Relias Media
From Relias

Vol. 29, Issue 1, April 2021
ReliasMedia.com

Critical Care [ALERT]

Authoritative, evidence-based summaries for the critical care clinician

SPECIAL FEATURE

Noninvasive Ventilation in Adult Acute Care: Beyond Clinical Indications

By J. Brady Scott, MSc, RRT, RRT-ACCS, AE-C, FAARC, FCCP

Associate Professor, Department of Cardiopulmonary Sciences, Division of Respiratory Care, College of Health Sciences, Rush University, Chicago

Noninvasive ventilation (NIV) is a commonly used modality in adult acute care.[1] When used to treat clinical conditions such as acute cardiogenic pulmonary edema and acute exacerbation of chronic obstructive pulmonary disease, NIV has been shown to reduce the need for intubation and improve mortality.[1-6] Although numerous studies have been done to evaluate the effect of NIV on outcomes such as morbidity, mortality, and costs, the focus largely has been on the clinical indications or the "who" of NIV. This article examines the other aspects of NIV that might affect the modality's success or failure.

THE INTERFACE

An essential consideration for NIV success is the mask interface. The mask interface separates NIV from invasive mechanical ventilation and is designed to allow for the delivery of positive pressure ventilation (PPV) without an endotracheal or tracheostomy tube. Masks are made from clear, hard plastic and are constructed with cushions and a soft inner lip to assure a seal around the face to allow for PPV. Ideally, the cushion and soft inner lip make the mask comfortable and tolerable for the patient and reduce facial skin breakdown.

Several types of masks are commercially available. Clinicians need to select the interface based on purpose, facial characteristics, staff experience/preference, patient preference (when applicable), and compatibility with the ventilator used to deliver NIV. In general, oronasal masks (covering the mouth and nose) and total face masks (covering mouth, nose, and eyes) are recommended when treating acute respiratory

Financial Disclosure: None of the planners or authors of this educational activity have relevant financial relationships to disclose with ineligible companies whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.

Critical Care [ALERT]
Authoritative, evidence-based summaries for the critical care clinician

Critical Care Alert (ISSN 1067-9502) is published monthly by Relias LLC, 1010 Sync St., Ste. 100, Morrisville, NC 27560-5468. Periodicals postage paid at Morrisville, NC, and additional mailing offices. POSTMASTER: Send address changes to *Critical Care Alert*, Relias LLC, 1010 Sync St., Ste. 100, Morrisville, NC 27560-5468.

GST Registration Number: R128870672.

SUBSCRIBER INFORMATION
(800) 688-2421
customerservice@reliasmedia.com
ReliasMedia.com

Back issues: $42. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

ACCREDITATION

JOINTLY ACCREDITED PROVIDER™
INTERPROFESSIONAL CONTINUING EDUCATION

In support of improving patient care, Relias LLC is jointly accredited by the Accreditation Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialing Center (ANCC), to provide continuing education for the healthcare team.

The Relias LLC designates this enduring material for a maximum of 2 *AMA PRA Category 1 Credit(s)*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

2 ANCC contact hours will be awarded to participants who meet the criteria for successful completion.

California Board ofRegistered Nursing, Provider CEP#13791.

Successful completion of this CME activity, which includes participation in the evaluation component, enables the participant to earn up to 2 MOC Medical Knowledge points in the American Board of Internal Medicine's (ABIM) Maintenance of Certification (MOC) program. Participants will earn MOC points equivalent to the amount of CME credits claimed for the activity. It is the CME activity provider's responsibility to submit participant completion information to ACCME for the purpose of granting ABIM MOC credit.

This CME activity is intended for critical care physicians and nurses. It is in effect for 36 months from the date of the publication.

failure.[1] The helmet interface has emerged as a promising option as well.[7,8] Regardless of the interface used, clinicians need to be specifically trained on mask interfaces to assure proper fit and interface/ventilator compatibility.

