In intubated patients, mechanical ventilation offers essential ventilatory support, while the respiratory system recovers from acute respiratory failure. Yet, invasive mechanical ventilation is associated with risks and complications that prolong the duration of mechanical ventilation and increase the risk for death. Increasing duration of mechanical ventilation itself is associated with increased mortality. Therefore, safely weaning the patient from the ventilator as soon as possible is paramount. A multisociety consensus conference characterized the weaning process as a continuum lasting from intubation until hospital discharge (Figure 1). Recognizing that respiratory failure and respiratory muscle function have improved and the patient is capable of spontaneous breathing, is termed readiness testing. Most patients satisfying readiness criteria tolerate spontaneous breathing (with no or minimal ventilator support) indicating that mechanical ventilation is no longer necessary. A minority of patients fail and may need a more gradual approach, with success ultimately dependent on identifying correctable causes for weaning intolerance. Once spontaneous breathing is tolerated, attention shifts to determining whether the patient can be extubated (Figure 2).

A new classification of weaning makes use of the following definitions:

1. Simple weaning: Patient tolerates first spontaneous breathing trial (SBT) and is successfully extubated (70% of all patients).
2. Difficult weaning: Patient fails to tolerate initial SBT, successful weaning requiring up to three SBTs or up to 7 days from first SBT.
3. Prolonged weaning: Patient fails at least three SBTs or takes more than 7 days after the first SBT.

Approximately one-third of patients fall into the difficult and prolonged categories and experience higher ICU
mortality (approximately 25%) than seen with simple weaning (approximately 5%). The higher mortality rate seen with difficult and prolonged weaning may result from either complications of mechanical ventilation or the underlying illness leading to mechanical ventilation.

Readiness Testing

The patient’s capacity to breathe spontaneously is often underestimated. For example, 50% of patients who self-extubate do not require reintubation. Rapid weaning must be balanced against the risks of premature spontaneous breathing. Objective assessments are favored because subjective, clinical judgment appears to be relatively inaccurate in assessing readiness. Nevertheless, 30% of patients never satisfying objective readiness criteria can still be successfully weaned.

A comprehensive evidence-based medicine review identified more than 50 objective physiologic tests (weaning predictors) as tools for assessing readiness for spontaneous breathing. Of the sufficiently studied weaning predictors, only five were associated with clinically significant changes in the probability of weaning success or failure but predictive capacity was modest.

Weaning predictors are given as follows:
1. Negative inspiratory force (maximal inspiratory pressure);
2. Minute ventilation;
3. Respiratory frequency;
4. Tidal volume; and
5. Frequency–tidal volume ratio (f/V T).

Measurement of f/V T during the initial 1–3 minutes of unassisted breathing, was most accurate, although associated with only a moderate change in the probability of success or failure. One problem is related to how the measurements are made. For example, one study showed lower f/V T when measured on pressure-support ventilation (PSV) or continuous positive airway pressure (CPAP) compared with T-piece. Consequently, an analysis of investigations of the f/V T noted an average sensitivity of 0.87, and concluded that heterogeneity in performance of the test was explained by variation in pretest probability of successful outcome.

The more clinically relevant question is whether the f/V T, or any weaning predictor, actually facilitates weaning decision-making. Tanios et al. randomized 304 patients ventilated for a minimum of 24 hours, determining a five-component daily screen (PaO₂/FiO₂, positive end-expiratory pressure [PEEP], hemodynamic stability, mental status, adequate cough, f/V T) in each. Those passing the screen were given a 2-hour SBT and then considered for extubation if the SBT was tolerated. In one group, f/V T was not used for weaning decision-making, whereas in the other only patients with f/V T less than 105 breaths/minute underwent an SBT. The group randomized to use of the f/V T took longer to wean and other outcomes were similar; there was no advantage to using the f/V T. One explanation is the demonstrated safety of a closely monitored SBT. Furthermore, Laghi et al. used phrenic nerve stimulation and found that low-frequency fatigue did not occur in patients failing a T-piece trial. Thus, a failed SBT should not result in respiratory muscle injury as long as patients are quickly reconnected to the ventilator when signs of weaning intolerance occur. Although unproven, structural respiratory muscle injury may occur if the failed weaning trial is improperly extended.

