REVIEW

The obese patient undergoing nonbariatric surgery

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Purpose of review
This article provides the reader with recent findings on the pathophysiology of comorbidities in the obese, as well as evidence-based treatment options to deal with perioperative respiratory challenges.

Recent findings
Our understanding of obesity-associated asthma, obstructive sleep apnea, and obesity hypoventilation syndrome is still expanding. Routine screening for obstructive sleep apnea using the STOP-Bang score might identify high-risk patients that benefit from perioperative continuous positive airway pressure and close postoperative monitoring. Measures to most effectively support respiratory function during induction of and emergence from anesthesia include optimal patient positioning and use of noninvasive positive pressure ventilation. Appropriate mechanical ventilation settings are under investigation, so that only the use of protective low tidal volumes could be currently recommended. A multimodal approach consisting of adjuvants, as well as regional anesthesia/analgesia techniques reduces the need for systemic opioids and related respiratory complications.

Summary
Anesthesia of obese patients for nonbariatric surgical procedures requires knowledge of typical comorbidities and their respective treatment options. Apart from cardiovascular diseases associated with the metabolic syndrome, awareness of any pulmonary dysfunction is of paramount. A multimodal analgesia approach may be useful to reduce postoperative pulmonary complications.

Keywords
mechanical ventilation, nonbariatric, obese, sleep apnea

INTRODUCTION

Within the last 25 years, prevalence of obesity more than doubled. According to World Health Organization (WHO), in 2014 more than 39% of the global adult population was overweight and 13% classified as obese [1]. Considering that prosperity is a major factor for developing overweight, its prevalence is still increasing in developed regions such as the USA, Europe, and Australia, but even more in some developing countries or the eastern Mediterranean countries with incidences between 70 and 80% of overweight [2].

Calculating BMI as actual body weight (kg) divided by squared actual height (m^2) is the most frequently used measure to roughly estimate the amount of body fat accumulation. The WHO classifies patients as overweight ($25 \leq BMI < 30\,kg/m^2$) as well as obese grade I ($30 \leq BMI < 35$), grade II ($35 \leq BMI < 40$), and grade III ($BMI \geq 40$). Moreover, the American Society of Anesthesiologists (ASA) classifies morbid or extreme obesity ($40 \leq BMI < 50$) 50) and super morbid obesity ($BMI \geq 50$).

For anesthetists, treatment of obese patients usually represents a challenge. Whereas bariatric surgery involves rather uniform, elective cases rarely presenting with severely progressed comorbidities, nonbariatric surgery in obese patients may include emergency cases, time-consuming procedures because of difficult surgical preparation and patients with severe comorbidities and older age. Obesity is a risk factor for postoperative infectious wound complications, but its association with pulmonary or cardiac complications is controversially discussed [3].

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Curr Opin Anesthesiol 2016, 29:000–000

DOI:10.1097/ACO.0000000000000337

KEY POINTS

- Obese patients are at increased risk for metabolic diseases and cardiovascular events as well as pulmonary comorbidities, such as OSA, asthma, and OHS.
- Anesthetists treating obese surgical patients must have access to appropriate equipment, be able to manage a difficult airway and have knowledge of altered pharmacokinetics in this population.
- Perioperative pulmonary function may be best preserved with optimal patient positioning, use of noninvasive positive pressure ventilation, and a multimodal analgesic approach to avoid opiods.
- Intraoperative mechanical ventilation should consist of low tidal volumes, whereas high PEEP levels and/or recruitment maneuvers or higher fraction of inspiratory oxygen may be part of a rescue therapy for desaturation.
- Considering the increased risk for postoperative complications, obese patients should be closely monitored after surgery.

Excellent reviews have been published in this field, focusing on respiratory physiology and intraoperative mechanical ventilation [4,5], perioperative management in in-hospital [6] and ambulatory patients [7,8], and anesthetic drugs [9,10] and perioperative complications [11] in the obese. The objective is to shed light onto the latest evidence-based knowledge about perioperative care with focus on the respiratory system.

COMORBIDITIES ASSOCIATED WITH OBESITY

The ASA physical status classification categorizes obese patients *per se* ASA 2, whereas obese patients experiencing any additional organ dysfunction are categorized minimum ASA 3.

