Noninvasive Ventilation in the Perioperative Period

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Introduction and Physiology

Noninvasive ventilation (NIV) is defined as ventilatory support that is delivered in a spontaneously breathing patient without establishing an endotracheal airway [1]. Instead, noninvasive ventilation is delivered through a tight-fitting mask applied to the face.

Like mechanical ventilation via endotracheal intubation, the goals of positive pressure noninvasive ventilation are the same: correct the underlying respiratory abnormality by improving oxygenation, ventilation, or both. To accomplish this task, patients who have an indication for NIV are connected to a ventilator circuit via a nasal mask or face mask. Depending on the clinical scenario, the ventilator is then either set to a volume-controlled setting or a pressure-controlled setting. Earlier noninvasive ventilators used volume ventilation settings that allowed for the delivery of a specific volume during the inspiratory cycle and were shown to be associated with improvement in acute respiratory failure [2, 3]. However, this mode is more difficult to tolerate for patients, and as the ventilator automatically adjusts airway pressures to achieve a specified volume, it can result in high inspiratory pressures and air leaks around the face or nose mask [4].

Since the early 1990s, pressure-controlled settings have been more commonly utilized, and their success has been demonstrated across levels of care and a variety of indications. Specifically, continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP) are the two most commonly used modes of noninvasive ventilation both of which can be delivered either by standard ICU ventilators or portable ventilators. Almost every mode of ventilation that can be delivered invasively can also be delivered noninvasively. However, certain modes are used more frequently. Here we will discuss BPAP and CPAP modes, but it is important for the provider to be aware that alternative modes of ventilation can be utilized (pressure support ventilation, assist control, proportional assist ventilation). The use of noninvasive ventilation in the medical population with acute COPD exacerbations and acute cardiogenic pulmonary edema is well established and beyond the scope of this chapter. Here we will focus our review on the physiology, rationale for use, equipment, indications, contraindications, and complications of NIV in the preoperative, intraoperative, and postoperative populations.

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Continuous Positive Airway Pressure (CPAP)

CPAP applies a fixed amount of positive pressure to be delivered continuously throughout the respiratory cycle and as such is a constant pressure but variable flow mode. This mode increases the functional residual capacity without increasing the tidal volume resulting in decreased atelectasis and reduced work of breathing [5–9]. Since CPAP does not provide additional pressure during inspiration, it technically does not directly support ventilation, but it does exert some effects that can indirectly improve ventilation. For example, by mitigating against atelectasis through increased alveolar recruitment, CPAP decreases the ventilation-perfusion mismatch caused by non-ventilated alveoli and improves hypoxemia. However, because CPAP cannot increase tidal volume, it is not indicated in the treatment of hypercapneic respiratory failure.

Bilevel Positive Airway Pressure (BPAP)

BiPAP, on the other hand, delivers variable positive pressure assistance to the patient at different phases of the respiratory cycle, in contrast to a set pressure applied continuously

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throughout the respiratory cycle as in CPAP mode. The terms "BiPAP" and "BIPAP" are often used incorrectly to refer to NIV in the BPAP mode. "BiPAP" refers to the BPAP mode of ventilation delivered by a specific portable ventilator manufactured by Respironics Corporation. Similarly, "BIPAP" stands for biphasic positive airway pressure and refers to a time-cycled, pressure-controlled mode that is also a constant pressure variable flow mode with a period of flow cessation for CO2 clearance available on ventilators produced by Draeger Medical, Inc. These are just two of the many ventilators that can deliver BPAP. Once this mode of NIV has been selected, the provider must then select the inspiratory positive airway pressure (IPAP) value and the expiratory positive airway pressure (EPAP) value. Unlike CPAP, BPAP will vary the pressure support delivered during inspiration and expiration and therefore must use a sensor which triggers alternation between the two pressures. This trigger is usually a flow or volume trigger that detects flow, volume, or pressure at the proximal airways.