These concepts are supported by the Awakening and Breathing Controlled (ABC) trial, in which greater than 50% passed an SBT when readiness was assessed using liberal oxygenation criteria.
Direct extubation after satisfying readiness criteria alone is unwise, as 40% of such patients require reintubation. Therefore a trial of spontaneous breathing, carried out on low-level pressure support (PSV ≤ 7 mmHg), CPAP, or unassisted through a T-piece, is indicated. Randomized controlled trials (RCTs) indicate these techniques are equivalent. Theoretically, PSV more effectively counterbalances endotracheal tube-related resistive workload, but a given level may either over-compensate or under-compensate for imposed work.

This limitation might be overcome by using automatic tube compensation (ATC), a technique that continuously adjusts PSV level on the basis of tube characteristics. One study found SBTs conducted with either ATC, PSV, or T-piece to be equivalent, whereas another found a trend for higher SBT success for ATC compared with CPAP. In a nonrandomized study of patients failing a 30-minute T-tube trial, immediate conversion to PSV 7 cm H2O for additional 30 minutes led to weaning success in 21 of 31 patients, suggesting the endotracheal tube can contribute to iatrogenic weaning failure.

Optimal SBT duration has been examined in two studies suggesting that 30 minutes is equivalent to 120 minutes with either T-piece or PSV. Optimal SBT duration may depend upon the duration of ventilation or the underlying cause for respiratory failure. An investigation of 75 patients with chronic obstructive pulmonary disease (COPD), ventilated for 15 or more days, found a median time to trial failure of 120 minutes. Therefore, in some patients the SBT should be extended to at least 120 minutes.

Causes of Weaning Failure

Several mechanisms for weaning failure have been identified including an imbalance between respiratory load and capacity (e.g., diaphragmatic strength and endurance). Excessive load may be imposed by the endotracheal tube, heat and moisture exchange devices, or the ventilator tubing and valves. Intrinsic factors such as increased airways resistance, increased elastance from dynamic hyperinflation, and reduced respiratory muscle capacity are more commonly responsible. Respiratory muscle fatigue does not occur as a consequence of a failed SBT, if that trial is closely monitored and the patient returned to ventilatory support as soon as distress appears. Diaphragmatic fatigue may also be avoided in weaning-failure patients because they recruit inspiratory ribcage, expiratory, and the sternocleidomastoid muscles.

Nevertheless, reductions in respiratory muscle endurance are likely to be important. Measures of load/capacity balance (indices of respiratory muscle endurance), the tension time index, trends in esophageal pressure swings, and the ratio P1/MIP (where P1 is mean inspiratory pressure and MIP is maximal inspiratory pressure) are independent predictors of weaning outcome. The latter index is calculated using the mean airway pressure obtained during passive inflation on assist-control ventilation with T1/Ttot set at 1/3.

An important component of load/capacity imbalance is reduced respiratory muscle strength. Mechanisms include reduced diaphragmatic pressure generation secondary to dynamic hyperinflation and phrenic nerve injury after cardiac surgery. Other identified causes include critical illness neuromyopathy, ventilator-induced diaphragmatic dysfunction, and the effects of endocrinopathy (e.g., hypothyroidism, adrenal insufficiency) or malnutrition.