Proper mask fitting can be challenging. Sizing guides are available to help clinicians find the appropriately sized mask based on individual patient characteristics. Using sizing guides can help reduce waste and cost and can improve patient compliance. In hirsute patients and those with facial irregularities, clinicians may need to change the interface completely (e.g., oronasal to total face mask) if an adequate seal cannot be made.[9] Current NIV mask designs allow clinicians to maintain an adequate seal without overtightening the straps. Overtightening a mask to correct leaks should be avoided since this can lead to facial skin breakdown. If skin breakdown is of concern, clinicians should assess for proper fit, adjust the forehead arm of the mask (if applicable), consider changing the interface altogether, or add skin barriers.[1,9]

Beyond proper fit, clinicians must use an interface compatible with the ventilator circuit configuration in use. Using an incorrect interface could result in carbon dioxide (CO_2) rebreathing. Single-limbed circuits should be fitted with an interface that includes an exhalation/leak port. Dual-limbed circuits do not require a leak port because of the exhalation limb and valve. Usually, masks are colored and packaged differently to identify their intended use. Clinicians should check the interface and circuit compatibility with the ventilation device being used before placing the patient on NIV.[1,9,10]

DELIVERING NIV: BI-LEVEL VS. CRITICAL CARE VENTILATORS

When NIV is clinically indicated, clinicians must choose the device capable of delivering it. In the acute care setting, both bi-level and critical care ventilators can be used to provide NIV. Bi-level ventilators have single-limb configurations and are designed specifically to operate in the presence of leaks. The leak flushes the circuit of exhaled gases through the leak port in the mask interface or circuit. Because of the absence of an exhalation limb of the circuit, mask interfaces used on bi-level ventilators should include an anti-asphyxiation valve. The anti-asphyxiation valve allows a patient to breathe fresh gas in the event of device failure.[1,9-11]

Critical care ventilators have dual-limb circuit configurations and do not require an anti-asphyxiation valve in the interface. Rebreathing of exhaled gases is minimized because of the exhalation limb and valve. Although historically poor at providing NIV, modern critical care ventilators now have NIV modes that may activate leak compensation and deactivate unnecessary and problematic alarms.[10,12,13]

The decision to use a bi-level or critical care ventilator is based on modes, leak-compensation abilities, trigger/cycle settings, monitoring capabilities, portability, and familiarity. Bench and clinical studies have shown that bi-level ventilators outperform most critical care ventilators in the presence of a leak.[10] That said, some critical care ventilators have performed comparatively well.[10] It also should be noted that some newer-generation devices have not yet been evaluated and may compare well to bi-level devices. More studies are needed to assess NIV performance in newer-generation mechanical ventilators. Clinicians responsible for initiating and managing NIV should be aware of the capabilities of devices they have available.

MODES

Several modes can be used for NIV.[1,10,12] Mode terminology differs between devices, which is of no consequence as long as the clinician understands the differences.[1] For example, in bi-level devices, the spontaneous/timed (S/T) mode is used commonly to support patients in acute hypercapnic and hypoxemic respiratory failure.[1,10,12] In that mode, clinicians set an inspiratory pressure, termed inspiratory positive airway pressure (IPAP), which is functionally similar to pressure support (PS). Clinicians also set an expiratory

pressure, termed expiratory positive airway pressure (EPAP), which is functionally similar to positive-end expiratory pressure (PEEP). Although similar, the relationship between IPAP and EPAP is different than that of PS and PEEP. For example, the setting of 12 cm H_2O of IPAP and 6 cm H_2O of EPAP on a bi-level device results in a PS level of 6 cm H_2O. The peak inspiratory pressure would be 12 cm H_2O. On a critical care ventilator, 12 cm H_2O of PS and 6 cm H_2O of PEEP results in an additive peak inspiratory pressure of 18 cm H_2O. The amount of inspiratory support given to the patient on the critical care ventilator would be 6 cm H_2O more than on the NIV device.[1,9,10]

LEAK

Although devices have leak compensation capabilities, leak is a significant cause of NIV failure. The ability to compensate for leaks varies between devices, since some appear to compensate better than others.[10,11,13] When leaks are present, clinicians should prioritize proper mask fitting. The amount of leak that each device can tolerate is not currently known. If trigger and cycle asynchrony occurs, the leak is unacceptable and needs to be resolved.