Once the ventilator detects that a patient is exhaling, it will maintain positive pressure assistance equal to the EPAP value. When inspiration is detected, the ventilator delivers positive pressure assistance equal to the IPAP value in addition to the EPAP, which is continuously delivered. For instance, if a ventilator were set to an EPAP of 5 cm H_2O and an IPAP of 10 cm H_2O, the machine would maintain 5 cm H_2O of positive pressure during expiration and deliver gas flow to establish 15 cm H_2O during inspiration. Commonly, inspiratory positive pressure assistance lasts until the ventilator detects a 25 % decrease in peak inspiratory flow or 3 s elapses, whichever comes first [5].

Like CPAP, BPAP increases the functional residual capacity and can recruit atelectatic lung segments, thereby decreasing shunting. Unlike CPAP, however, the addition of extra inspiratory pressure increases tidal volume. Augmentations in tidal volume subsequently cause increases in minute ventilation and thus give BPAP the ability to treat hypercapneic respiratory failure in addition to hypoxemic respiratory failure. Finally, the addition of IPAP also decreases the work of breathing and total lung resistance, which is particularly beneficial in patients who require BPAP for an acute or severe indication [5].

Rationale and Epidemiology

The most important advantage that NIV offers is avoidance of invasive endotracheal intubation and the associated deleterious effects including airway injury, sedation, and ventilator-associated infections and conditions. Unlike intubated patients, noninvasively ventilated patients have the ability to be liberated from the ventilator intermittently, which promotes progressive mobility, pulmonary toilet/coughing, eating, and speaking.

There is abundant high-quality evidence to recommend the use of NIV in specific medical conditions, including acute cardiogenic pulmonary edema, obstructive sleep apnea, and acute COPD exacerbations [10–12]. These indications allowed NIV to gain significant popularity and expand its applicability to medical patients over the last two decades. Increasingly, NIV is being applied to specific populations of surgical patients with similar improvements in outcomes as outlined later in this chapter.

Respiratory dysfunction in the postoperative patient represents a complex clinical challenge that differs from the medical patient. Intensive care providers must take into consideration several factors before using NIV for a postoperative patient including clinical status, surgical procedures performed including anatomic and physiologic alterations, and the potential for further surgical intervention.

Although supplemental oxygen administration and incentive spirometry are effective in treating mild postoperative hypoxemia, endotracheal intubation and mechanical ventilation may be required in 8–10 % of patients who develop acute postoperative respiratory failure [13]. The use of endotracheal intubation and invasive mechanical ventilation has been shown to increase the risk of nosocomial infections, utilization of critical care resources, prolong length of hospital stay, and increase overall morality [14]. There is compelling evidence that demonstrates the benefits of NIV for both the patient and health-care utilization through avoidance of invasive ventilation [12]. Additionally, increased recognition of postoperative patients' exceptional vulnerability to hypercapnia due to incisional pain, opioid agents, and unrecognized sleep apnea has led to increased use of NIV in the perioperative period.

Equipment

NIV can be delivered by standard ICU ventilators or portable ventilators. Modern ICU ventilators can provide higher inspiratory flow rates, have separate inspiratory and expiratory tubing which minimizes carbon dioxide rebreathing, are capable of delivering a higher fraction of inspired oxygen (F_iO_2), and have more appropriate monitors and alarms [15].

Interface

The ideal interface is one that minimizes air leakage and is most comfortable, thus promoting efficacy and compliance. The most commonly used interface in the critical care setting is the oronasal mask [16]. Other available interfaces include nasal prongs (pillows), a full-face mask (covers the mouth, nose, and eyes), a nasal mask, and a helmet. Regardless of the interface chosen, they should be properly fitted, comfortable, effective, and minimize leakage to maximize efficacy.

Equipment Complications

Patient discomfort and thus compliance with NIV is a limiting factor in its clinical applicability and contributes significantly to NIV failure rate. The most common complications of NIV equipment include air leakage, pressure ulceration, and patient-ventilator dyssynchrony.

