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Critical Care [ALERT]

Authoritative, evidence-based summaries for the critical care clinician

SPECIAL FEATURE

Achieving Successful Rehabiliation in the ICU

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Dr. Radigan reports no financial relationships relevant to this field of study.

Almost 50% of intensive care unit (ICU) patients with sepsis, multi-organ failure, or prolonged respiratory failure exhibit protracted muscular weakness during their critical illness that often persists after hospital discharge.[1] In a study that examined consecutive ICU patients without preexisting neuromuscular disease who underwent mechanical ventilation for 7 or more days, the prevalence of ICU-acquired weakness (ICU-AW) was 25.3%.[2] Profound weakness may affect any muscle group, including the diaphragm. In one study that examined brain-dead organ donors undergoing mechanical ventilation, the diaphragm showed marked atrophy of both slow-twitch and fast-twitch fibers within hours of inactivity.[3] Patients who develop ICU-acquired weakness (ICU-AW) require a longer duration of mechanical ventilation and ICU stay and suffer significant long-term physical, mental, and financial sequelae.[4] Herridge et al showed that even relatively young survivors of acute respiratory distress syndrome demonstrated persistent subjective weakness, exercise limitation, and reduced physical quality of life 5 years after their critical illness.[5]

DIAGNOSIS

ICU-AW may be neuropathic or myopathic, often with considerable overlap. Clinicians should consider ICU-AW in almost every critically ill patient who is ventilated and especially in those with failure to wean from the ventilator. Signs of critical illness myopathy include proximal and distal muscle weakness and decreased reflexes with normal sensation. Critical illness polyneuropathy presents with limb muscle weakness and atrophy, reduced or absent deep tendon reflexes, loss of peripheral sensation to light touch and pin prick, and relative preservation of cranial nerve function.

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[INSIDE]

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Electromyography, nerve conduction studies, and consultation with a neurologist may be helpful to confirm the diagnosis.

PREVENTION AND TREATMENT

Many factors may contribute to the risk of ICU-AW. There is a strong relationship between ICU length of stay (LOS) and poor physical outcomes. Implementing existing evidence-based strategies to reduce ICU LOS and associated bed rest may be the best preventive measures for improving patient outcomes. Although there is still significant controversy whether other specific treatment strategies (e.g., minimizing corticosteroids, control of severe hyperglycemia, avoidance of paralytics) affect physical outcomes in the ICU, it is always better to err on the side of caution and modify these risks whenever possible.[6,7]