TRIGGER AND CYCLE

Setting proper trigger and cycle criteria on NIV can improve patient-ventilator synchrony and increase compliance with the modality. On bi-level ventilators, the trigger and cycle criteria are auto-adaptive and based on internal algorithms, preventing the need for clinicians to set them. On critical care ventilators, trigger and cycle have to be set manually by the clinician. Generally, flow-trigger is used and has been shown to reduce trigger delays.[14] The best way to set trigger is unknown, but as with invasive mechanical ventilation, setting it as sensitive as possible without causing auto-triggering probably is best.[10] The cycle criteria on critical care ventilators when PS is used are as a percentage of peak inspiratory flow. When large leaks are present, the cycle criteria may need to be adjusted to allow the breath to terminate. Backup safety systems may cycle the breath to exhalation after a set time at IPAP or PS, and this may vary between devices.

If pressure control modes are used on critical care ventilators for NIV, the cycle setting is inspiratory time.[10] The central point with trigger and cycle criteria is that some devices require adjustments, whereas others do not.

[The decision to use a bi-level or critical care ventilator is based on modes, leak-compensation abilities, trigger/cycle settings, monitoring capabilities, portability, and familiarity.]

MONITORING, PORTABILITY, and FAMILIARITY

Both bi-level and critical care ventilators have sophisticated alarm and monitoring capabilities. Alarms should be set carefully to provide maximum safety while simultaneously reducing nuisance alarms.[10,15] Scalar graphics, pressure readings, and other values should be assessed similarly to patients on invasive mechanical ventilation in an effort to improve patient-ventilator synchrony and reduce harm.[16] Most modern NIV devices can connect to remote monitors, allowing facilities to use NIV outside of the intensive care or emergency department environment. However, using NIV to treat patients with acute respiratory failure outside of those environments has not been well-studied and should be avoided when possible.[10,17]

If a patient requires transport while on NIV, portability will need to be considered. Devices vary significantly regarding their battery life. Some devices are equipped only with internal batteries, while others have optional external batteries to supplement internal batteries. Either way, when a compressor is in use, battery life may be shortened significantly.[18]

Finally, clinicians responsible for the initiation and subsequent NIV management should be familiar

with the NIV device and its adjuncts. Clinical training programs designed to familiarize clinicians with NIV should include comprehensive training on the nuances between devices, appropriate sizing of mask interfaces, humidity, aerosol delivery techniques, and strategies to improve patient compliance.

SUMMARY

A substantial amount of literature informs clinicians about proper patient selection regarding NIV. However, to be successful, clinicians also should consider how devices and settings can affect NIV success. Those responsible for initiating and managing NIV should be well-trained in all aspects of the modality beyond the clinical indications. ■