Pressure Ulceration

Facial skin lesions, including ulceration and necrosis, are pressure-related lesions that result from prolonged contact with tight-fitting masks and predominantly develop on the bridge of the nose. Their development is directly related to the duration of NIV therapy. Factors that have been associated with formation of nasal skin lesions, and must be considered at initiation of NIV therapy, include progressive tightening of the harness, increasing the air volume in the mask cushions, and increasing inspiratory pressures [17].

Patient-Ventilator Dyssynchrony

Dyssynchrony occurs when the phases of ventilator-delivered breaths do not match with the patient's. This results in poor tolerance of NIV and can be alleviated by using an alternative ventilator mode (pressure support ventilation allows the patient to trigger each breath and may be more comfortable for some patients) or minimizing mask leaks [18]. Air leakage increases the time required for the ventilator to reach its pressure target, thus prolonging inspiration and causing discomfort.

Patient Selection

Prior to discussing the indications for NIV, it is important to understand the constituents of appropriate patient selection and the contraindications to NIV. Patient selection and continuous monitoring are critical to recognizing and reducing NIV failure. In general, the most important factors to consider when selecting patients for NIV are patient cooperation, ability to protect the airway, and their unique risk of aspiration. NIV should not be used in patients with altered mental status, severely agitated or obtunded patients, hemodynamically unstable patients, and those suffering from claustrophobia either due to an inability to cooperate or an impaired ability to protect their airway. Patients with obvious respiratory distress, proximal gastrointestinal hemorrhage, active emesis, facial trauma or burns, and those with neuromuscular dysfunction are at an increased risk of aspiration and should avoid NIV. These patients warrant prompt endotracheal intubation and mechanical ventilation. Similarly, patients with impending respiratory failure due to copious secretions that they are unable to clear are poor candidates for NIV.

Early Recognition of NIV Failure

Improvement in respiratory status is usually apparent within the first 1–2 h after initiation of NIV. The absence of improvement in a patient's respiratory status is a strong indication to promptly proceed with intubation. Delays in recognition of NIV failure and postponing invasive ventilation result in increased morbidity and mortality and should be avoided. Predictive factors associated with an increased risk of NIV failure include advanced age, high-acuity illness score at admission, presence of ARDS, sepsis, or multisystem organ failure (MSOF). In ARDS patients, an arterial oxygen tension/inspired oxygen fraction (P_aO_2/F_IO_2) ratio <175 mmHg drawn 1 h following initiation of a NIV trial accurately predicts failure [19].

NIV should be initiated and continuously monitored in a critical care setting with a multidisciplinary team familiar with this therapy and advanced airway techniques; NIV as rescue therapy is generally not appropriate for ward care. There is no established consensus on NIV failure criteria; however, general recommendations including failure to clinically improve, unrelieved dyspnea, worsening P_aO_2/F_IO_2 ratio, and increasing oxygen or pressure requirements should prompt transition to invasive ventilation. Should the provider anticipate failure, it is essential to promptly proceed to intubation while the patient is still able to adequately preoxygenate, allowing a safe window of time to perform endotracheal intubation. Patients requiring 100 % F_IO_2 on BPAP are prone to respiratory arrest due to a lack of pulmonary reserve and rapid desaturation during intubation. High-flow NC O2 may be used as an aid in maintaining oxygenation in the period between removing the BPAP mask and establishing a definitive airway.

Protocol for Initiating NIV

Parameters to be set upon initiation of NIV will be guided by the mode of ventilation chosen. Currently, there is not a universally accepted established protocol for initial NIV settings; however, general recommendations can be made. It is imperative to tailor the ventilator mode and settings to each clinical scenario and adjust parameters as needed to alleviate respiratory distress. Table 12.1 presents some commonly recommended settings for initiation of BPAP [16].