Cardiac dysfunction contributes to weaning failure especially in patients with coronary artery disease or chronic heart failure. The elevated work of breathing and associated release in catecholamines resulting from spontaneous breathing can induce myocardial ischemia. Spontaneous (negative pressure) breathing is associated with increased left ventricular preload and afterload, causing an elevation of transmural pulmonary artery occlusion pressure and resulting in pulmonary edema. Additionally, left ventricular compliance can decrease with myocardial ischemia or because of ventricular interdependence. Patients failing SBTs may not appropriately increase cardiac output and stroke volume during the trial, manifested as decreased mixed venous oxygen...
satisfaction or increased oxygen extraction ratio. \(^{45-47}\) Patients at risk for weaning failure from cardiac disease can manifest an elevated B-type natriuretic peptide (BNP) \(^{48}\) or N-terminal pro-BNP \(^{49}\) prior to the weaning trial or an elevated N-terminal pro-BNP at the end of the trial. In one study, a pre-SBT BNP more than 275 pg/dL correlated with a longer duration of weaning. \(^{48}\) The stress of weaning is considerable as it results in increased levels of plasma insulin, cortisol, and glucose. \(^{50}\) Lastly, positive fluid balance has been associated with weaning failure. \(^{51}\)

**Progressive Withdrawal**

Once reversible factors contributing to weaning intolerance are corrected, further efforts are made to wean from mechanical ventilation. How long should the patient rest after a failed weaning effort? When clinical evidence of respiratory muscle fatigue is absent, multiple daily SBTs are well tolerated. Yet, a comparison of two international studies found declining use of this approach from 1998 to 2004. \(^{2,52}\) In contrast, if unequivocal evidence for fatigue is evident then clinicians should consider providing 24 hours of rest on full support before preceding with the next weaning effort. \(^{53}\)

The clinician must decide whether to perform daily SBTs or whether to more gradually reduce ventilatory support (progressive withdrawal). Whether progressive withdrawal trains or reconditions the respiratory muscles or simply provides time needed for recovery is unknown. Along these lines, a randomized trial showed no benefit to using inspiratory muscle training. \(^{54}\) Two RCTs compared progressive withdrawal techniques in patients satisfying readiness criteria but intolerant of a 2-hour SBT. \(^{55,56}\) Although one study found T-piece superior and the other observed PSV to be most efficient, both demonstrated that synchronized intermittent mandatory ventilation (SIMV) alone delays the process. This is in agreement with physiologic investigations demonstrating the degree of respiratory muscle rest on SIMV is not proportional to the level of ventilatory support. The neuromuscular apparatus poorly adapts to changing loads because respiratory muscle contraction during lower levels of SIMV is similar during both intervening (unsupported) and mandatory (supported) breaths. \(^{57}\) This effect can be overcome by adding low-level PSV to the unsupported breaths during SIMV. \(^{58,59}\) A more recent investigation randomized patients to SBTs (120 min) with T-piece or PSV and found the latter associated with decreased weaning time, duration of mechanical ventilation, and ICU length of stay. \(^{60}\) These results must be scrutinized as the study was not blinded, the weaning protocol not explicitly stated, and the randomization unequal (150 patients to PSV, 110 patients to T-piece).

Three published RCTs have explored the use of noninvasive ventilation (NIV) in patients having trouble weaning from mechanical ventilation. \(^{51,61-63}\) The most recent randomized 43 patients who had failed three SBTs, 77% of whom had chronic lung disease. \(^{61}\) This study was stopped at an interim analysis finding that NIV was associated with shorter duration of mechanical ventilation, shorter ICU and hospital stay, fewer tracheostomies, higher ICU survival, and a lower incidence of nosocomial pneumonia and septic shock. These studies indicate that NIV can facilitate weaning in a highly select group of patients with acute on chronic lung disease. Important caveats include the following: SBT readiness criteria must be satisfied; extubation criteria must be satisfied; and, the patient must be a good candidate for NIV (able to breathe spontaneously for at least 5–10 minutes and not be a difficult reintubation).