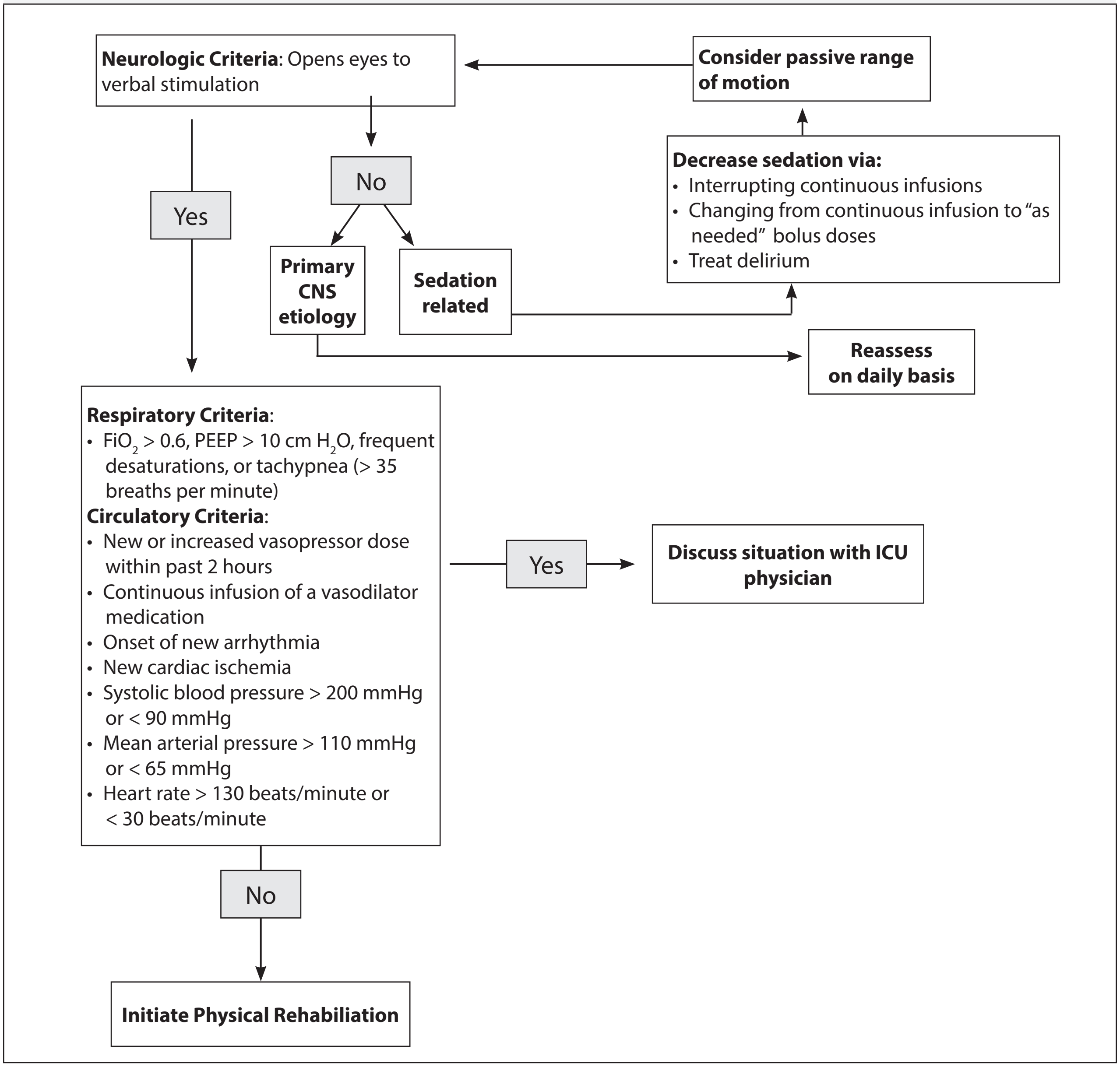
Physical therapy during critical illness has proven to mitigate many of the potential complications of critical illness. Historically, it has been standard of care for critically ill patients to be placed on bed rest, often in a medication-induced coma. More recently, it is becoming common to see ventilated patients not just receiving physical therapy but even taking laps around the unit. Patients usually start with sitting up at the side of the bed and then progress stepwise to dangling legs over the side of the bed, standing, transferring to a chair, and ultimately walking. Physical therapy within the ICU is associated with improved walking ability at discharge, improved respiratory and overall muscle strength, increased ability to perform activities of daily living at discharge, and improved health-related quality of life (i.e., higher number of patients with independent functional status and improved SF-36 physical functioning scores).[8-15] Rehabilitation within the ICU has also been shown to shorten ICU and hospital LOS, increase number of discharges home, and improve 1-year mortality.[8,13,14,16,17] Theoretically, physical rehabilitation may also lead to improved interdisciplinary communication as it requires daily coordination with the physician team (assessment of appropriateness for therapy), nursing (minimizing sedation in advance of physical therapy), respiratory therapists (maintenance of the airway and effective ventilation during therapy), and the physical therapy team. This coordinated effort often leads to reduced need for sedation and physical restraints. Patients' family members often positively perceive improved team communication, which would be predicted to improve patient and family satisfaction. Furthermore, implementation of physical therapy is safe, with a reported incidence of adverse outcomes < 1% in careful trials, none of which are severe.[13,16,18-20] To decrease the risk of adverse events, every institution should have a plan of care protocol (*see Figure 1*).

Early mobilization during ICU admission is a key aspect to implementing an ICU physical therapy program. A randomized, controlled trial at two university hospitals showed that interruption of sedation along with physical and occupational therapy during mechanical ventilation, as opposed to initiation of therapy after discontinuation of mechanical ventilation, resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care.[7] Despite receiving the same amount of daily physical therapy after mechanical ventilation, the intervention group received an average of 19 minutes of physical therapy per day during mechanical ventilation while the control group received no physical therapy until after extubation.[8] This study demonstrated that the benefits of physical and occupational therapy occur while patients are receiving mechanical ventilation, a time in which many medical centers defer physical therapy.

