sampling of gastric aspirates, and auscultation were the most commonly reported methods for verifying placement, with no description of what type of assessment was made of the aspirates.

Two morphological measurements for predicting insertion length have been described. One method is to measure from the tip of the nose (or the corner of the mouth for an orogastric tube) to the ear lobe and then to the xiphoid process (nose-ear-xiphoid [NEX] method[106]). The second method is to measure from the tip of the nose to the ear lobe to a point midway between the xiphoid process and the umbilicus (nose-ear-mid-umbilicus [NEMU] method). Other measurement methods, such as measuring from the bridge of the nose to the earlobe to the xiphoid process, nose around the ear to the 10th rib, and nose to umbilicus have been mentioned in the literature[107] but lack any supportive evidence.

In premature infants, the NEMU method is superior to the NEX method for correct prediction of tube placement.[87,108-110] In a study[87] comparing the NEX method with the NEMU method in 60 premature infants; 55.6% of tubes placed by using the NEX method were incorrectly placed, whereas 39.3% of tubes placed by using the NEMU method were incorrectly placed. Tedeschi et al[108] reported that the NEMU method was predictive of correct placement in 95% of premature infants. Additionally, malpositioning of tubes placed in infants and children by using the NEX method was reported in 25% to 50% of cases.[109,110]

More recently, age regression equations that use height/length in age groups (age-related, height-based [ARHB]) as predictors of optimal placement have been described. Beckstrand et al[107] studied how accurate morphological measures were for predicting insertion length compared with regression equations on height in 494 children 2 weeks to 19 years old. This was the first study of a large sample of children to demonstrate the accuracy of age-specific height/length-based equations. The authors concluded that approximately 96.6% of nasogastric and orogastric tubes placed by using these equations would be placed in the stomach. The NEMU method approached the accuracy of the regression equations, and the NEX method provided predictions that often would have resulted in malpositioned tubes.

> Either the age-related, height-based (ARHB) equation method or the nose-ear-mid-umbilicus (NEMU) method should be used to predict insertion length of nasogastric tubes in infants and children.

Building on previous research, Ellett et al[111] compared the ARHB, NEX, and NEMU methods in 173 neonates of less than 1 month corrected age. All tubes placed by using the ARHB method were correctly placed in the stomach, duodenum, or pylorus, compared with 92% of the tubes placed by using the NEMU method and 61% of the tubes placed by using the NEX method. When a stricter definition of correct placement was applied

Table 2 Age-related height-based equations for predicting feeding tube insertion length[111,112]

Insertion site	Age, months	Equation for calculating insertion length, cm
Orogastric	1-28	13.3 + (0.19 x height in cm)
	29-100	16.8 + (0.19 x height in cm)
	>100	15.1 + (0.22 x height in cm)
Nasogastric	<1	1.95 + (0.372 x height in cm)[a]
	1-28	14.8 + (0.19 x height in cm)
	29-100	18.3 + (0.19 x height in cm)
	>100	16.6 + (0.22 x height in cm)

[a] This equation assumes that all orifices of the tube are within 1.5 cm of the distal tip.

(placement in stomach), 78% of tubes placed by using the ARHB method, 91% of tubes placed by using the NEMU method, and 61% of tubes placed by using the NEX method were correctly placed. When tubes were placed by using the NEX method, 39% of tubes had the tip in the esophagus or gastroesophageal junction. Similar findings were reported in a study[112] that involved 103 children 1 month to 17 years old: 89% correct placement of tubes in the stomach when the ARHB method was used, 86% correct placement with the NEMU method, and 59% correct placement with the NEX method. The AHRB equations used by Ellett et al are displayed in Table 2.