Metabolic and cardiovascular diseases

Because adipose soft tissue is not only storage for lipids but has also important endocrine and immunological functions, obesity is thought to be a major risk factor for metabolic, cardiovascular, and thromboembolic diseases. As one of the key features of the metabolic syndrome, obesity is related to comorbidities such as atherosclerotic cardiovascular disease, heart failure, systemic arterial hypertension, pulmonary hypertension as a consequence of impaired breathing, deep vein thrombosis and pulmonary embolism, as well as type II diabetes mellitus and imbalances in lipid metabolism [12]. On the other hand, there still may be an important proportion of up to 30% of obese patients that are metabolically healthy, presenting with normal insulin sensitivity, lower liver fat content and fewer signs of arterial intima media thickening [13], although the existence of 'healthy obesity' was questioned recently [14]. The discrepancy between metabolically healthy and diseased obese patients could be explained, at least in part, by different metabolic activity of subcutaneously versus viscerally (or ectopically) deposited adipose tissue. Higher amounts of visceral fat are more likely related to an adverse metabolic risk profile [15]. Therefore, in selected obese cohorts, indices like waist circumference, waist hip ratio, or imaging technics could be employed to screen for patients without obvious signs of cardiovascular and metabolic diseases but with a high amount of ectopic adipose tissue [14]. Those patients might benefit from liberal use of advanced hemodynamic monitoring (e.g., 5-lead electrocardiogram, invasive arterial monitoring). As the proportion of obese patients with ectopic fat is high [14], for general purposes obese patients can be assumed as being at high risk for cardiovascular events.

Against the background of difficult physical examination (e.g., heart/lung sounds, assessment of edema, and venous congestion) and challenging assessment of cardiopulmonary capacity in patients with impaired physical activity, Poirier *et al.* proposed a stepwise algorithm to evaluate cardiovascular comorbidities in obese patients (Fig. 1). One of the key points of this algorithm is to apply advanced imaging and diagnostics earlier in order not to underestimate the severity of cardiovascular impairment.

Respiratory system comorbidities

It is well established, that obesity largely influences respiratory mechanics, which has been conclusively reviewed elsewhere [4,16]. Briefly, the respiratory pattern is characterized by reduced tidal volumes and elevated respiratory rates to adapt to the increased work of breathing. Obesity produces a restrictive pattern with decreased respiratory system compliance involving not only the chest wall but also the lungs, favoring atelectasis formation. Although lung volumes are decreased, especially functional residual capacity and end-expiratory reserve volume, spirometric indices like forced expiratory volume at one second tend to remain unaltered when adjusted to forced expiratory capacity. Apart from the direct mechanical effects of obesity, comorbidities such as sleep apnea,