Specific Indications and Patient Considerations

NIV is now generally regarded as safe in most surgical patients and provides the most benefit to patients with rapidly reversible physiology (atelectasis, acute pulmonary edema, etc.) and patients with an oropharynx prone to

Table 12.1 Protocol for initiation of BPAP in the ICU

Ensure patient is an appropriate candidate for NIV
Patient is located in a monitored unit with, at a minimum, continuous pulse oximetry, blood pressure, and heart rate being monitored frequently
Elevate head of bed to at least 30°
Provide education and reassurance to patient and family members prior to application of interface to reduce patient anxiety and improve compliance
Apply a well-fitting mask, secure straps to patient's head
Turn on ventilator, select desired mode (BPAP, pressure-limited, flow-triggered) used in this example). Recommended initial settings: IPAP 8–12 cm H_2O, EPAP 4–5 cm H_2O
Respiratory rate: BPAP is a spontaneously triggered mode and can be set with or without a backup rate. If a backup rate is chosen, ensure it is lower than the patient's intrinsic respiratory rate to reduce discomfort. An initial rate of 8–10 breaths/min is usually appropriate
Supplemental oxygen: set the F_IO_2 at a level adequate to maintain oxygen saturations >90 %. Initial setting F_IO_2 of 0.35–0.40 is recommended
Monitor patient comfort, air leakage, and respiratory status. Draw an arterial blood gas within 1 h of NIV initiation. Failure to improve or reverse acute respiratory distress warrants intubation and invasive ventilation

This table describes one example of initial BPAP settings for noninvasive ventilation in perioperative patients with acute respiratory distress that do not require intubation. Initial pressures are set low to facilitate patient acceptance and compliance, but they can be titrated up to alleviate respiratory distress. Avoid pressures in excess of 20 cm H_2O

F_IO_2 fraction of inspired oxygen, *IPAP* inspiratory positive airway pressure, *EPAP* expiratory positive airway pressure, *NIV* noninvasive ventilation, *BPAP* bilevel positive airway pressure

obstruction. Below, we outline the use of NIV in the preoperative, intraoperative, and postoperative settings.

Preoperative NIV

NIV has been used preoperatively to successfully reduce postoperative pulmonary dysfunction after pulmonary resection [20, 21]. For OSA patients maintained on PAP therapy preoperatively, it is recommended to continue patients on their home PAP regimen preoperatively if clinically appropriate with regard to the surgical procedure [22].

NIV for Pre-oxygenation During Anesthetic Induction

Compared to high-flow oxygen administration by oronasal mask, the addition of positive pressure noninvasive ventilation, specifically CPAP, has been shown to improve pre-oxygenation prior to intubation of both hypoxemic patients in the intensive care unit and clinically severely obese patients in the operating room [23]. Increasing the duration of apnea without desaturation allows for a greater window of time for tube placement in the event of a difficult intubation. Prior to induction of general anesthesia, pre-oxygenation with supplemental oxygen for 3 min (or until fraction of excreted oxygen, F_eO_2, is >90 %) is considered sufficient to maintain adequate arterial oxygen saturations during the apneic period of endotracheal intubation. However, application of low-pressure CPAP (5–7 cm H_2O) plus 100 % F_iO_2 for 3 min prior to induction maintained higher arterial oxygen saturations during intubation and lower arterial carbon dioxide levels immediately following intubation suggesting improved oxygenation and ventilation [23].

Postoperative NIV

Abdominal Surgery

Increased recognition that postoperative patients are exceptionally vulnerable to hypercapnia due to incisional pain, opioid agents, and unrecognized sleep apnea has led to the increased use of NIV in the postoperative period [23]. Atelectasis is common after major abdominal surgery and can usually be managed successfully with supplemental oxygen and incentive spirometry. However, approximately 10 % of acutely hypoxemic patients currently require intubation and mechanical ventilation [24].