Implications for Practice: Predicting Insertion Length

One practice to achieve safe tube feeding in infants and children is to use the most accurate method to predict insertion length. Current best evidence indicates that either the ARHB method or the NEMU method should be used to predict insertion length.[107,111,112] The ARHB method can be implemented either by entering the equations into the hospital's electronic health record or by referring to published tables.[111,112] A robust repository of evidence exists to advocate for the retirement of the NEX method for determining insertion length for the placement of feeding tubes in infants and children.[87,108-112]

Reviewing the Evidence: Methods of Verifying Placement

Radiography is considered the reference standard for verifying feeding tube placement[89,113] and is the recommended method for verification of initial placement in children and adults.[85,95] Tube location must be routinely confirmed after placement to determine if the tip has migrated out of position. Routine use of radiographic confirmation is not practical because of concerns about radiation exposure and cost, so nurses must rely on methods that can be used at the bedside. To prevent harm, the nurse must understand the usefulness, limitations, and in some cases, the futility, associated with these methods.

Auscultation. The presence of a "whoosh" sound heard over the epigastrum during air insufflation though a feeding tube is the traditional method used to confirm placement and continues to be used by pediatric nurses despite evidence in the adult literature of its lack of reliability for detecting misplacement in the lungs.[105,114] Researchers in 1 study[86] reported that when nurses verified placement of nasogastric tubes in neonates by using auscultation, radiographic evidence indicated that 47.5% of these tubes were not in the correct place, with 7.1% of tubes having orifices in the esophagus. In infants and children, reported error rates with auscultation range from 3.4% to 50%.[109,110] Additionally, numerous case reports in children describe instances of malpositioned tubes in the esophagus or respiratory tract that went undetected by auscultation, leading to aspiration,[115] pneumothorax,[100] pulmonary hemorrhage,[100] pulmonary perforation,[97] esophageal perforation, and death.[97,100] A significant problem with auscultation is that sounds can be transmitted to the epigastric area, regardless of the location of the tube tip; this concern is even more exaggerated in infants and young children because of their smaller torsos. Evidence in pediatric publications supports the principle that auscultation is not reliable for distinguishing between respiratory and gastric placement, nor can it be used to differentiate gastric from intestinal placement.[86,109,110]

Carbon Dioxide. Capnography (measuring exhaled carbon dioxide levels) and capnometry (colorimetric indicator of end-tidal carbon dioxide level) have been used to measure and detect carbon dioxide from the distal end of feeding tubes in adult patients. Respiratory placement of feeding tubes in adults has been detected correctly with both methods.[93,116-119] Ellett et al[89] reported on the use of capnography in 72 children less than 7 years old. No respiratory placements of tubes were detected in their sample, and carbon dioxide levels were 0 mm Hg in 71 cases and 2.0 mm Hg in 1 case, suggesting that absence of or minimal levels of carbon dioxide indicates enteral placement. The lack of an established cutoff value to differentiate respiratory from enteral placement limits the usefulness of capnography at this time.[89]

Gilbert and Burns[120] demonstrated that a colorimetric device was successful in detecting carbon dioxide during insertion of a nasogastric tube in infants and children. In their study, once carbon dioxide was detected, the tubes were removed immediately and tube placement was not verified radiographically. When the device did not detect carbon dioxide, all tubes were associated with gastric placement. A factor to consider when interpreting these results is that the detection of carbon dioxide does not necessarily mean that the tube entered the respiratory tract. Crying and gulping may result in swallowed carbon dioxide with subsequent detection by capnography or capnometry.[95,120] Although capnometry may be helpful in detecting inadvertent respiratory placement of feeding tubes, it is not useful for discriminating between esophageal, gastric, or intestinal placement and thus has limited usefulness in confirming tube placement.[89,121]

Bilirubin, Pepsin, and Trypsin. Testing of aspirates for bilirubin, trypsin, and pepsin has been studied in adults and children under the premise that the concentration of these substances varies depending on the location of the feeding tube. Bilirubin and trypsin are present in high amounts in the intestine, whereas pepsin is present in high concentrations in the stomach. Aspirates with bilirubin levels of 5 mg/dL or greater, pepsin levels less than 100 μg/mL, and trypsin levels greater than 30 μg/mL have been associated with intestinal placement in adults.[122,123] Although some researchers have reported similar results in neonates and children for bilirubin,[124,125] others have failed to find a bilirubin concentration of 5 mg/dL or greater to be predictive of tubes placed in the duodenum.[89] Bilirubin may be helpful to identify postpyloric placement; however, bilirubin results, on their own, do not enable discrimination between esophageal, gastric, and respiratory placement of feeding tubes.