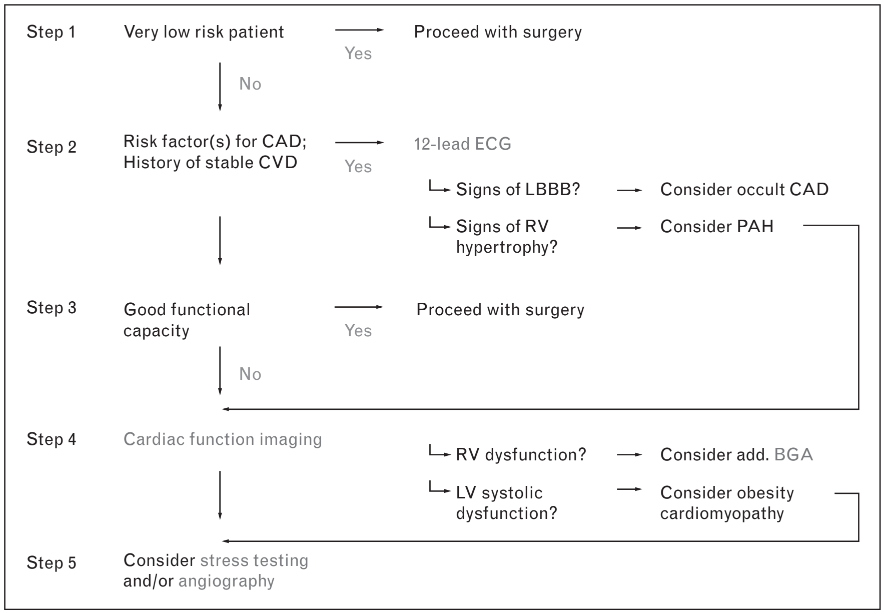

FIGURE 1. Preoperative stepwise cardiovascular assessment in obese patients. CAD, cardiovascular disease; CVD, coronary artery disease; ECG, electrocardiogram; LBBB, left bundle-branch block; PAH, pulmonary arterial hypertension; RV, right ventricle; LV, left ventricle; BGA, blood gas analysis. Adapted with permission from [12].

obesity hypoventilation syndrome (OHS), as well as asthma may further worsen lung function.

Sleep apnea

In obese patients, sleep apnea largely results from upper airway obstruction [obstructive sleep apnea (OSA)] rather than central dysregulation, leading to intermittent events of hypoxia and sleep fragmentation [17]. The diagnosis is based on overnight cardiorespiratory monitoring demonstrating at least five interruptions of ventilation per hour (apnea/hypopnea index) in its mild form, more than 10 in its moderate, and more than 15 in its severe form. Using polysomnography, a Finish multicenter study revealed a prevalence of 70% in a mixed population of patients with mean BMI 43 kg/m^2 scheduled for bariatric surgery, being in men as high as 90% [18].

Perioperative sedation and opioids may worsen upper airway collapsibility and impair arousal response, thereby aggravating OSA symptoms [19]. Vasu *et al.* emphasized the importance of altered rapid eye movement (REM) sleep in the postoperative phase. Interestingly, REM sleep episodes are rare or even absent in the first postoperative nights as a result of surgical stress, pain and inflammatory responses [20,21]. This phase can be followed by a high density of REM sleep events between nights 2–5, in which OSA symptoms are more likely to worsen or even to occur for the first time [21,22▪▪]. Usually, patients are less well monitored during this second phase, favoring ignorance of exacerbations. However, disturbance of sleep characteristics largely depends on the extent and type of surgery as well as eventual postoperative stay on ICU.

Obesity hypoventilation syndrome

Whereas sleep apnea is not essentially linked to obesity and 'vice versa', OHS appears as obesity-associated hypercapnia (arterial partial pressure of carbon dioxide $\geq$45 mmHg or 6 kPa) during wakeful daytime. In most patients OHS is associated with sleep disordered breathing such as sleep apnea, but may be coincident with chronic obstructive pulmonary disease (called overlap syndrome) [23]. The diagnosis of OHS can be missed because of agitated hyperventilation during drawing of the respective blood gas sample. Preoperatively elevated standard bicarbonate may be a better guide to OHS, but does not necessarily differentiate between primary and compensatory metabolic alkalosis [24]. In addition, there is even an important proportion of patients being hypoxemic, rather caused by sleep disordered breathing than by chronic obstructive pulmonary disease [25▪].

Both sleep apnea and OHS are associated with higher incidences of postoperative respiratory failure, cardiac complications, and need for ICU admission [26,27▪]. Wakeful hypercapnia may be a predictor of higher risk for those complications [27▪]. Although of great importance, both anesthetists and surgeons frequently fail to diagnose OSA, preoperatively [28]. As the gold standard polysomnography is costly and not easily available in the preoperative phase, other screening methods must be employed. The Snoring, Tired, Observed, blood Pressure - BMI, Age, Neck circumference, Gender (STOP-Bang) score (Table 1) was introduced as a very sensitive and easy to use tool for screening of moderate to severe OSA [30,31]. A score of 3 or more out of possible 8 points is considered high risk for OSA in an unselected surgical cohort. During validation in obese and morbidly obese patients, a score of 4 or higher had high sensitivity, whereas confirmation of severe OSA was specifically possible with score values of 6 or higher [32]. However, using the STOP-Bang score to identify patients with OSA failed to predict higher postoperative mortality in a large surgical prospective observational study [33]. It remains unclear, whether the score failed to identify OSA patients or whether OSA *per se* did not increase mortality in this study. Nevertheless, we strongly recommend routine application of the STOP-Bang questionnaire in obese patients without previous diagnostics on or diagnosis of OSA. Accordingly, high-risk patients should be transferred to monitoring areas postoperatively or should have initialized continuous positive airway pressure (CPAP) perioperatively [22▪▪].