Recent clinical trials suggest a decrease in intubation rates with the use of CPAP for the treatment of atelectasis-induced acute hypoxemia following elective major abdominal surgery [24]. The proposed mechanism of atelectasis-related hypoxemia after abdominal surgery is the impairment of the pulmonary ventilation-perfusion ratio due to loss of functioning alveolar units caused by the recumbent position, high oxygen concentration, temporary diaphragmatic dysfunction/poor diaphragmatic excursion, impairment of pulmonary secretion clearance, pain, and potentially the absence of PEEP during intra-op mechanical ventilation [24].

As previously mentioned, administration of continuous positive airway pressure increases functional residual capacity, improves gas exchange, and promotes alveolar recruitment resulting in improved oxygenation. It is important to note that these benefits are not applicable to patients with any relative or absolute contraindication to NIPPV, and intubation should never be delayed in the setting of persistent respiratory failure. For the treatment of acute hypoxemia early in the postoperative period following major abdominal surgery, the use of CPAP in the ICU has been demonstrated to decrease the risk of pneumonia and re-intubation rates and

improve oxygenation faster compared to supplementation oxygen and chest physiotherapy alone [25].

Foregut Surgery

Application of postoperative NIV in patients with proximal foregut anastomoses remains a controversial topic. Despite emerging data strongly supporting the safe and effective use in this population, there remains a large resistance for acceptance and incorporation into clinical practice due to trepidations for excessive anastomotic stress and resulting leak [26]. These concerns stem from the *theoretical* risk that pressurized air applied to the oropharynx will be distributed between the lungs and the GI tract causing inflation of the stomach and proximal intestine. Thus, many surgeons have chosen to avoid NIV in this population given the morbidity and mortality associated with an anastomotic leak.

With increasing recognition that NIV decreases complications, length of stay, infections, and cost compared to invasive ventilation, this theoretical risk merits critical reappraisal. CPAP has been demonstrated to be safe in the immediate postoperative period following bariatric surgical procedures including Roux-en-Y gastrojejunostomy for use in their patients with preoperative OSA without increasing the risk of anastomotic leak or major postoperative complications [27, 28].

Most interestingly, a recent study using a porcine esophagectomy model captured in vivo esophageal pressures during NIV and the minimum esophageal pressures required to induce an anastomotic disruption. Esophageal pressures increased as more pressure was applied; however, the luminal pressures were profoundly lower than the minimum threshold required for the occurrence of an anastomotic leak in their model [29]. The spectrum of pressure applied to the oropharynx was 20–40 cm H_2O, and the corresponding median transmitted esophageal pressures detected were 5 cm H_2O, 11 cm H_2O, and 15 cm H_2O, respectively. The minimum esophageal pressure needed to induce a leak, in vivo, was 46 cm H_2O, demonstrating that the esophageal anastomosis can tolerate considerably higher pressures than is transmitted by NIV.

Several limitations apply to the aforementioned data and further investigation is needed before generalizability is applied, but this is an important foundation to suggest the safety of NIV in patients with a proximal foregut anastomosis. While anastomotic disruption is unlikely, gastric insufflation is a more common concern in these patients and can be limited by keeping the applied positive pressure less than 20 cm H_2O and judicious use of nasogastric tube decompression. In addition, large tidal volumes (800 mL–1,200 mL), high airway resistance, low respiratory system compliance, and short inspiratory time all increase airway pressure and promote gastric insufflation and should be limited when possible [19].

There is a paucity of data that demonstrate an increased risk of anastomotic complications from NIV in this population. With the accumulating human and laboratory evidence to suggest its safety and the lack of data to demonstrate NIV being harmful, the use of NIV has the potential to become more widely accepted in the postoperative management of foregut surgery [19, 26–29].