Several researchers have reported that gastric secretion of pepsin is much lower in infants, especially those less than 3 months old, than in adults, with levels highly variable up to 1 year of age.[126-128] This maturational difference was confirmed by Gharpure et al,[124] who reported that pepsin levels of 20 μg/mL or less as well as trypsin levels of 50 μg/mL or greater were associated with aspirates from intestinal tubes. Westhus[129] reported that pepsin levels greater than 20 μg/mL and trypsin levels less than 50 μg/mL are good predictors of gastric placements of feeding tubes; however, negative results were not good predictors of intestinal placement. The inconclusive evidence of the predictive value of bilirubin, pepsin, and trypsin levels, coupled with the lack of a bedside test for these substances, limits the clinical usefulness of such measurements at the bedside for assessing tube placement.

pH. Gastric aspirate pH is easily measured at the bedside, and measurement of the pH of gastric aspirates has been studied as a method of confirming tube placement on the basis that the pH of secretions from different body locations differs. In fasting adults, gastric pH is usually 5 or less.[130,131] A consideration for the use of pH assessment in children is that newborns and young infants have decreased acid secretion and gastric pH levels do not reach adult levels until 3 to 4 months of age.[132] Despite this maturational difference, pH values of 5.0 or less are good predictors of gastric tube placement in neonates, infants, and children.[89,124] However, values greater than 5.0 are not as helpful at identifying tubes that are not in the stomach. Ellett et al[89] reported that only 25% of tubes predicted to be misplaced on the basis of pH measurements actually appeared to be misplaced on a radiograph. Aspirate pH is helpful in determining gastric placement, but results are not always useful for distinguishing between respiratory and intestinal fluids, because both are alkaline.[122,133]

> Radiography remains the only single method by which feeding tube placement can be reliably determined; otherwise, multiple methods should be used.

Because a variety of situations may affect gastric pH in infants and children, including administration of total parenteral nutrition,[134,135] fasting versus feeding,[122] and

Location	Color	Appearance
Stomach	Colorless, off-white, white (milky), tan, green, bloody, brown[124,129]	Clear, cloudy, turbid, curdled appearance[124,129]
Intestine	Yellow, colorless, bile-stained[124,129]	Clear[124]

Table 3 Characteristics of aspirate associated with feeding tube location

acid-inhibiting medications,[124,129] the use of pH as a sole indicator of gastric placement is not recommended.[95] Several researchers have reported that various combinations of pH, levels of bilirubin, pepsin, and trypsin, and aspirate color have improved success at predicting correct and incorrect tube placement compared with relying on pH alone.[123,124,129]

Characteristics of Aspirates. A concern that has been raised related to evaluation of aspirates is the potential inability to obtain aspirates from small-bore feeding tubes. Until research is available to answer this question, the current clinical recommendation remains, that if aspirate cannot be obtained on the first attempt, the child should be repositioned and a second attempt should be made to obtain fluid. Verification by radiography is warranted if aspirate is not obtained on a second attempt.[95,124,129]

Assessing the color and clarity of gastric aspirates is a common method used by pediatric nurses to confirm placement of feeding tubes.[105] In adults, aspirates from the stomach are usually cloudy and green, tan, or off-white and sometimes bloody or brown, whereas aspirates from the small bowel are more often clear and yellow or bile stained.[136] Studies in infants and children support these findings for color.[124,129] Westhus[129] noted that most gastric aspirates in fasting children are clear (Table 3). Both the Society of Pediatric Nurses and the AACN recommend assessing the appearance of tube aspirate when confirming tube placement.[85,105]

Implications for Practice: Methods of Verifying Placement

The essential point in verifying tube placement is to determine if it is safe to feed or continue to feed through a nasogastric or orogastric tube. The nurse should feel confident with the result of the verification methods that the tip of the tube is in the stomach. Table 4 summarizes