Asthma

Obesity is also linked to bronchial hyper-reactivity and asthma-like symptoms, possibly caused by increased systemic and airway inflammation and mechanical effects as a result of chronic lung compression [34]. Obese asthmatics usually face poor asthma control and respond to therapy at a lower rate [29]. This might be relevant for perioperative treatment of bronchospasm as one of the typical complications, but data are lacking. Distinguishing two subtypes of asthma identifies patients with allergic, early-onset asthma complicated by obesity and another group with nonallergic, adult-onset asthma being likely a direct consequence of obesity, with minimal airway inflammation and low immunoglobulin E [35]. In theory, mass loading of the chest wall by fat accumulation favors a reduction in lung volumes, compression of distal airways with increasing closing capacity at reduced functional residual capacity. However, some individuals develop asthma-like symptoms during weight gaining and others not. Investigating the effects with weight loss (=lung decompression) 1 year after bariatric surgery revealed that distal airways are much more likely to collapse in patients with late-onset asthma compared to nonasthma patients [36]. This investigation improves our pathophysiological understanding in a way that differences in lung volumes do not necessarily account for obesity-associated asthma. Structural alterations of the peripheral airways may always play a role in obese asthmatics.

Table 1. STOP-Bang-score for evaluation of risk for obstructive sleep apnea

1. Snoring	Do you snore loudly (loud enough to be heard through closed doors)?
2. Tired	Do you often feel tired, fatigued, or sleepy during daytime?
3. Observed	Has anyone observed you stop breathing during your sleep?
4. Blood pressure	Do you have or are you being treated for high blood pressure?
5. BMI	BMI $>35\,kg/m^2$?
6. Age	Age over 50 years old?
7. Neck circumference	Neck circumference $>40\,cm$?
8. Gender	Male?
Total score	Yes to _____ questions

Adapted from [29].

Evaluation of airway

In obese patients, awareness of a difficult airway and measures to deal with is critical. The Fourth National Audit Project on major complications of airway management in the UK found airway problems to occur twice as common in obese and four times as common in morbidly obese patients [37]. A BMI more than 30 was recently found to be an independent risk factor for difficult mask ventilation and challenging laryngoscopy in a retrospective multicenter study investigating almost 500 000 patients [38▪]. Focusing on the obese population, short neck, higher neck circumference (e.g., <43 cm), Mallampati score III/IV and mandibular protrusion were independently associated with poor face mask ventilation [39,40]. Others found OSA and reduced cervical mobility as risk factors for difficult intubation [41]. Another study suggested the STOP-Bang score to be applicable as a predictor for difficult intubation, which is not surprising considering the subscores [42]. The risk factors mentioned above do not largely diverge from that observed in the mixed (including nonobese) population [38▪], supporting the use of established bundles like mouth opening, thyromental distance, oropharyngeal (Mallampati) classification, head and neck movement, ability to prognath, body weight, and history of difficult tracheal intubation for predicting difficult airway [43,44].

INTRAOPERATIVE CHALLENGES

Anesthesia induction

As obese patients are at risk for hypoventilation, preoperative sedation should be used cautiously and, if prescribed, peripheral oxygenation should be continuously monitored until arrival in the anesthetic/operating room. Nevertheless, advantages of preoperative sedation using short acting drugs such as reduced risk for accidental awareness or need for fewer anesthetic drugs at induction must be taken into account when evaluating the risk -to- benefit relationship.