CULTURE CHANGE

Unfortunately, improving weakness in our ICU patients is not as simple as the implementation of physical therapy. Ideally, each ICU should have a mobility team that includes a physical therapist to assess and treat, a nurse to assist in physiologic stability, and a respiratory therapist who is responsible for airway and ventilator management. The critical care physician should also be involved to assure there are no clinical

Figure 1. Rehabilitation Plan of Care Protocol[25]



contraindications to physical activity and recommend changes in mechanical ventilator settings during exercise. To be successful with mobility, most ICUs need to go through a culture change. The ABCDE Initiative outlines straightforward tenets to enable success with this culture change. The ABCDE bundle includes implementing the Awakening and Breathing Coordination, Delirium monitoring/management, and Early exercise/mobility bundle into everyday practice.[21] This initiative promotes effective physical therapy as it encourages treatment of delirium and limitation of sedative medications. An 18-month prospective, before-after study of 146 pre-bundle and 150 post-ABCDE bundle patients examined the effectiveness and safety of this initiative. Investigators were aggressive with daily physical therapy when patients met pre-specified criteria with exceptions permitted only by a specific order. Patients who underwent the ABCDE bundle spent 3 more days breathing without mechanical ventilation, experienced less delirium, and increased their odds of mobilizing out of bed at least daily compared to pre-bundle patients. Although this initiative stressed the importance of patients being awake, it has also been shown that passive range of motion and bedside ergometer (along with active exercise training when the patient is able to participate) enhanced recovery of functional exercise capacity, self-perceived functional status, and muscle force at hospital discharge.[10]

To successfully change cultural practice, it is also

Table 1. Steps to Ensure Culture Change[22]

- Change standardized ICU admission orders from default activity level of "bed rest" to "as tolerated."
- Change sedation practice from continuous IV to as-needed bolus doses or no sedation.
- Develop safety-related guidelines regarding when patients are eligible for physical therapy.
- Change staffing in the ICU to include full-time, part-time, and overtime, in addition to part-time rehabilitation assistant.
- Standardize physiatrist consults for MICU patients with severe or prolonged muscle weakness.
- Supporters of the initiative should establish a vocal presence in the ICU. Advocacy should include stakeholders in every area of the team, including nursing, respiratory therapy, physical and occupational therapy, pharmacy, and physicians.

paramount to understand the specific barriers to a project in order to design the correct intervention. Needham et al developed the 4 Es model, which promotes Engagement, Education, Execution, and Evaluation to overcome barriers within their ICU physical therapy program.[13] Engaging the group meant convening regularly scheduled interdisciplinary meetings, providing information and updates on the project with MICU and hospital-wide newsletters, designing informational posters, conducting didactic conferences and presentations, and inviting ICU survivors who participated in rehabilitation to share their stories. Patient experiences emphasized the importance of decreased sedation and early rehabilitation. Education was the next important aspect of the process and included meetings, presentations addressing long-term complications of critical illness, and benefits of physical and occupational therapy, including 16 educational sessions to inform all MICU nurses regarding sedation-related issues that may dictate the effectiveness of physical therapy. Execution included various measures to modify standardized admission orders, encourage culture change with sedation practices, develop safety guidelines, change staffing, and encourage consultations with physiatrists and neurologists (*see Table 1*). Finally, evaluation of the project occurred on an ongoing, regular basis to discuss progress, barriers, and solutions.

IMPLEMENTING PHYSICAL THERAPY IN THE ICU

What if your hospital doesn't have physical therapy in the ICU? Take ownership and make it happen. Appeal to the financial senses of your institution with data. Rehabilitation within the ICU shortens ICU and hospital LOS, increases the number of discharges home, and improves 1-year mortality.[8,13,14,16,17] These improvements are associated with significant cost savings. Needham et al evaluated the potential annual net cost savings of implementing their own early rehabilitation program. This data set is available in easily adaptable spreadsheets to adjust to the needs of hospitals with 200, 600, 900, and 2000 annual admissions, accounting for both conservative and best-case scenarios. For example, they calculated a net cost savings of more than $800,000 generated in a scenario of 900 annual admissions with actual LOS reductions of 22% and 19% for the ICU and floor, respectively. They were able to show that investment in an ICU early rehabilitation program can generate net financial savings for U.S. hospitals.[22] Needham et al have published an Excel model that can assist in conducting such financial analyses customized to a hospital's unique situation.[23]