Table 4 Limitations of bedside methods of verifying feeding tube placement

Method	Limitations
Auscultation	Unreliable Error rates as high as 50%[109] Numerous case reports of tubes verified as being in correct place by auscultation, later found to be malpositioned[97,100,101,115]
Detection of carbon dioxide	Cutoff values for capnography not established Colorimetric device may detect respiratory placement[120] but does not allow distinction between esophageal, gastric, and intestinal placement
Aspirate concentration of bilirubin	Conflicting evidence that the cutoff of 5 mg/dL allows distinction between gastric and intestinal placement[89,124,125] No bedside test
Aspirate concentration of pepsin	Values highly variable during first year of life[126-128] Conflicting evidence regarding predictive value[124,129] No bedside test
Aspirate concentration of trypsin	Values <50 µg/mL may be associated with gastric placement, but values ≥50 µg/mL may not be associated with intestinal placement[129] No bedside test
pH	pH values ≤5 good predictor of gastric placement[89,124]; however, values >5.0 are not as helpful at identifying tubes that are not in the stomach[89] Does not allow distinction between respiratory and intestinal placement Most useful if used in conjunction with aspirate color[102,105,129,130]
Aspirate color	Subjective May not allow distinction between respiratory, esophageal, and gastric placement Most useful if used in conjunction with pH[102,105,129,130]

limitations associated with various methods of verifying tube placement. Radiography remains the only single method by which feeding tube placement can be reliably determined.[95,130] For routine confirmation, and when radiography is not practical, multiple methods should be used. Experts agree that using indicators from more than 1 method to confirm placement is superior to using a single indicator.[88,105,129,137,138] Auscultation is associated with significant error rates and serious complications in infants and children, including death. This traditional method should be replaced with more reliable methods, and its results should be interpreted cautiously.[89,105,139] Several authors recommend the combination of aspirate pH and color as 2 bedside methods for confirming placement.[102,105,129,130] The inability to obtain any aspirate should raise concern about misplacement. Whenever there is a doubt about tube placement, placement should be verified radiographically.

Table 5 Risk factors for venous thromboembolism in hospitalized medical patients[149]

Method
Active cancer
Previous venous thromboembolism
Reduced mobility
Already known thrombophilic condition
Recent (<1 month) trauma and/or surgery
Elderly age (>70 years)
Heart and/or respiratory failure
Acute myocardial infarction or ischemic stroke
Acute infection and/or rheumatologic disorder
Obesity (body mass index[a] >30)
Ongoing hormonal treatment

[a] Calculated as weight in kilograms divided by height in meters squared.

Prevention of Venothromboembolism

It is a well-known fact that hospitalized acutely and critically ill adults are at high risk for venothromboembolism, specifically development of deep vein thrombosis. This preventable and frequently fatal complication of acute illness continues to challenge clinicians despite well-researched and clear prevention guidelines. Prevention of venothromboembolism was discussed at the 2008 AACN National Teaching Institute and was addressed in the second article in this series in *Critical Care Nurse* in 2009.[8] Yet in 2013 we are addressing the topic again. Unlike the other topics in this series, the need to prevent venothromboembolism is not controversial or ambiguous. There is a clear and obvious danger of clot formation in hospitalized patients and clear evidence-based guidelines to direct care are available.[140-144]

Reviewing the Evidence

Evidence-based guidelines offer clinicians a foundation to direct practice in the prevention of development of venothromboembolism. Despite a large body of evidence to guide practice, venothromboembolism prophylaxis is still underused or used inappropriately.[142,145] Recommendations for prevention of venothromboembolism addressed in this section come from 3 sources: The American College of Chest Physicians (ACCP) 9th edition of "Antithrombotic Therapy and Prevention of Thrombosis,"[140-142] published in 2012; the Surviving Sepsis Campaign guidelines,[146] published in 2013; and the AACN practice alert[147] published in 2010.