Although induction rooms are available in some hospitals, anesthetists might carefully consider the advantages of inducing anesthesia directly in the operating room, where anesthesia machines are usually better equipped, without disconnection from the ventilator and reducing the risk for accidental awareness during transport [45▪]. Using this approach the patient might best position himself/herself on the table, while avoiding pressure points [46]. Positioning for anesthesia induction in the beach-chair, ramped or head-up position maximizes safe apnea time by increasing functional residual capacity [47–49]. Compared to the sniff position, the ramped-up position also better facilitates laryngeal exposure [50]. Preoxygenation by a well sealed face mask is crucial and should be rather guided by end-expiratory fraction of oxygen (e.g., >0.8) than by fixed time intervals of oxygen supply. Evidence suggests that positive end-expiratory pressure (PEEP) with optional pressure support may be set to prolong safe apnea time and preserve oxygenation [51–53].

Controversy exists about the sequence of anesthesia induction [54]. A rapid sequence induction (RSI) could lower the risk for desaturation or for aspiration of gastric contents considering increased gastric pressures [55] and gastric volumes [56], although this claim has been repeatedly challenged [57,58]. On the other hand, a RSI is associated with increased risk of awareness during anesthesia [45▪] and succinylcholine, still the first choice muscle relaxant during RSI, increases oxygen consumption during fasciculation [59]. Rocuronium could serve as an alternative muscle relaxant for induction [59,60], but measures to appropriately use Sugammadex in a cannot-ventilate/cannot-intubate situation must be considered [61]. As long as conclusive data about whether normal fastened obese patients without typical indication for RSI experience higher risk for aspiration are missing, risks, and advantages of standard induction vs. RSI must be thoroughly and individually reviewed.

Andersen *et al.* [62] compared direct laryngoscopy with video laryngoscopy, hypothesizing that the latter technique could improve intubation performance of a well trained anesthetic team. Surprisingly, video-assisted intubation lasted significantly longer, but improved laryngeal views. The study was not powered to detect a possible difference in critical events; therefore video laryngoscopy could rather serve as early rescue in case of difficult laryngeal view than approached routinely.

Few randomized controlled trials (RCTs) address airway access with supraglottic devices as compared to tracheal intubation, recently summarized in a meta-analysis following Cochrane criteria [63]. Accordingly, supraglottic devices can provide with better postoperative pulmonary performance once fitted to the airway, but may be reserved to very well selected patients.

Selection and dosing of anesthetic drugs was extensively discussed recently [9]. Apart from titrating drugs according to their respective (clinical) effect, hydrophilic drugs are dosed according to lean body weight rather than total body weight, which might be even relevant for lipophilic drugs. Considering the rapid redistribution of lipophilic drugs to the greater compartment of adipose tissue implies that immediate maintenance of anesthesia after induction is critical [46], having the chance to reduce the higher overall risk for accidental awareness previously seen in the obese [45▪]. Use of short-acting anesthetic drugs (e.g., remifentanil, desflurane, and propofol) monitored by measurements of anesthesia depth might be the first choice.

Mechanical ventilation

There is no evidence for superiority of either volume or pressure-controlled mechanical ventilation [64], as intensively debated in the last years. In theory, pressure-controlled ventilation could lead to a more homogeneous air distribution within different lung compartments. However, volume-controlled ventilation allows for better control of tidal volumes during surgical procedures intermittently affecting chest wall elastance (e.g., abdominal surgery), and an adequate inspiratory pause would maintain comparable air distribution.

Obesity may be a risk factor for delivering high tidal volumes [65,66], a setting that was previously found to be associated with adverse postoperative pulmonary outcome [67,68]. Recent RCTs have proven the protective effects of lower tidal volumes, mostly in the range of 6–8 ml/kg predicted body weight, as part of a strategy using high PEEP and recruitment maneuvers in nonobese patients

[69■■,70]. There is no rationale, why obese patients should *per se* receive higher tidal volumes. In the late 1970s, the only RCT in obese patients that used different tidal volumes found higher volumes to improve intraoperative gas exchange [71]. The authors achieved arterial oxygen tension values comparable to that observed at PEEP of 10 cmH_2O, but ignored potential ventilator-induced injurious effects – an approach that was common clinical practice at that time.