Can the weaning process be automated? One multicenter study randomized 144 patients to conventional weaning versus computerized weaning using a closed-loop knowledge-based system. \(^{64}\) The computer-driven ventilator continuously monitors physiologic parameters (respiratory rate, tidal volume, PetCO\(_2\)) and adjusts pressure support by 2–4 cm H\(_2\)O to maintain the patient in a “zone of comfort.” When a minimal level of PSV is reached, an SBT is conducted and the clinician prompted if the SBT proves successful. Computer-driven ventilation resulted in decreased duration of weaning, total duration of ventilation, median ICU stay, without adverse event or increase in reintubation. A subsequent single-center study using the same computerized system was unable to confirm the superiority of this approach. \(^{65}\) Differences in ICU staffing, management of the control arms, and the patient population may explain the disparate results; the latter study had younger patients (none with COPD) with less severity of illness.

**Weaning Protocols**

In certain settings, uncontrolled investigations and RCTs demonstrate improved outcome with protocol-driven weaning implemented by physicians or by respiratory care practitioners and ICU nurses. Ely et al. \(^{66}\) randomized 300 mechanically ventilated medical patients to either standard care or an intervention strategy that combined readiness testing with a daily screen. Control patients were screened but the testing did not influence care. In contrast, intervention patients passing the daily screen underwent a 2-hour SBT with a prompt for extubation if the trial was tolerated. The intervention strategy resulted in significant decrease in weaning time, duration of mechanical ventilation, complication rate, and ICU costs; no differences were noted in ICU or hospital length of stay, hospital costs, or mortality. Two RCTs in medical and surgical ICUs found that a protocol directed by a respiratory care practitioner–ICU nurse also shortened mechanical ventilation duration. \(^{57,68}\) Protocols must be adapted to the local ICU environment and should be modified for application to unique patient populations. For example, subsequent studies performed in well staffed medical, \(^{69}\) neurosurgical, \(^{70}\) and pediatric \(^{71}\) ICUs found no advantage to a protocolized approach. In the latter settings, neurological dysfunction (not comprehensively assessed in the protocols tested) was tied to weaning failure.

Observational and randomized trials demonstrate that protocols directed at minimizing the use of sedative infusions shorten the weaning process. Specifically, approaches intended to avoid oversedation by limiting the use of
continuous infusions either through sedation assessment scoring or by daily cessation of sedative infusions, 

decrease duration of mechanical ventilation and duration of ICU stay. Nevertheless, a single-center Australian study showed no difference in outcome comparing nurse-managed sedation with or without a protocol. Girard et al. recently published the results of a trial that employed a “wake up and breathe” strategy (the ABC trial). Patients randomized to a daily awakening trial (SAT) followed by an SBT (versus SBT alone) experienced increased time off of mechanical ventilation, decreased time in coma, decreased ICU and hospital length of stay, and improved survival at 1 year. Interestingly, the two groups progressed to the point of passing an SBT at the same rate. Therefore, the improved outcome combining SAT and SBT derived from patients being awake and ready for extubation once they passed the SBT.

**Extubation**

Assessment for extubation follows successful completion of an SBT. Between 25 and 40% of patients develop signs of respiratory distress after extubation. Extubation failure, when defined as reintubation within the subsequent 24–72 hours, occurs in 5%–20% of patients, depending on the patient population. Risk is greatest for medical and neurologic patients. Reintubated patients experience increased hospital mortality, prolonged ICU and hospital stays, greater need for tracheostomy, and more frequently require long-term acute care. Conversely, avoidable delays in extubation prolong ICU stay, heighten the risk for pneumonia, and increase hospital mortality.