Thoracic Surgery

Patients undergoing lung volume reduction surgery (LVRS) or pulmonary transplantation represent a selected group of patients with advanced chronic respiratory disease and are at high risk of preoperative and postoperative complications. Respiratory distress requiring re-intubation in this patient population portends a very poor prognosis. Attempts are made to avoid endotracheal intubation with the use of BPAP, which has been demonstrated to be beneficial in both decreasing re-intubation rates and increasing hospital survival in several clinical trials [24, 30, 31]. BPAP is a useful adjunct in improving the postoperative course of lung surgery patients. Thus, noninvasive ventilation should be considered in selected postoperative patients at high risk of pulmonary complications or with frank respiratory failure, especially in the setting of underlying COPD or pulmonary edema.

Injured Patients

Several small studies have demonstrated that application of NIV following blunt thoracic trauma (flail chest, rib fractures, pulmonary contusions) results in lower intubation rates [32, 33], improves oxygenation, decreases endotracheal intubation rates, and lowers ICU length of stay [34]. However, caution must be exercised with the use of positive pressure ventilation in the setting of a preexisting pneumothorax. The potential for progression to a tension pneumothorax warrants treatment with tube thoracostomy decompression prior to initiation of positive pressure ventilation. Data is less clear with regard to progression to a clinically evident pneumothorax, when the pneumothorax is occult (visible only on CT but not plain radiography).

Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is a syndrome characterized by repetitive partial or complete upper airway obstruction occurring during sleep, resulting in recurrent self-arousal to restore airway patency. This cycle of disturbed sleep with frequent apneic episodes results in nocturnal oxygen desaturation and hypercarbia and is exacerbated in the perioperative patient due to the plethora of the aforementioned factors that impair level of consciousness and the integrity of the pulmonary system [22]. Postoperative patients are particularly prone to sleep apnea because of the changes in respiratory dynamics as a result of general anesthesia, opioid agents, and incisional pain [23].

In theory, the widespread use of supplemental oxygen via the nasal cannula in the immediate postoperative period may

blunt the respiratory drive of patients who have a hypoxic respiratory drive (as opposed the normal medullary proton concentration driven respiratory drive) and delay recognition of hypoventilation, putting these patients at further risk of postoperative pulmonary complications. In the perioperative and critical care setting, OSA represents a significant clinical challenge. It is crucial for the health-care team to have a better understanding of potential perioperative complications specific to these patients with the goal of improving morbidity and mortality.

Perioperative OSA Risk Assessment

Ideally, preoperative evaluations for elective operations would be completed in advance. This would allow for appropriate in-laboratory polysomnography confirmatory testing and therefore initiation of CPAP preoperatively. Rather, the majority of undiagnosed OSA patients are not recognized until postoperatively [22]. Untreated OSA patients are known to have a higher incidence of difficult intubation and postoperative complications, increased intensive care unit admissions, and greater duration of hospital stay [22]. Thus, identifying OSA patients preoperatively and initiating appropriate postoperative therapies are crucial for reducing perioperative morbidity and mortality.

The STOP-Bang questionnaire (Fig. 12.1) is a validated screening tool used to identify suspected OSA patients and risk stratify them into low, intermediate, and high risk for OSA based on an eight-question evaluation [35]. A score of 3 or more is indicative of intermediate risk and a score of 5 or more indicates high-risk for OSA. This stratification allows for appropriate management by the anesthesiology team in all phases of the perioperative setting.

The American Society of Anesthesiology Task Force recommends that known OSA patients previously on PAP therapy should be encouraged to be compliant with PAP therapy postoperatively, and PAP therapy should be ordered in the postoperative period [22]. High-risk, suspected OSA patients who develop recurrent apnea and hypoxemia in the postoperative recovery unit (PACU) should be monitored in a critical care setting and initiated on PAP therapy if the surgical procedure does not prohibit PAP use [22].

Immunocompromised Patients

Immunocompromised patients represent a population of critically ill patients who benefit significantly from NIV for treatment of acute respiratory failure. Avoidance of endotracheal intubation in this population dramatically reduces the risk of nosocomial infections and reduces ICU mortality. This benefit has been demonstrated in several different immunocompromised populations including solid organ transplant recipients [36], patients with hematologic malignancies [37], and acquired immunodeficiency syndrome (AIDS) patients with *Pneumocystis carinii* pneumonia [38].