CONCLUSION

Survivors of critical illness suffer from physical disabilities for at least 5 years after their initial illness.[5] Clinicians should consider ICU-acquired weakness in almost every critically ill patient who is ventilated but especially those with failure to wean from the ventilator. Early physical therapy is a crucial intervention to both prevent and treat ICU-acquired weakness. Appealing to the financial senses of your institution to implement physical therapy in the ICU may be crucial to improve ICU patient outcomes. ■

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ABSTRACT & COMMENTARY

Should High-flow Oxygen Therapy Change Our Approach to Managing Acute Respiratory Failure?

By Richard Kallet, MS, RRT, FAARC, FCCM

Director of Quality Assurance, Respiratory Care Services, San Francisco General Hospital

Mr. Kallet reports no financial relationships relevant to this field of study.

SYNOPSIS: Managing acute hypoxemic respiratory failure with high-flow nasal cannula (HFNC) significantly reduced intubation rates compared to standard oxygen (O_2) mask delivery and non-invasive ventilation among patients whose arterial O_2 tension to inspired O_2 fraction ratio (PaO_2/FiO_2) was < 200. Among all study patients, hospital mortality was lower in the HFNC group.

SOURCE: Frat JP, et al. High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure. *N Engl J Med* 2015;372:2185-2196.

This multicenter, randomized, controlled trial posited that heated, humidified high-flow nasal cannula (HFNC) standard oxygen (O_2) at 40-60 L/min provides a high stable FiO_2, reduces upper airway dead space, and creates continuous positive airway pressure (CPAP). This would reduce minute ventilation demand and work of breathing, thereby reducing the need for invasive mechanical ventilation (MV).

The study enrolled 313 patients who met these criteria: 1) PaO_2/FiO_2 < 300 breathing face mask O_2 > 10 L/min, 2) respiratory rate > 25 breaths/min, and 3) arterial carbon dioxide tension < 45 mmHg. Patients with chronic lung disease, cardiogenic pulmonary edema, neurologic injury, severe neutropenia, hemodynamic instability, or limited care were excluded. Patients were randomized to HFNC at 40-60 L/min, face mask O_2 at > 10 L/min, or NIV with inspiratory pressure titrated to achieve a tidal volume of 7-10 mL/kg with a CPAP of 5 cm H_2O for at least 8 hours/day. For all treatment arms, FiO_2 was titrated to keep O_2 saturation > 92%. Baseline physiology, demographics, and comorbidities were not different between the treatment arms.

Overall, the primary outcome of need for invasive MV was not significantly different between the treatment groups. However, in a post hoc analysis of those with an initial PaO_2/FiO_2 < 200, there was a significant difference in the need for invasive MV in favor of the HFNC group (35% for HFNC vs

53% for standard O_2 therapy and 58% for NIV; $P = 0.009$). Neither the time interval to intubation nor the underlying cause necessitating invasive MV were different between therapies. The HFNC cohort had a significantly higher number of ventilator-free days (24 ± 8 days) compared to those receiving standard O_2 therapy (22 ± 10 days), and those on NIV (19 ± 12 days) ($P = 0.02$). The hazard ratio (HR) for death at day 90 was significantly higher in the standard O_2 and NIV groups compared to the HFNC group (HR, 2.01; 95% confidence interval [CI], 1.01-3.99; HR, 2.50; 95% CI, 1.31-4.78, respectively; $P = 0.02$). Those treated with HFNC also experienced greater improvement in dyspnea compared to those receiving standard O_2 and NIV (76% vs 42% vs 58%, respectively; $P < 0.001$).

■ COMMENTARY

The FLORALI (High-Flow Oxygen Therapy for the Resuscitation of Acute Lung Injury) study suggests we reconsider our initial management approach in select patients with acute hypoxemic respiratory failure. The concern, however, is that misapplication of HFNC O_2 therapy may lead to delayed intubation that paradoxically worsens outcomes. It is essential to target appropriate candidates while clearly specifying early discontinuation.