REFERENCES

1. Hess DR. Noninvasive ventilation for acute respiratory failure. *Respir Care* 2013;58:950-972.
2. Pearson SD, Patel BK. Noninvasive ventilation for acute asthma: The neglected sibling. *Am J Respir Crit Care Med* 2020;202:1491-1493.
3. Vital FM, Ladeira MT, Atallah AN. Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary oedema. *Cochrane Database Syst Rev* 2013;(5):CD005351.
4. Masip J, Betbesé AJ, Páez J, et al. Non-invasive pressure support ventilation versus conventional oxygen therapy in acute cardiogenic pulmonary oedema: A randomised trial. *Lancet* 2000;356:2126-2132.
5. Hess DR. The evidence is in: Noninvasive ventilation saves lives. *Crit Care Med* 2015;43:927-928.
6. Cabrini L, Landoni G, Oriani A, et al. Noninvasive ventilation and survival in acute care settings: A comprehensive systematic review and metaanalysis of randomized controlled trials. *Crit Care Med* 2015;43:880-888.
7. Patel BK, Wolfe KS, Pohlman AS, et al. Effect of noninvasive ventilation delivered by helmet vs face mask on the rate of endotracheal intubation in patients with acute respiratory distress syndrome: A randomized clinical trial. *JAMA* 2016;315: 2435-2441.
8. Raoof S, Nava S, Carpati C, Hill NS. High-flow, noninvasive ventilation and awake (nonintubation) proning in patients with coronavirus disease 2019 with respiratory failure. *Chest* 2020;158:1992-2002.
9. Scott JB, Vines DL. Noninvasive ventilation in the adult. In: Cheifetz I, MacIntyre NR, Marini J, eds. *Mechanical Ventilation: Essentials for Current Adult and Pediatric Practice*, 1st ed. Society of Critical Care Medicine; 2017:199-216.
10. Scott JB. Ventilators for noninvasive ventilation in adult acute care. *Respir Care* 2019;64:712-722.
11. Scala R, Naldi M. Ventilators for noninvasive ventilation to treat acute respiratory failure. *Respir Care* 2008;53:1054-1080.
12. Chatburn RL. Which ventilators and modes can be used to deliver noninvasive ventilation? *Respir Care* 2009;54:85-101.
13. De Luca A, Sall FS, Khoury A. Leak compensation algorithms: The key remedy to noninvasive ventilation failure? *Respir Care* 2017;62:135-136.
14. Rabec C, Rodenstein D, Leger P, et al; SomnoNIV group. Ventilator modes and settings during non-invasive ventilation: Effects on respiratory events and implications for their identification. *Thorax* 2011;66:170-178.
15. Scott JB, De Vaux L, Dills C, Strickland SL. Mechanical ventilation alarms and alarm fatigue. *Respir Care* 2019;64:1308-1313.
16. Scala R. Ventilators for noninvasive mechanical ventilation: Theory and technology. In: Esquinas AM, ed. *Noninvasive Mechanical Ventilation: Theory, Equipment, and Clinical Applications*. Springer International Publishing; 2015:41-54.
17. Cabrini L, Esquinas A, Pasin L, et al. An international survey on noninvasive ventilation use for acute respiratory failure in general non-monitored wards. *Respir Care* 2015;60:586-592.
18. Blakeman TC, Robinson BRH, Branson RD. Battery performance of 4 intensive care ventilator models. *Respir Care* 2010;55:317-321.

ABSTRACT & COMMENTARY

COVID-19 ARDS Is Associated with Higher Compliance and Lung Gas Volume Compared to Non-COVID-19 ARDS

By Vibhu Sharma, MD, MS

Assistant Professor of Medicine, University of Colorado, Denver

SYNOPSIS: This retrospective analysis compared historical cohorts with COVID-19-related acute respiratory distress syndrome (ARDS) with respect to compliance and arterial partial pressure of oxygen/fraction of inspired oxygen (P/F) ratios. For comparable P/F ratios, patients with ARDS caused by COVID-19 had higher lung compliance and more lung gas volume.

SOURCE: Chiumello D, Busana M, Coppola S, et al. Physiological and quantitative CT-scan characterization of COVID-19 and typical ARDS: A matched cohort study. *Intensive Care Med* 2020;46:2187-2196.

This was a small, retrospective cohort study wherein 32 consecutive patients with COVID-19-related acute respiratory distress syndrome (ARDS) were matched with two historical ARDS cohorts, one matched for compliance (Crs) and the other matched for arterial partial pressure of

oxygen/fraction of inspired oxygen (P/F) ratio. Historical cohorts also were matched for age, sex, ideal body weight, and body mass index (BMI). The study cohorts were comprised of patients cared for in Milan, Italy, by Luciano Gattinoni's group.

Crs and P/F ratios for the matching non-COVID-19 cohorts were obtained at a positive end-expiratory pressure (PEEP) of 5 cm H_2O during mechanical ventilation immediately before computed tomography (CT) imaging. CT imaging was available for all patients, and all patients underwent standardized physiologic testing and management as per the institution-specific protocol and ARDSNet criteria, respectively.