Hospitalization alone increases the risk of venothromboembolism developing 8-fold.[148] The other medical conditions that have been identified as independent risk factors for venothromboembolism are listed in Table 5.[149] Not surprisingly, the risk is greater in surgical patients.[143,144] Clinicians are continually faced with the question of which options for preventing venothromboembolism and deep vein thrombosis will render the most benefit and least harm to each patient. The classic options are support compression devices (eg, intermittent pneumatic compression), elastic stockings, and oral or parenteral anticoagulant or antiplatelet agents.[140-144] The best clinical practices are found in the evidence-based guidelines that focus on quality care of hospitalized adults. Best practices are not found in tradition, bedside standards of care, or drug or product manufacturers' recommendations, if those recommendations were not based on solid high-quality research.

The ACCP 9th edition of "Antithrombotic Therapy and Prevention of Thrombosis" includes more than 600 recommendations in 24 separate guidelines for the prevention, diagnosis, and treatment of thrombosis.[144] Three of these are dedicated specifically to prevention of venothromboembolism: (1) nonsurgical patients,[142] (2) nonorthopedic surgical patients,[141] and (3) orthopedic surgery patients.[140] Readers are encouraged to review each of these guidelines in their original form. A brief summary of the practice implications from 2 of these evidence-based guidelines for preventing venothromboembolism are provided next.

Practice recommendations in the ACCP guidelines are evaluated on the basis of the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system.[150] The GRADE system applies a systematic and explicit approach to grading the quality of the evidence and strength of recommendations by using a numeric and lettering system.[150,151] Evidence found to be grade 1 is considered strong evidence and the intervention or evidence is recommended; grade 2 is weaker evidence supporting an intervention, thus the intervention is suggested.[150,151] Recommendations are further defined by using a lettering system in which A is the highest level of research evidence to support the recommendation; B is moderately strong evidence usually consisting of 1 high-quality study and several studies with limitations; C is assigned to lower level evidence, suggesting further research is needed to support the intervention; D is assigned to very low evidence such as expert opinion or non–research-based evidence.[150,151] When evaluating the strength of suggested interventions discussed in this section, nurses should consider both the number and letter assigned to the intervention to critically evaluate the evidence supporting specific interventions. Readers are referred to the GRADE working group for more information (http://www.gradeworkinggroup.org/index.htm).[151]

Prevention of Venothromboembolism in Nonsurgical Patients[142]

For acutely ill hospitalized medical patients at increased risk of thrombosis, the recommendation is

> anticoagulant thromboprophylaxis with low-molecular-weight heparin (LMWH), low-dose unfractionated heparin (LDUH) twice a day or 3 times a day, or fondaparinux (grade 1B)

For acutely ill hospitalized medical patients at low risk of thrombosis, the recommendation is

> to avoid use of pharmacological prophylaxis or mechanical prophylaxis (grade 1B).

For acutely ill hospitalized medical patients at increased risk of thrombosis who are bleeding or are at high risk for major bleeding, the recommendation is

> mechanical thromboprophylaxis with graduated compression stockings (grade 2C) or intermittent pneumatic compression (grade 2C).

For critically ill patients, the recommendation is using

> LMWH or LDUH thromboprophylaxis (grade 2C).

For critically ill patients who are bleeding or are at high risk for major bleeding, the recommendation is

> mechanical thromboprophylaxis with graduated compression stockings and/or intermittent pneumatic compression at least until the bleeding risk decreases (grade 2C).

Prevention of Venothromboembolism in Nonorthopedic Surgical Patients[141]

When the risk for venothromboembolism is very low, the recommendation is

> that no specific pharmacologic (grade 1B) or mechanical (grade 2C) prophylaxis be used other than early ambulation.

For patients at low risk for venothromboembolism, the recommendation is

> mechanical prophylaxis, preferably with intermittent pneumatic compression, over no prophylaxis (grade 2C).

For patients at moderate risk for venothromboembolism who are not at high risk for major bleeding complications, the recommendation is

> LMWH (grade 2B), LDUH (grade 2B), or mechanical prophylaxis with intermittent pneumatic compression (grade 2C) over no prophylaxis.