FLORALI and other studies provide practical guidelines for appropriate patient selection.[1] HFNC is contraindicated in those with acute hypercapnia because it signifies either respiratory muscle fatigue or depressed respiratory drive, both of which necessitate invasive MV. Likewise, profound tachypnea and accessory muscle use not readily reversed with HFNC (e.g., within < 30 min) requires invasive MV. In addition, HFNC is not indicated for patients who are either hemodynamically unstable or manifest signs of acute neurologic deterioration.

HFNC therapy should be terminated quickly in favor of invasive MV when exclusion criteria develop after therapy commences: a sustained respiratory rate > 35 breaths/min, lack of improvement in respiratory distress/dyspnea, sustained O_2 saturation < 90%, arterial pH < 7.35, decreased systolic (< 90 mmHg) or mean (< 65 mmHg) arterial blood pressure despite fluid boluses and/or vasopressors, or when either definitive airway control is indicated or with the presence of copious pulmonary secretions.[1]

In considering HFNC, NIV can provide some guidance. The principle indications for NIV also apply to HFNC, namely situations where the cause of respiratory failure can be readily reversed. In contrast, clinical conditions such as acute respiratory distress syndrome (ARDS) are not ideal for NIV and, likewise, HFNC. This condition often resolves more slowly, frequently requiring several weeks of MV. Moreover, ARDS is associated with an elevated minute ventilation and severely impaired pulmonary mechanics, both of which greatly increase WOB.[2] As a result, NIV failure rates in ARDS typically exceed 50% and delayed intubation is associated with heightened mortality risk.[3] Similarly, in those failing HFNC O_2 therapy, ICU mortality was markedly lower (39% vs 67%) when invasive MV was instituted within 48 hours (median of 10 hours).[1]

The apparent success of HFNC over NIV requires comment. NIV was used only 8 hours/day, which likely limited its efficacy. Also, in patients with pneumonia (the primary diagnosis among FLORALI subjects), HFNC was as effective as CPAP of 5 cm H_2O in reducing inspiratory effort.[4] Although HFNC reduced the work of breathing in these pneumonia patients, the baseline spontaneous work of breathing was not markedly elevated compared to the spontaneous work of breathing measured in patients with ARDS.[2] Moreover, the mortality in the NIV group is consistent with the NIV literature and likely signifies complications associated with invasive MV rather than pre-intubation management, per se. The FLORALI study did not explicitly state whether protocol managed invasive MV. Therefore, the significance of mortality differences reported in the FLORALI study remains uncertain.

In summary, current high-level evidence supports using HFNC as the primary O_2 delivery method for patients in acute respiratory failure from pneumonia without hypercapnia and who exhibit hemodynamic and neurologic stability. ■

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ABSTRACT & COMMENTARY

National Practice Patterns and Outcomes of Tracheostomy Placement in the United States

By Betty Tran, MD, MSc, Editor

SYNOPSIS: Tracheostomy use rose over the last two decades until 2008 in the United States and was associated with an increase in discharge to long-term care facilities with a concomitant decrease in hospital length of stay and hospital mortality.

SOURCE: Mehta AB, et al. Trends in tracheostomy for mechanically ventilated patients in the United States, 1993–2012. *Am J Respir Crit Care Med* 2015;192:445-454.

Using the National Inpatient Sample (NIS) from the U.S. Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project, Mehta et al had the primary aim of examining yearly rates of tracheostomy among mechanical ventilation (MV) patients from 1993 to 2012. Secondary outcomes included hospital length of stay (LOS), hospital mortality, discharge location, and factors associated with receipt of tracheostomy. As the NIS is a 20% probability sample of all nonfederal acute care inpatients, the hope was that it would be representative of ICU care provided across the United States. Adults receiving mechanical ventilation (> 18 years), tracheostomies, and the presence of surgical procedures were identified using ICD-9 codes. Sensitivity analyses were performed excluding patients with diagnosis-related groups for tracheostomies related to face, head, or neck conditions and for patients with time to tracheostomy ≤ 0 days, as the focus was on patients with anticipated prolonged MV as opposed to those receiving emergent or prophylactic tracheostomies.