Post-extubation Respiratory Failure

The use of NIV in post-extubation patients critically depends on two factors: patient selection and timing. Patients who are prone to atelectasis, fatigue requiring intermittent augmentation of work of breathing, and those with known OSA are most likely to benefit from NIV post-extubation [39]. It is important to note however that the data supporting this benefit is highly dependent on the timing of NIV initiation. There is a clear benefit in the prophylactic use of NIV immediately upon extubation in high-risk patients, prior to the development of acute respiratory failure post-extubation [40]. The use of NIV to treat established post-extubation respiratory failure, as opposed to prophylactic application, results in the delay of re-intubation and increased mortality [22, 41, 42].

Palliative NIV

As NIV gains popularity, there has been increased interest in the use of NIV for patients who have declined invasive life support measures. The utility of NIV in patients with acute respiratory failure who refuse intubation (DNI) or have chosen comfort measures only remains controversial. Palliative NIV is effective and should be considered in relieving symptoms of dyspnea, improving the patient's ability to communicate, and prolonging life to allow for affairs to be arranged [43, 44]. However, NIV can reverse nonterminal acute respiratory failure and therefore may be considered inappropriate when patients have chosen to limit life support near the end of their lives. It is important to consider noninvasive ventilation as an option when discussing comfort care measures with patients and family members. The decision to use palliative NIV should be guided by clear delineation of the patient's goals of care and may be optimized in conjunction with planned palliative care medicine consultation.

STOP-Bang Questionnaire

☐ Yes	☐ No	**Snoring?** Do you **snore loudly** (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?
☐ Yes	☐ No	**Tired?** Do you often feel **tired,fatigued,or sleepy** during the daytime (such as falling asleep during driving)?
☐ Yes	☐ No	**Observed?** Has anyone **observed** you **stop breathing** or **choking/gasping** during your sleep?
☐ Yes	☐ No	**Pressure?** Do you have or are being treated for **High Blood Pressure?**
☐ Yes	☐ No	**Body Mass Index more then 35kg/m^2?**
☐ Yes	☐ No	**Age older then 50 years old?**
☐ Yes	☐ No	**Neck size large?(Measured around Adams apple)** For male, is your shirt collar 17 inches or larger? For female, is your shirt collar 16 inches or larger?
☐ Yes	☐ No	**Gender=Male?**

Scoring Criteria

Low Risk of OSA: Yes to 0 to 2 questions

Intermediate Risk of OSA: Yes to 3 to 4 questions

High Risk of OSA: Yes to 5 to 8 questions

Fig. 12.1 STOP-Bang questionnaire for preoperative OSA risk assessment. *OSA* Obstructive sleep apnea (Adapted with permission from Chung et al. [35])

Conclusion

Noninvasive positive pressure ventilation has been shown to reduce the need for endotracheal intubation, decrease rates of nosocomial infections, and decrease length of ICU stay in a variety of medical and surgical critical care populations including major abdominal surgery, immunocompromised patients, thoracic injury, and high-risk postextubation patients. More data will be needed, but emerging evidence suggests NIV can be safely used in patients with proximal foregut anastomoses, which has previously been regarded as a relative contraindication due to concerns for anastomotic leak risk. The success and efficacy of NIV relies heavily on several notable factors including proper patient selection, timing of NIV initiation, interface fit and comfort, patient compliance, and appropriate physiologic monitoring. Most importantly, the use of NIV should never delay endotracheal intubation in a patient whose clinical condition requires invasive ventilation for salvage. Noninvasive positive pressure ventilation is an important adjunct in our expanding

repertoire of therapies for respiratory dysfunction and, when properly applied, may improve perioperative patient outcomes in the critical care setting.

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