Whole lung imaging was performed under static conditions (all patients received muscle relaxation) with an end-expiratory breath hold at 5 cm H_2O PEEP. Lung weight, gas volume, and amount of overinflated, well-aerated, poorly aerated, and non-aerated tissue were estimated using CT criteria. The radiodensity of various tissues is estimated by linear transformation of attenuation coefficients and expressed in Hounsfield units (HU). Overinflated tissue was estimated by assessing overall estimates of tissue with radiodensity of -1,000 HU to -900 HU, well-aerated tissue at -899 HU to -500 HU, poorly aerated tissue at -499 HU to -100 HU, and non-aerated tissue at -100 HU to + 100 HU. All analyses were performed using proprietary software on each whole slice as well as on 10 equally spaced slices on each lung.

Both COVID-19 ARDS and matched non-COVID-19 ARDS cohorts had similar baseline characteristics. At similar P/F ratios, COVID-19-ARDS lungs had higher compliance (49.9 ± 15 vs. 39.9 ± 11 mL/cm H_2O; $P = 0.003$) as well as lower plateau pressures (Pplat) and driving pressures. At similar compliance levels, COVID-19-ARDS P/F ratios were significantly lower than matched non-COVID-19-ARDS P/F ratios (106.5 ± 59 vs. 160 ± 62 mmHg; $P < 0.001$). Alveolar to arterial oxygen concentration (A-a) gradients were higher in both compliance-matched and P/F-matched non-COVID-19 ARDS. Interestingly, although P/F ratios decreased as Crs dropped in non-COVID-19 ARDS, this was not true in the group of patients with COVID-19 ARDS. Indeed, there was no association between Crs and P/F ratios in COVID-19-ARDS lungs.

With respect to CT criteria, when matched for P/F ratio, COVID-19-ARDS lungs had more aerated lung tissue, less non-aerated lung tissue, and more normally aerated lung tissue. When matched for Crs, COVID-19-ARDS lungs had higher lung gas volumes. When measured by lung segment, COVID-19-ARDS lungs had the highest gas volumes, followed by Crs-matched non-COVID-19-ARDS lungs, and then P/F-matched non-COVID-19-ARDS lungs. The authors also assessed response to a PEEP trial, wherein PEEP was increased from 5 cm H_2O to 15 cm H_2O. Oxygenation improved in all three cohorts. However, dead space and respiratory system mechanics improved in the P/F-matched non-COVID-19-ARDS cohort, but remained unchanged or worsened in the Crs-matched non-COVID-19-ARDS cohort and the COVID-19-ARDS cohort.

■ COMMENTARY

The results of this interesting study contrast with some large studies that have shown that COVID-19 ARDS is similar to non-COVID-19 ARDS with respect to lung compliance and P/F ratios. The authors surmised that this may be related to the timing/condition of measurements. In this study,

all measurements were made at a PEEP of 5 cm H_2O and at 9.6 ± 4 days after the onset of COVID symptoms and were compared to non-COVID-19-ARDS patients early in their disease course (< 7 days from admission). As the disease course progresses, the imaging findings of COVID-19 ARDS progressively change from bilateral diffuse ground glass opacities to consolidations seen in the more typical non-COVID-19-ARDS population caused by sepsis and trauma, for example.

[Although the histologic pattern of lung injury in both COVID-19 ARDS and influenza-related ARDS is diffuse alveolar damage, lungs from patients with COVID-19 ARDS show unique pathology.]

One reason for the higher lung gas seen in COVID-19-ARDS lungs may be the unique endothelialitis that accompanies COVID-19 ARDS. Although the histologic pattern of lung injury in both COVID-19 ARDS and influenza-related ARDS is diffuse alveolar damage, lungs from patients with COVID-19 ARDS show unique pathology. A histologic analysis found a nine-fold higher prevalence of alveolar capillary microthrombi compared with influenza.[1] Neovascular angiogenesis also was seen more frequently. Both of these processes likely lead to a larger dead space fraction. Therefore, ventilation-perfusion (V/Q) mismatching seen in these patients may be related to the abnormalities in the capillary bed and not the result of alveolar filling or shunt physiology that is seen in more typical ARDS. However, this remains speculative, and more studies are needed to better define the endothelialitis that accompanies COVID-19 ARDS.