Between 1993 and 2012, 9.1% of patients on MV received a tracheostomy, with rates increasing from 6.9% in 1993 to a peak of 9.8% in 2008 and subsequently declining to 8.6% in 2012 ($P < 0.0001$). Age-adjusted, population-based rates of tracheostomy increased 106% over the study period, which was disproportionate to the growth in MV. This was mainly driven by an increase in tracheostomies for surgical MV patients, whereas tracheostomy rates in nonsurgical MV patients kept pace with the rise in MV during the same time.

During the study period, patients receiving tracheostomy tended to be younger, more likely to be male, more likely to be in a racial/ethnic minority group, and more likely to have Medicaid insurance; these trends were noted to outpace smaller changes in the overall MV population. Additionally, there was an increase in the number of comorbidities over time in patients undergoing tracheostomies. Median time to tracheostomy decreased from 11 days in 1998 to 10 days in 2012 ($P < 0.0001$).

Hospital mortality for patients receiving tracheostomies decreased from 38.1% in 1993 to 14.7% in 2012 ($P < 0.0001$) with similar findings for both surgical and nonsurgical patients. Hospital LOS decreased from a median of 39 days to 26 days ($P < 0.0001$). In conjunction with theses findings, there was a significant increase in discharges to long-term acute care hospitals (LTACHs) and skilled nursing facilities (SNFs) (40.1% in 1993 vs 71.9% in 2012) and fewer discharges to home (21.4% in 1993 vs 13.1% in 2012; $P < 0.0001$). Similar trends in factors associated with tracheostomy placement were observed in the sensitivity analyses.

■ COMMENTARY

The study by Mehta et al provides an insightful glimpse into the practice patterns surrounding not just tracheostomy use but also ICU care in the United States over the past two decades. Tracheostomy has become a more readily available procedure; it can be performed at bedside and by a variety of specialists, including otolaryngologists, general surgeons, cardiothoracic surgeons, and critical care physicians. Coupled with observations that patients on MV with tracheostomies tend to require less sedation and may be more comfortable, as well as some early studies that suggested early tracheostomies were associated with decreased days on MV and hospital LOS, it is no surprise that tracheostomy rates have increased over the past two decades. Although rates peaked in 2008, they remain higher overall, despite more recent, randomized studies showing no differences in mortality, antibiotic-free days, or ICU LOS.[1]

At first glance, the ramifications of this trend are deceivingly optimistic. The authors found that hospital mortality and LOS decreased over the same time period. I agree, however, with their discussion that this may represent merely a shift from dying in an acute care hospital to dying in an LTACH. Rates of discharges to LTACHs increased during the study, which is consistent with the rapid increase in number of LTACHs and LTACH beds observed over the past two decades.[2] Additionally, studies have shown that 1-year outcomes for patients with prolonged MV are grim: Only 56% are alive, only 27% report a good quality of life, and a mere 9% are at home and independently functioning.[3] Tracheostomy placement, in addition to advances in critical care medicine, have resulted in a growing population of patients with chronic critical illness who receive their care settings outside the acute care hospital. Although some patients do recover, discussions about tracheostomy in the acute care setting should inform patients and/or surrogates about prognosis and expectations surrounding long-term hospitalization at LTACHs/SNFs and explore whether these outcomes are in line with the patients' values, preferences, and goals. ■

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CME/CNE QUESTIONS

1. The most benefit to physical and occupational therapy occurs for patients:

a. while receiving mechanical ventilation.
b. at the rehabilitation facility.
c. on the general medical floor.
d. at home.
e. immediately after extubation.

2. Which of the following is true regarding the FLORALI study of high-flow nasal cannula (HFNC) standard oxygen (O_2) therapy?

a. The primary cause of respiratory failure was pneumonia.
b. The HFNC only reduced intubation in those patients with a $PaO_2/FiO_2 > 300$.
c. There was no significant difference in the need for intubation among all study patients.
d. Ninety-day mortality reduction was directly attributable to HFNC's very high O_2 flow.
e. Both a and c.

3. Rates of tracheostomy use in the United States from 1993 to 2012:

a. have increased overall.
b. have decreased overall.
c. have remained stable.
d. have been influenced primarily by surgical patients.
e. Both a and d

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