For patients at high risk for venothromboembolism who are not at high risk for major bleeding complications, the recommendation is

> pharmacological prophylaxis with LMWH (grade 1B) or LDUH (grade 1B) over no prophylaxis.
>
> In these patients, we suggest adding mechanical prophylaxis with elastic stockings or intermittent pneumatic compression to pharmacological prophylaxis (grade 2C).

Table 6 reviews the recommended elements for assessing risk of venothromboembolism. Nurses should be aware of the risk assessment and use it much like the Braden Scale, which has become a routine part of pressure ulcer assessment.

The Surviving Sepsis Campaign international guidelines for the management of severe sepsis and septic shock were first introduced in 2004. They were updated in 2008 and again in February 2013.[146] In all 3 of these landmark sepsis management publications, recommendations for prophylaxis of deep vein thrombosis are described in the supportive therapy discussions. Three recommendations

Table 6 Assessment of risk for venous thromboembolism[141]

Risk	Description
Low	<40 y old, minor surgery
Moderate	>40 y old, minor surgery with additional risk factor
	40-60 y old with no additional risk factor
High	>60 y old, surgery
Highest	>40 y old with multiple risk factors: hip or knee surgery/interventions, major trauma, spinal cord injury

for prophylaxis of deep vein thrombosis in the care of patients with sepsis are as follows:

1. Patients with severe sepsis receive daily pharmacoprophylaxis (grade 1B).

   daily subcutaneous LMWH (grade 1B vs unfractionated heparin twice daily and grade 2C vs unfractionated heparin given 3 times daily).

   If creatinine clearance is less than 30 mL/min, use of dalteparin (grade 1A) or another form of LMWH that has a low degree of renal metabolism (grade 2C) or unfractionated heparin (grade 1A).

2. Patients with severe sepsis be treated with a combination of pharmacological therapy and intermittent pneumatic compression devices whenever possible (grade 2C).

3. Patients with sepsis who have a contraindication to heparin use not receive pharmacoprophylaxis (grade 1B). Rather, we suggest they receive mechanical prophylactic treatment, such as graduated compression stockings or intermittent compression devices (grade 2C), unless contraindicated. When the risk decreases, we suggest starting pharmacoprophylaxis (grade 2C).

The AACN practice alert for venous thromboembolism prevention, released in 2010, has 50 references to support the recommendations for practice.[147] Consistent with the other EBP guidelines, the practice alert directs nurses and providers in performing daily assessment of the patient's risk for venothromboembolism to evaluate the need for central venous catheter devices, encourage maximal mobility, and use mechanical prophylaxis devices and medical therapies appropriately.

Implications for Practice

The Joint Commission has established that the prevention of venothromboembolism is a core measure for patient safety and hospital performance.[152] We have the evidence to guide practice, and prevention of venothromboembolism must be a priority for every member of the multidisciplinary team. It is essential that all acute and critically ill adult patients receive an appropriate prevention for their current condition that is based on sound high-level evidence. The evidence to support the prevention of venothromboembolism is vast. It is time to put the evidence into practice to prevent this high-risk complication associated with critical illness.

Prevention of venothromboembolism starts with the nurse assessing all patients upon admission to the ICU for risk factors and anticipating orders for prophylaxis based on that risk assessment. Prophylaxis will typically consist of chemical and mechanical therapies. Critical care nurses must ensure that both therapies are maintained to reduce risk of venothromboembolism. Mobility is also an important intervention in the prevention of venothromboembolism. AACN's first PEARL (Practice, Evidence, Application, Resources and Leadership), known as the ABCDE bundle,[153] states that early exercise and progressive mobility are key to improving respiratory status, decreasing ICU and hospital stay, and preventing deep vein thrombosis.