Case series of COVID-19 ARDS have demonstrated low lung compliance similar to patients with non-COVID-19 ARDS and the need for high levels of PEEP to maintain oxygenation.[2-4] Although there may be a subset of patients with COVID-19 ARDS that has higher lung gas volumes when studied early in their disease onset, the preponderance of the evidence suggests that, on average, COVID-19 ARDS and non-COVID-19 ARDS have similar physiology, and the overall differences are not significant enough to merit a change in ventilator management. Until a large, multicenter, randomized study is able to demonstrate conclusively that a different approach to ventilator management of early COVID-19 ARDS (or the subset with higher lung gas) leads to improved outcomes, it is prudent to continue to rigorously adhere to the well-established ARDSNet criteria. ■

REFERENCES

1. Ackermann M, Verleden SE, Kuehnel M, et al. Pulmonary vascular endothelialitis, thrombosis, and angiogenesis in Covid-19. *N Engl J Med* 2020;383:120-128.
2. Schenck EJ, Hoffman K, Goyal P, et al. Respiratory mechanics and gas exchange in COVID-19-associated respiratory failure. *Ann Am Thorac Soc* 2020;17:1158-1161.
3. Grasselli G, Tonetti T, Protti A, et al. Pathophysiology of COVID-19-associated acute respiratory distress syndrome: A multicentre prospective observational study. *Lancet Respir Med* 2020;8:1201-1208.
4. Grasselli G, Zangrillo A, Zanella A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy region, Italy. *JAMA* 2020;323:1574-1581.

ABSTRACT & COMMENTARY

Defining Patient- and Family-Centered Care Outcomes in the ICU

By Betty Tran, MD, MSc

Associate Professor of Medicine, Division of Pulmonary and Critical Care Medicine, Northwestern University Feinberg School of Medicine, Chicago

SYNOPSIS: Using semi-structured interviews with intensive care unit (ICU) survivors and their family members, investigators identified several ICU processes of care and outcomes after the ICU that were important to this population.

SOURCE: Auriemma CL, Harhay MO, Haines KJ, et al. What matters to patients and their families during and after critical illness: A qualitative study. *Am J Crit Care* 2021;30:11-20.

There is no agreed-upon definition of high-quality patient- and family-centered (PFCC) care in the intensive care unit (ICU). To fill this void, Auriemma et al aimed to determine: 1) the aspects of care that patients and families valued during their ICU time, 2) outcomes that they prioritized after discharge, and 3) the outcomes they viewed as equivalent to or worse than death.

Adult, English-speaking patients or patient caregivers with a medical ICU length of stay (LOS) of at least four days were approached for recruitment into the study, with interviews to begin after hospital discharge. Interviews were semi-structured, using a qualitative content-analysis approach whereby key concepts were identified and coded to identify themes and patterns.

Overall, 49 interviews were conducted (19 ICU survivors, 18 family caregivers of survivors, and 12 family caregivers of deceased patients) during a median of 18 days after hospital discharge (interquartile range [IQR] of 14-47 days for patients, 16-48 days for caregivers). Most patient participants were women (68%) with a median ICU LOS of 11 days (IQR, 7-13 days) and hospital LOS of 23 days (IQR, 15-29 days).

Regarding ICU processes of care, patients and their families prioritized communication with providers, patient comfort and avoidance of pain, and they frequently wanted to know that the medical team was providing exhaustive medical care (i.e., was "doing everything"). In terms of post-discharge outcomes, 25% cited survival as the most important ICU outcome, but most participants qualified this within a range of specific functional outcomes that mattered most to them. About 50% of participants mentioned either physical function (independence, not being a burden to others) or cognitive function (ability to communicate) as a part of meaningful survival.

When asked if there were post-ICU outcomes worse than death, nine participants answered no, but the majority listed various levels of dysfunction as bad or worse than death that included: inability to communicate, severe physical disability (especially lack of independence necessary to "maintaining dignity"), dependence on machines or medical equipment, and severe or constant pain.