As both extubation delay and extubation failure are linked to adverse outcomes, strategies to more accurately predict and prevent postextubation respiratory failure have been sought. Measuring blood gases at the end of the SBT has not been shown to accurately predict extubation outcome. In general, traditional weaning predictors perform poorly in predicting extubation outcome. Although one study found utility in examining the f/V\textsubscript{T} at SBT conclusion, another found that serial measurements at 1, 30, and 120 minutes did not help predict risk for extubation failure. One promising technique has demonstrated that risk of extubation failure is associated with greater time needed to return to baseline minute ventilation after resumption of full ventilatory support. Another involves measuring the airway occlusion pressure at 0.1 second (P0.1) and the degree of expiratory flow limitation. Other recent described predictors of extubation failure include positive fluid balance in the 24 hours before extubation and, in patients with COPD, identifying a pathogen on quantitative culture of tracheobronchial secretions obtained with 72 hours of extubation.

Extubation failure often results from inability to protect the airway and manage respiratory secretions. The upper airway can be assessed by identifying an audible air leak when the endotracheal tube balloon is deflated (cuff leak test). Air leak can be quantified as the difference between the inspired and expired tidal volume during assist-control ventilation. False-positive tests result from secretions adhering to the external surface of the endotracheal tube or when an undetected increase in inspired volume (machine tidal volume and spontaneous gas inspired around the tube) contributes to an elevated exhaled tidal volume. Because these confounders are difficult to detect prior to extubation an expert in airway management should be immediately available when extubating the patient with a positive cuff leak test.

Recent RCTs demonstrate that systemic corticosteroids can reduce postextubation stridor, especially in high-risk patients. For example, Cheng et al. randomized 128 high-risk patients (cuff leak volume <24% of tidal volume) to placebo or methylprednisolone injection (multi-dose or single dose) during the 24 hours prior to extubation. Treatment with methylprednisolone significantly reduced the risk for postextubation stridor and need for reintubation.

The ability to protect the airway is also dependent upon cough strength and volume of respiratory secretions (e.g., suction requirement > every 2 hours), parameters that can be qualitatively and quantitatively measured. Mental status is also important, although studies looking exclusively at this parameter have come to conflicting conclusions. The integration of several parameters is most useful. Salam et al. found that measuring peak cough flow rates (cut-off <60 L/min), secretions (cut-off >2.5 mL/h) and abnormal mental status (inability to complete four simple commands) was highly predictive of extubation outcome. Failing all three criteria led to certain extubation failure, whereas the absence of all three was associated with only a 3% risk for reintubation.

Despite these advances, accurate prediction of extubation outcome remains challenging. The success of NIV for acute respiratory failure and its recent successful application in facilitating weaning has led to renewed interest in application to prevent extubation failure. Randomized trials in heterogeneous populations (few with COPD) with overt or those with early signs of extubation failure found that NIV does not decrease need for reintubation or improve survival. A case control study found that NIV effectively reduced reintubation in COPD patients with early evidence of postextubation hypercapnic respiratory failure. Two recently published RCTs indicate that immediate postextubation application of NIV in patients at highest risk for extubation failure is effective in preventing reintubation and may reduce mortality (Table 1).

**Weaning from Prolonged Mechanical Ventilation**

Ten to 20% of patients with acute respiratory failure require 21 or more days of ventilatory support and thus
constitute a subset of prolonged mechanical ventilation defined earlier. Once stable, these patients are often transferred to a chronic ventilator or long-term acute care unit. A recent multicenter observational study of more than 1400 patients transferred to long-term care hospitals found that 50% could be successfully weaned from mechanical ventilation. As in the acute ICU setting, standard weaning predictors perform poorly in foretelling outcome for patients with prolonged mechanical ventilation.

Weaning efforts should start as soon as possible after transfer as 10%–30% of patients with prolonged mechanical ventilation will tolerate their initial SBT and be liberated. For the remaining patients, an imbalance between respiratory load and neuromuscular capacity often forms the basis of ventilator dependence. The only RCT in prolonged mechanical ventilation found no difference between PSV weaning and tracheotomy collar trials of increasing duration in 52 patients with COPD. When compared with historic controls, weaning protocols in this long-term setting are associated with shorter duration of weaning than traditional strategies.