Critical care nurses are in an optimal position to apply current best evidence to improve patients' outcomes through translation of practice guidelines such as the ABCDE bundle to reduce venothromboembolism. Recognizing that deep vein thrombosis is a problem is not enough. Recognition must be followed with consistent implementation of EBP guidelines to improve care and decrease risk of preventable complications and death from venothromboembolism.

As critical care nurses, we must continually evaluate our practice and adopt evidence-based practice interventions as research and new evidence evolve.

Summary

As critical care nurses, we must continually evaluate our practice and adopt EBP interventions as research and new evidence evolve. Once again, it is time to evaluate our individual practice to ensure that the current best evidence is guiding practice interventions, rather than providing care that is based on tradition alone. An 18th century poet stated it nicely: "Knowing is not enough; we must apply. Willing is not enough; we must do"

(Johann Wolfgang von Goethe).[154] Critical care nurses are well positioned to be the catalysts who translate evidence into practice, providing excellence in clinical care to the patients and families that we serve. CCN

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None reported.

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To learn more about evidence-based practice, read Inside Looking In" or "Inside Looking Out"? How Leaders Shape Cultures Equipped for Evidence-Based Practice by Halm in the *American Journal of Critical Care*, July 2010;19:375-378. Available at **www.ajcconline.org**.

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CCN Fast Facts

Examining the Evidence to Guide Practice: Challenging Practice Habits

Facts

Four practice interventions within the realm of nursing are critiqued on the basis of current best evidence.

Turning Patients Every 2 Hours

- Should patients be turned at least every 2 hours? The short answer is yes.
- Increased frequency of turning should be driven by the nurse's assessment of the patient's risk for pressure ulcer injury (ie, Braden risk score).
- Nurses should strive to turn patients every 2 hours; however, if hemodynamic instability is a concern or the Braden risk score is low, more frequent weight shifts are indicated to relieve pressure and prevent adverse outcomes for patients.
- Critical care nurses are in an ideal position to advocate for the use of support surface therapies if warranted by the severity of the patient's illness and associated immobility. Frequent turning along with good skin care practices, providing nutritional support, and encouraging early mobility are evidence-based interventions to optimize patients' outcomes.
- Patients may need to be turned more often than every 2 hours, depending on the patient's severity of illness and driven by nursing assessment.

Promoting Sleep in the ICU

- Regardless of the cause of sleep disruption, the consequences of lack of sleep include worsening symptoms, physical and cognitive dysfunction, mood instability, and fatigue.
- Nurses can improve the patient's sleep cycle through modifications of the environment (eg, reduce noise and light), clustering care to minimize sleep disruptions, limiting sedation, optimizing mechanical ventilation modes that enhance sleep, and assessing for the presence of signs of delirium. Early mobility may also enhance sleep.
- Complementary therapies such as massage, music, aromatherapy, and acupressure enhance relaxation and may reduce activation of the sympathetic nervous system, thereby enhancing sleep.
- Last, development of nurse-driven sleep protocols can provide consistent medical and nonmedical interventions that promote sleep. Clinicians should be vigilant about sleep enhancement through patient-centered approaches that enhance optimal intensive care unit recovery.

Feeding Tube Management in Infants and Children

- To ensure optimal outcomes for children, nurses must use age-specific evidence, when it exists, to guide practice.
- Ensuring safe and effective feeding via nasogastric tubes requires the nurse to initially insert the tube to the correct place and periodically confirm that the tube remains in the intended location. Even if a nasogastric tube is positioned correctly upon insertion and secured, the distal tip can migrate from its original position.
- Current best evidence indicates that either the age-related, height-based method or the nose-ear-mid-umbilicus method should be used to predict insertion length in infants and children.
- Radiography remains the only single method by which feeding tube placement can be reliably determined. For routine confirmation, and when radiography is not practical, multiple methods should be used.
- Auscultation is associated with significant error rates and serious complications in infants and children, including death.