Because obesity favors atelectasis formation, appropriate levels of PEEP and recruitment maneuvers might be valuable to reopen collapsed lung tissue and/or maintain the lungs fully aerated [72]. Whereas PEEP alone does not reduce atelectasis in morbid obesity after anesthesia induction, and recruitment maneuvers up to 55 cmH_2O show only transient effects, a combination of recruitment maneuvers and PEEP-improved oxygenation while reducing atelectasis for at least 20 min [73]. Controversially, a Belgian RCT found no benefits from additional recruitment maneuvers after induction of pneumoperitoneum and after exsufflation when added to PEEP of 10 cmH_2O [74]. As figured out by two recent meta-analyses, many studies confirmed improved oxygenation and lung mechanics with the use of higher PEEP and/or recruitment maneuvers [64,75]. However, no study included *a priori* addressed midterm and long-term effects of the open lung measures undertaken; such as postoperative lung function or postoperative pulmonary complications. Whalen *et al.* [76] found the beneficial effects of recruitment maneuvers and high PEEP on oxygenation to disappear soon after tracheal extubation. Accordingly, the results of a small four-arm study comparing the use of pre vs. intra vs. postoperative PEEP (CPAP) vs. physiotherapy alone suggest that the optimum time point to apply positive airway pressure is the immediate postoperative phase [77■■].

Currently, we cannot draw any recommendation about how PEEP should be set and whether recruitment maneuvers are beneficial in obese patients. Individually titrating PEEP can improve pulmonary function but may require the measurements of transpulmonary pressure [78], and can be time-consuming [79]. However, in patients without obesity, intraoperative PEEP and recruitment maneuvers did not protect against adverse pulmonary events after open abdominal surgery when low tidal volumes were used [80]. Finally, intraoperative adverse effects of open lung ventilation strategies must be balanced against long-term beneficial outcomes. The ongoing multicenter RCT PRotective Ventilation with Higher versus Lower PEEP during General Anesthesia for Surgery in OBESE Patients (PROBESE) will provide with more data on this topic. Böhm and colleagues [81] already reported on the price to pay for keeping patients hemodynamically stable during appropriate lung recruitment maneuvers in morbidly obese patients, while preparing them with approximately 1 l of colloids before the intervention.

Obesity favors wound infection [3,82], and a higher concentration of inspired oxygen was sought to protect against this complication. In a subgroup analysis of patients with BMI more than 30 kg/m^2 of the Supplemental Oxygen and Complications After Abdominal Surgery (PROXI)-trial, a Danish multicenter RCT on the effects of intraoperative 30 vs. 80% oxygen, no difference in surgical site infections were seen [83]. Without strong evidence for high inspired oxygen to reduce infections, its adverse effects might become relevant. Accordingly, lower oxygen concentrations can reduce the venous admixture or amount of atelectasis, especially in the obese [51,84].

There are alternative strategies to improve lung function during mechanical ventilation, like use of pressure support ventilation [85] or prone positioning [86], but feasibility of those measures largely depend on the type of surgery.

EMERGENCE FROM ANESTHESIA AND RECOVERY

Measures considered for induction are also relevant during emergence from anesthesia. Placing the patient in the upright position with complete reversal of neuromuscular blocking agents confirmed by quantitative neuromuscular monitoring, difficulties in airway management and breathing must be anticipated. Keeping the high incidence of pulmonary comorbidities in mind, a generous, if not routine transfer to postoperative monitoring areas seems reasonable. A recent study suggested that routine postoperative monitoring on ICU was not necessary in patients undergoing bariatric surgery [87]. Translating this finding to the broad spectrum of nonbariatric surgery is impossible, and postoperative monitoring should be rather guided by severity of the underlying comorbidities, requirement for postoperative parenteral opioids, and the surgical procedure itself.

In obesity, postoperative oxygen desaturation is common [88]. Especially in the preoperatively hypoxemic obese, treatment with supplemental oxygen alone may even worsen respiratory dysfunction by aggravation of carbon dioxide retention [89]. Application of positive airway pressure seems to be in favor as it represents a causal treatment option [77■■,90]. Patients with a history of OSA and adequate treatment should use their CPAP device as early as possible after extubation. By today, it remains unclear, whether such patients experience fewer postoperative complications compared to previously untreated ones. RCTs investigating this question find no differences regarding this end point [91–93]. Emphasizing the unethical nature of RCTs to further address this issue, Chung *et al.* [22■■] provide with strong indications that support the perioperative initiation of CPAP in previously unknown high-risk OSA patients.