■ COMMENTARY

This study extends prior knowledge on salient aspects of the patient and caregiver ICU experience by providing themes that may serve as important future PFCC outcome measures. Needham et al previously published a set of patient-centered outcomes for survivors of acute respiratory failure that included measurements in the areas of cognition, pain, survival, and physical function and symptoms.[1] This study aligns with that work and also extends it by focusing on perspectives mainly from patients and their family caregivers and including feedback from a broader population of ICU survivors (i.e., not just those admitted with acute respiratory failure).

[Regarding ICU processes of care, patients and their families prioritized communication with providers, patient comfort and avoidance of pain, and they frequently wanted to know that the medical team was providing exhaustive medical care.]

Limitations of this study to consider include the fact that it was conducted in a single medical ICU with high mortality rates and LOS, it was not culturally diverse (it included only English speakers), and it was done mostly within one month after hospital discharge and, therefore, was unable to capture whether perspectives of patients and/or caregivers changed over time.

Framing the question of whether there are post-ICU outcomes as bad or worse than death is a different approach to asking whether there are health outcomes that patients and caregivers would prefer to avoid when deciding whether to pursue aggressive ICU interventions.

Although more work is needed to determine whether these outcomes should be used in studies evaluating specific ICU interventions, this study supports the notion that outcomes such as mortality rate, number of ventilator-free days, and ICU length of stay, although easier to quantify and measure, are unlikely to provide a full view of patients' and caregivers' ICU experiences to promote PFCC goals. ■

REFERENCE

1. Needham DM, Sepulveda KA, Dinglas VD, et al. Core outcome measures for clinical research in acute respiratory failure survivors. An international modified Delphi consensus study. *Am J Respir Crit Care Med* 2017;196:1122-1130.

CME/CE INSTRUCTIONS

To earn credit for this activity, please follow these instructions:

1. Read and study the activity, using the provided references for further research.

2. Log on to **ReliasMedia.com** and click on My Account. First-time users must register on the site. Tests are taken after each issue.

3. Pass the online test with a score of 100%; you will be allowed to answer the questions as many times as needed to achieve a score of 100%.

4. After successfully completing the test, your browser will be automatically directed to the activity evaluation form, which you will submit online.

5. Once the completed evaluation is received, a credit letter will be emailed to you.

CME/CE OBJECTIVES

Upon completion of this educational activity, participants should be able to:

- identify relevant topics in the practice of critical care medicine;
- utilize recommendations from current clinical guidelines; and
- manage common critically ill patient and ICU administration scenarios.

CME/CE QUESTIONS

1. **Regarding bi-level and critical care ventilators, which of the following statements is true?**
   a. Bi-level ventilators are superior and should be used only to deliver noninvasive ventilation (NIV).
   b. Critical care ventilators are superior and should be used only to deliver NIV.
   c. Both bi-level ventilators and some critical care ventilators can be effective at providing NIV.
   d. The settings for NIV are the same between bi-level ventilators and critical care ventilators when the NIV mode is turned on.

2. **If skin breakdown is of concern during NIV, the clinician should avoid which of the following?**
   a. Overtightening the mask
   b. Adding skin barriers
   c. Assessing for proper mask fit
   d. Changing to a different mask interface

3. **Chiumello et al reported which one of the following with respect to COVID-19 acute respiratory distress syndrome (ARDS) compared to oxygen/fraction of inspired oxygen ratio-matched non-COVID-19 ARDS?**
   a. Higher lung gas volumes
   b. More non-aerated lung tissue
   c. Less normally aerated tissue
   d. Lower lung compliance

4. **In the study by Auriemma et al, which of the following was a salient process of care theme in the intensive care unit (ICU) based on interviews of ICU survivors and their families?**
   a. Limiting the number of invasive procedures
   b. Increasing access to therapy animals
   c. Improving sleep quality and duration
   d. Supporting a sense of exhaustive medical care (“doing everything”)