Prevention of Venothromboembolism

- Prevention of venothromboembolism starts with the nurse assessing all patients upon ICU admission for risk factors and anticipating orders for prophylaxis. Prophylaxis will typically consist of chemical and mechanical therapies. Mobility is also an important intervention in the prevention of venothromboembolism.
- Critical care nurses are in an optimal position to apply current best evidence to improve patients' outcomes through translation of practice guidelines such as the ABCDE bundle to reduce venothromboembolism. Recognizing a problem is not enough; it must be followed with consistent implementation of evidence-based guidelines to improve care and decrease risk of preventable complications and death from venothromboembolism. CCN

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CNE Test Test ID C1423: Examining the Evidence to Guide Practice: Challenging Practice Habits

Learning objectives: 1. Articulate the benefits of implementing evidence-based practice 2. Differentiate between evidence-based practice and nursing care that is steeped in tradition 3. Distinguish strong evidence from lower levels of evidence that are used to guide practice

1. Which of the following are benefits of implementing evidence-based practice?
a. Decreased cost of care and increased staff efficiency
b. Increased quality of care and improved patient outcomes
c. Increased staff retention and patient satisfaction
d. Decreased length of stay and improved staff satisfaction

2. Which of the following statements related to turning critically ill patients is supported by strong evidence?
a. Repositioning patients is not needed when specialty mattresses are used.
b. Frequency of turning a patient may need to be increased depending on the patient's acuity.
c. The optimal time for turning critically ill patients is every 2 hours.
d. Continuous lateral rotation therapy should be used for all critically ill patients.

3. What percentage of clinicians consistently implement evidenced-based care?
a. 5%-8% c. 20%-25%
b. 10%-15% d. 30%-35%

4. Which of the following are consequences of sleep disruption in intensive care unit patients?
a. Cognitive dysfunction
b. Hemodynamic instability
c. Increased time in rapid eye movement sleep
d. Impaired hearing

5. Although the Environmental Protection Agency recommends maximum hospital noise levels to be 35 decibels at night, which of the following is the average reported noise level of an intensive care unit?
a. 20 decibels c. 80 decibels
b. 40 decibels d. 100 decibels

6. Evidence regarding the effect of mechanical ventilation on sleep disruption suggests which of the following statements?
a. Sleep can be less fragmented with assist-control or pressure-controlled ventilation.
b. Pressure support mode reduces sleep disruption.
c. The mechanical ventilation mode does not affect sleep patterns.
d. Data are inconclusive and more research is needed.

7. Evidence regarding the placement verification of feeding tubes in infants and children suggests which of the following statements?
a. Studies of the adult population regarding feeding tube placement can be applied to children.
b. Auscultation can be useful in infants and children to distinguish between gastric and intestinal placement.
c. Auscultation is the premiere method for verifying placement.
d. Auscultation is not reliable for distinguishing between respiratory and gastric placement.

8. Which of the following was identified as a limitation of using capnography and capnometry for feeding tube placement verification?
a. No studies have evaluated effectiveness in children.
b. A cutoff value to distinguish respiratory from enteral placement has not been established.
c. Carbon dioxide detection may be cost prohibitive.
d. A high incidence of false-positive results when used for adults.

9. Which of the following was identified as an advantage to using aspirate testing for bilirubin to verify feeding tube placement?
a. Bedside testing is readily available.
b. It can solely be used to determine placement.
c. It can discriminate between gastric and esophageal placement.
d. Bilirubin testing can be helpful to determine postpyloric placement.

10. Which of the following is the only single method that can reliably determine feeding tube placement?
a. Gastric pH testing c. Radiography
b. Auscultation d. Bilirubin testing

11. Which of the following ratings represents the strongest evidence according to the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system?
a. Grade 2D c. Grade 1C
b. Grade 1A d. Grade 2B

12. Which recommendation for the prevention of venothromboembolism in acutely ill hospitalized patients who are at increased risk of thrombosis is supported by the strongest evidence?
a. Administration of low-molecular-weight heparin 2 to 3 times a day
b. Application of compression stockings 23 hours per day
c. Application of intermittent pneumatic compression devices
d. Administration of pharmacological prophylaxis and mechanical prophylaxis

Test answers: Mark only one box for your answer to each question. You may photocopy this form.

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