REGIONAL ANESTHESIA TECHNIQUES AND MULTIMODAL APPROACH

The use of regional anesthesia techniques may be advantageous in obese patients undergoing nonbariatric surgery. It has been claimed that obese patients with OSA are at high risk for postoperative complications, especially those related to the use of opioids in the first 24 h [94]. In fact, nocturnal hypoxemia in study participants at high risk for OSA is associated with an increased potency of opioid analgesia compared to volunteers [95]. On the other hand, the use of regional anesthesia and/or analgesia is particularly cumbersome in obese patients. Also, BMI levels of at least 25 kg/m^2 are associated with higher risk of failure [96] and catheter-related infections [97] in various peripheral block procedures, whereas neuroaxial techniques are comparatively less prone to those complications. Possibly, a multimodal approach consisting of adjuvants like clonidine, ketamine, pregabalin, NSAIDs, as well as regional anesthesia/analgesia techniques or even infiltration techniques might offer an optimal way to reduce the need for systemic opioids and associated complications [98■■].

CONCLUSION

Special recommendations to provide anesthesia in obese patients for nonbariatric surgery safely are pointed out in Table 2. Anesthetic management requires specific training, use of adequate equipment, ability to detect obesity-related comorbidities during the preanesthetic visit for optimizing the patient's status, expertise in advanced airway management, knowledge of pharmacokinetics, and drug dosing, and individual needs of mechanical ventilation. A multimodal analgesia approach

Table 2. Recommendations for anesthetic management in obese patients

Preoperative assessment
Identify central obesity and features of the metabolic syndrome as risk factors for cardiovascular events
Identify pulmonary comorbidities such as OSA, OHS, and asthma
If not previously diagnosed, screen patients with BMI $>$ 30 kg/m^2 using STOP-Bang score $>>$ if STOP-Bang $\geq$ 6, consider polysomnography and/or perioperative initiation of nocturnal CPAP
Consider preop SpO_2 in beach chair/sitting position $>>$ if $SpO_2 \leq 95$, perform BGA assessing pCO_2, standard bicarbonate for diagnosis of OHS
Waive preoperative sedative drugs, if continuous pulsoxymetry + CPAP supply cannot be employed
Organization
Schedule experienced anesthetic team for management of obese patients
Organize special equipment (blood pressure cuffs, soft foam/gel pads for positioning, long spinal/epidural/peripheral nerve needles)
Intraoperative management
Consider anesthesia induction in the operating room
Consider regional anesthesia techniques whenever possible
Be aware of possibly difficult airway, prepare videolaryngoscopy for rescue
Induce anesthesia in the ramped/anti-Trendelenburg/sitting position
Use CPAP and/or pressure support during preoxygenation, monitor endtidal oxygen (FeO_2) to reach $>$0.8 for successful preoxygenation
Prefer short acting drugs (e.g., propofol, desflurane, remifentanil), titrate according to lean body weight and effect
Monitor neuromuscular function quantitatively, if neuromuscular blocking agents are used; antagonize appropriately, if TOF ratio $<$0,9 before extubation
Postoperative visit
Use postop CPAP, if supplemental oxygen $>$2 l/min to achieve $SpO_2 > 90$
Initiate intensive care monitoring and support, if risk for pulmonary complications is high
Avoid opioids for postoperative analgesia, if patients are not monitored
Use appropriate measures for prophylaxis against venous thromboembolism

Adapted from [50]. BGA, blood gas analysis; OHS, obesity hypoventilation syndrome; OSA, obstructive sleep apnea.

may be useful to reduce postoperative respiratory complications.

Acknowledgements

The authors are indebted to our students and laboratory staff.

Financial support and sponsorship

The work was funded, in part, by the European Society of Anaesthesiology (ESA).

Conflicts of interest

M.G.d.A. is principal investigator; T.B. is trial coordinator; and P.P. is core member of the steering committee of the ongoing multicenter randomized controlled study PROBESE. There are no conflicts of interest.

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Excellent review on a multimodal approach to postoperative analgesia in the obese patient.