effective care strategies. Such evidence-based care can then be disseminated broadly to all physicians who encounter patients with PASC to advance the care of this growing population. For example, it is important for clinical and research leaders to remain up to date with evolving PASC guidelines and the development of core outcome measures. Local resources and capacity will determine whether these clinical structures derive leadership from primary care, pulmonary medicine, physical medicine and rehabilitation, or other specialties as is the case in PASC clinics across the United States. We advocate strongly for a concentrated leadership model, regardless of the primary discipline, while the knowledge base is being developed. This provides a central resource to coordinate the care of often complex presentations. The pre-COVID-19 literature in recovery from acute care that requires hospitalization, including in the ICU, has jumpstarted comprehensive care of survivors of COVID in these populations and provided a substantive framework for the care of those who did not require hospitalization. Importantly, PASC clinics provide a structure for the identification of similarities and differences between patients with initial mild vs moderate-to-severe COVID-19 illness to further tailor management approaches.

Ultimately, necessary and sufficient care will require cooperation across multiple disciplines, especially primary care, to advocate for essential resources; together, we can overcome this challenge. We applaud your novel approach and look forward to learning about more innovative methods from our national and international colleagues as we collectively join our patients in confronting PASC/long COVID.

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Central Sleep Apnea

Adaptive Servo-Ventilation, Intelligent Volume-Assured Pressure Support, and Hypoventilation

To the Editor:

Treatment-emergent central sleep apnea (TEC) is the development or persistence of central sleep apneas during positive airway pressure (PAP) therapy in subjects with predominantly OSA. Risk factors for TEC and the role of loop gain are well-reviewed by Zeineddine and Badr1 in an issue of CHEST (June 2021). However, we disagree with some of their statements and use a different approach to TEC.

They say “BPAP (bilevel positive airway pressure) delivers fixed tidal volume for a given pressure support (PS) level,” but tidal volume varies with respiratory effort, muscle activity, airway patency, and body position. Lower tidal volume (and higher PCO2) can occur supine vs not supine and rapid eye movement (REM) vs non-REM for a given pressure support.

They say “ASV (adaptive servo-ventilation) is contraindicated in patients with reduced ejection fraction.”, but the American Association of Sleep Medicine recommends not using ASV only for patients with left ventricular ejection fraction (LVEF) ≤45% and predominant moderate or severe central sleep apnea.2 The Treatment of Sleep-Disordered Breathing with Predominant Central Sleep Apnea by Adaptive Servo Ventilation in Patients with Heart Failure (SERVE-HF) trial3 of patients with LVEF <45% excluded patients with primarily OSA and thus patients with TEC. The SERVE-HF trial also found that ASV improved outcomes in patients with Cheyne Stokes respiration <20% of recording time,4 which suggests that the ASV risk is low in the TEC population.

We found improved central apneas and worse obstructive apneas during REM compared with non-REM and worse central sleep apneas with BPAP than
CPAP and that central apneas can persist with BPAP spontaneous timed mode.\(^5\) Higher pressure support during BPAP titration often triggers central apneas and backup rate in spontaneous timed mode, forcing large breaths when PCO\(_2\) is lowest during Cheyne Stokes central apneic periods that often extends the central apnea duration.

Our approach to PAP titration includes transcutaneous CO\(_2\) (TCCO\(_2\)) monitoring and intelligent volume-assured pressure support (iVAPS). With the availability of volume assured pressure support, we no longer titrate BPAP spontaneous timed mode. We first titrate CPAP to treat obstructive and/or central events. If there is intolerance of CPAP, hypoventilation, or central apneas on CPAP, we titrate BPAP spontaneous mode to eliminate obstruction, and if hypoventilation, we increase pressure support to improve TCCO\(_2\). Then for patients with emergent or persisting central apnea on BPAP, we titrate ASV if TCCO\(_2\) is not elevated and if the patient does not have predominant central sleep apnea with LVEF \(<\)45\%, otherwise we titrate iVAPS. ASV varies pressure support with a backup rate to even out breathing by targeting 90\% recent minute ventilation (ResMed) or 90\% to 95\% of recent tidal volume (Phillips Respironics),\(^6\) so it is appropriate when TCCO\(_2\) is not elevated. If poorly controlled sleep apnea or hypoventilation occurs while the patient is on ASV, we also titrate iVAPS. iVAPS varies the level of pressure support to maintain a target alveolar ventilation (and thus PCO\(_2\)) and lowers the backup rate during spontaneous breathing.\(^6\)

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References

Response
To the Editor:

We thank the authors for calling attention to the challenges of treating treatment-emergent central sleep apnea (TECSA) and for highlighting their management approach. We recognize the limitations of existing literature and the need to incorporate physiologically based approaches into the management strategy; therefore, our review aimed to supplement best available evidence with our experience in treating this challenging condition. The authors raise several substantive points:

First, we agree with the authors that delivered tidal volume during bilevel positive airway pressure (BPAP) therapy is influenced by several variables, most importantly the resistance and elastance of the respiratory system, both of which may vary throughout the night and by changing sleep position.

Second, regarding the use of adaptive servo-ventilation (ASV) in patients with heart failure with reduced ejection fraction, we posit that ASV should not be used in patients with TECSA and heart failure with reduced ejection fraction (defined as left ventricular ejection fraction \(\leq\)45\%). We believe that the American Association of Sleep Medicine recommendation of not using ASV for patients with left ventricular ejection fraction \(\leq\)45\% and predominant moderate or severe central apnea applies only to those with clinically significant TECSA.\(^2\) Regardless, the presence of reduced ejection fraction may indicate increased risk of the use of ASV, given the co-existence of obstructive and central events and the contribution of central events to upper airway narrowing during sleep.\(^3\)

Third, the authors also questioned the utility of using BPAP-spontaneous timed mode (with back up rate), opting instead to use BPAP as a pressure-support device (with no back up rate or BPAP-spontaneous timed mode). We do not use BPAP-spontaneous timed mode alone, given the likelihood that BPAP may worsen...