Conclusions

On the basis of a large body of well-conducted studies, there is now high-level evidence to guide many aspects of the weaning process. Patients are ready to breathe spontaneously much earlier than typically appreciated by even the most skilled clinicians. Determining readiness is best achieved using liberal oxygenation criteria; does not require routine use of weaning predictors; and can often be conducted using protocols driven by respiratory therapists or ICU nurses. SBTs should last at least 30 minutes and can be conducted on low levels of pressure support, CPAP, or T-piece. Weaning failure often results from an imbalance between respiratory load and capacity. Yet, there is increasing appreciation that cardiac dysfunction can be a limiting factor. Randomized trials suggest that NIV (in patients with COPD) and computer-driven approaches show promise as weaning strategies. New techniques can identify patients at highest risk for extubation failure. These include the qualitative cuff leak test and an assessment that integrates cough strength, the volume of respiratory secretions, and mental status. When used in high-risk patients, NIV can decrease extubation failure and the need for reintubation.

REFERENCES


65. Dawson SR, DePriest JL. Are blood gases necessary in mechanically ventilated patients who have successfully completed a spontaneous breathing trial? *Respir Care* 2004;49:1316-1319.


68. Dawson SR, DePriest JL. Are blood gases necessary in mechanically ventilated patients who have successfully completed a spontaneous breathing trial? *Respir Care* 2004;49:1316-1319.


View past, current, and future issues of your paid subscription to *Contemporary Critical Care* online for free! Follow these instructions to log on to your account.

1. Locate your **12-digit account number** on the mailing label of your current issue.
2. Go to: **www.lwwnewsletters.com**.
3. From the choices on the top yellow toolbar, select “**Sign On**.”
4. In the spaces provided, enter your “**Username**” and “**Password**.” Your **username** will be the letters **LWW** (case sensitive) followed by the 12-digit account number on your address label. We have provided an easy-to-remember “default” password for you: Simply type the numbers **1234**. (This password **cannot** be changed.)
5. Click “**Sign On**.”
6. Click “**Access My Account**.”
7. Click “**View or Renew Subscriptions**.” Click on “**Contemporary Critical Care**,” and select the current or archive issue you wish to view. All issues are posted in PDF format. You will need **Adobe Acrobat Reader** installed on your computer to view the issues. To download your free copy of the Acrobat Reader, visit [www.Adobe.com](http://www.adobe.com).

If you have any questions or problems regarding your print or electronic account, please call 1-800-787-8981.
CME QUIZ: Volume 7, Number 8

To earn CME credit, you must read the CME article and complete the quiz and evaluation on the enclosed answer form, answering at least seven of the 10 quiz questions correctly. Select the best answer and use a blue or black pen to completely fill in the corresponding box on the enclosed answer form. Please indicate any name and address changes directly on the answer form. If your name and address do not appear on the answer form, please print that information in the blank space at the top left of the page. Make a photocopy of the completed answer form for your own files and mail the original answer form in the enclosed postage-paid business reply envelope. Your answer form must be received by Lippincott CME Institute by December 31, 2010. Only two entries will be considered for credit. For more information, call (800) 787-8981.

Online quiz instructions: To take the quiz online, go to http://cme.LWWnewsletters.com, and enter your username and password. Your username will be the letters LWV (case sensitive) followed by the 12-digit account number on your mailing label. You may also find your account number on the paper answer form mailed with your issue. Your password will be 1234; this password may not be changed. Follow the instructions on the site. You may print your official certificate immediately. Please note: Lippincott CME Institute, Inc., will not mail certificates to online participants. Online quizzes expire at 11:59 pm Pacific Standard Time on the due date.

1. All of the following statements are true, except
   A. Weaning from mechanical ventilation must be accomplished as soon as possible to prevent ventilator-associated risks and complications.
   B. Most patients satisfying readiness criteria for weaning tolerate spontaneous breathing (with or no minimal ventilator support).
   C. At least half of patients fail the initial weaning attempt and may need a more gradual approach.
   D. Once spontaneous breathing is tolerated, attention shifts to determining whether the patient can be extubated.

2. Which one of the following statements is false?
   A. Weaning is a continuum lasting from intubation until extubation.
   B. Readiness for spontaneous breathing is best achieved using liberal oxygenation criteria.
   C. Weaning predictors have no role in determining readiness for spontaneous breathing.
   D. In some populations, readiness for spontaneous breathing can be conducted with respiratory therapist-driven or ICU nurse-driven protocols.
   E. Patients are considered ready for weaning when there is evidence of clinical improvement, oxygenation is adequate, hemodynamics are stable, and spontaneous breathing efforts are present.

3. Which one of the following statements is true?
   A. After satisfying readiness criteria alone, direct extubation is advised, as less than 10% of such patients require reintubation.
   B. Low-level pressure support, continuous positive airway pressure, and use of a T-piece are equivalent techniques to conduct a spontaneous breathing trial (SBT). There is no evidence that endotracheal tubes contribute to iatrogenic weaning failure.
   C. An SBT should not extend beyond 120 minutes.
   D. An SBT should not extend beyond 120 minutes.

4. Patients who experience prolonged weaning
   A. fail at least three SBTs or require more than 7 days after the first SBT
   B. are at 25% increased risk of death in the ICU
   C. may be more likely to die than patients who are more easily weaned, either from complications of mechanical ventilation or the underlying illness leading to mechanical ventilation
   D. of the above

5. Which one of the following statements is false?
   A. Correction of reversible factors contributing to weaning intolerance is an important component of successful weaning from mechanical ventilation.
   B. When clinical evidence of respiratory muscle fatigue is absent, multiple daily SBTs are well tolerated.
   C. When clinical evidence of respiratory muscle fatigue is present, clinicians should consider providing 24 hours of rest on full support before proceeding with the next weaning effort.
   D. There is no proven benefit to use of inspiratory muscle training.

6. Strategies to prevent postextubation respiratory failure include all of the following except
   A. use of systemic corticosteroids in high-risk patients
   B. having an expert in airway management immediately available when extubating the patient with a positive cuff leak test
   C. measuring blood gases at the end of the SBT
   D. ensuring peak cough flow rates, secretions, and mental status are within specific parameters
   E. immediate postextubation application of noninvasive ventilation (NIV) in patients at highest risk for extubation failure

7. Which one of the following patients is at increased risk for extubation failure?
   A. 60-year-old man with resolving intestinal obstruction
   B. 39-year-old woman with type 2 diabetes
   C. 45-year-old woman with hyperthyroidism
   D. 54-year-old man with coronary artery disease
   E. All of the above

8. Which of the following statements regarding NIV is true?
   A. NIV is appropriate for patients with acute or chronic lung disease.
   B. NIV is associated with shorter duration of mechanical ventilation and lower incidence of nosocomial pneumonia and septic shock.
   C. NIV is associated with shorter ICU and hospital stay, higher ICU survival rates, and fewer tracheotomies.
   D. SBT readiness and extubation criteria must be satisfied before NIV can be used.
   E. All of the above

9. Patients being transferred to a chronic ventilator or long-term acute care unit
   A. should undergo weaning efforts as soon as possible after transfer
   B. are good candidates for standard weaning predictors
   C. become permanently ventilator-dependent in more than half of cases
   D. achieve higher rates of success with use of traditional weaning strategies vs. weaning protocols
   E. None of the above

10. Which one of the following statements is false?
    A. Patients are ready to breathe spontaneously much earlier than typically appreciated by even the most skilled clinicians.
    B. Weaning failure often results from an imbalance between respiratory load and capacity.
    C. An imbalance between respiratory load and neuromuscular capacity often forms the basis of ventilator dependence.
    D. Cardiac dysfunction can be a factor that limits successful weaning from mechanical ventilation.
    E. None of the above