Obesity, obstructive sleep apnoea, and diabetes mellitus: anaesthetic implications

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Obesity is an epidemic in much of the Western World. The extent of this problem, combined with the increasing preference for ambulatory surgical procedures, has produced a difficult situation for many anaesthesiologists. Even the simplest anaesthetic procedures can become very complicated and potentially difficult in this population. Although there are numerous complications associated with obesity, perhaps obstructive sleep apnoea (OSA) and diabetes mellitus are among the more significant. Patients with OSA are often not ideal candidates for certain day-case procedures, but many outpatient procedures can be performed on patients with OSA as long as attention is paid to anaesthetic technique. Diabetic patients are prone to numerous complications in the perioperative period, including cardiac problems, but with careful management, they are able to undergo day-case surgical procedures safely.

Keywords: anaesthesia, day-case; complications, obesity; diabetes; sleep apnoea

Obesity

In the USA, more than one-third of the adult population suffers from obesity. There is a higher prevalence in certain ethnic populations, including African-, Asian-, and Mexican-Americans. While definitions vary, obesity is defined as a BMI of 30 kg m\(^{-2}\) or greater and morbid obesity as a BMI \(>35\) kg m\(^{-2}\). Super morbid obesity is often categorized as patients with a BMI \(>50\) kg m\(^{-2}\) and ultra obese patients as those with a BMI \(>70\) kg m\(^{-2}\). Obese patients, especially those with a central distribution of fat, have an increased risk of various medical disorders such as cardiovascular disease, stroke, and diabetes.

Obesity can be classified as primary obesity resulting from increased caloric intake and secondary obesity, which is often a result of medications (e.g. corticosteroids) or medical disorders such as Cushing’s disease or hypothyroidism. This review focuses on primary obesity, the associated diseases of diabetes and obstructive sleep apnoea (OSA), and their implications for anaesthetic management focusing on the ambulatory care setting. The secondary form of obesity is associated with numerous other complications beyond the scope of this review.

Pathophysiology

Obesity can present significant problems for anaesthesiologists, including difficult airway management, intravascular access, pulmonary aspiration, monitoring, and choosing appropriate medications. Although numerous organ systems are affected in obese patients, the burden placed on the cardiovascular and respiratory system is especially concerning to the anaesthesiologist. Because of the restrictive ventilatory effects of obesity, these patients often show a decreased functional residual capacity and a decreased expiratory reserve volume, all leading to an overall decrease in total lung capacity. These decreases lead to arterial hypoxaemia, ventilation–perfusion mismatch, and right-to-left shunting. Obese patients require increased cardiac output to maintain pulmonary and systemic circulations. Since increased left ventricular blood volume and systemic hypertension are common in these patients, complications of chronic, increased afterload, which translates into increased cardiac work and increased oxygen demands, are often encountered.

Apart from cardiovascular and pulmonary issues, morbidly obese patients suffer from higher perioperative complication rates including renal problems, atelectasis, pneumonia, wound infections, sleep apnoea-related problems, and thromboembolic events. Thromboembolic problems, such as deep vein thrombosis, most likely arise from polycythemia, high abdominal pressures, and reduced mobility, all leading to venous stasis. Prophylactic techniques can reduce the occurrence of deep vein thrombosis and include early ambulation, compression devices, and sometimes preoperative inferior vena cava filter placement.

Anaesthetic considerations

Mask ventilation and intubation can pose a challenge in an obese patient as a result of the excessive fat and
comparatively normal pH and improved oxygenation with pressure-control ventilation compared with volume-control ventilation. The history of snoring. 37 Tracheal intubation and positive high volume level 1 trauma centre.50 patients and can be safely and successfully performed at a trauma patients was not different from non-obese trauma patients and concluded that emergency intubation of obese patients. 37% overweight, 15% obese, and 2% morbidly obese patients. The study included 9980 patients, with 46% lean, the impact of obesity on emergency intubations in trauma patients undergoing laparoscopic gastric bypass procedures by reducing the amount of opioids required, thus giving the added advantage of reduced emesis and decreased duration of post-anaesthesia care unit stay.30 51 Yet another study demonstrated the use of dexmedetomidine as the sole sedative agent for awake fiberoptic intubations in a series of obese patients.1

The altered physiology in an obese individual, when compared with a non-obese patient, affects the pharmacokinetics of many drugs including volatile anaesthetics. A study by Mantouvalou and colleagues41 showed that there was no significant difference in the emergence and recovery characteristics of desflurane or sevoflurane in obese patients. In contrast, another study conducted by La Colla and colleagues46 did show a significant difference in the recovery profiles between desflurane and sevoflurane with desflurane leading to significantly faster wash-in and wash-out and a shorter recovery room stay compared with sevoflurane.

The use of regional anaesthesia has been less explored for morbidly obese patients. Challenges in performing regional anaesthesia in obese patients often lie in finding correct landmarks, selecting the right equipment and positioning, all of which can be improved through obese-specific anaesthetic techniques.15 42 For example, fluoroscopic or ultrasonographic guidance can be used to improve the success rate and ease of regional anaesthesia procedures in obese patients.42 While obese patients are increasingly being treated in ambulatory care centres with regional anaesthesia, they have a higher rate of block failures and complications. For example, phrenic nerve palsy after brachial plexus block in a morbidly obese patient led to unanticipated hospitalization as a result of dyspnoea, flank pain, chest discomfort, and anxiety.24 Overall, obese patients are 1.62 times more likely to have an unsuccessful block in an ambulatory setting. Despite these difficulties, regional anaesthesia can still be an excellent option for obese patients in an outpatient setting, particularly in patients with OSA.42
**Ambulatory patients**

Candidacy for surgery, clinical outcomes, and likelihood of being able to leave the hospital are factors often considered when assessing the obese patient for ambulatory and other procedures. Morbid obesity does not appear to be a significant independent risk factor for unanticipated admissions after operation, and ambulatory surgeries should not be avoided solely on the basis of weight. However, morbidly obese patients have an increased likelihood of bronchospasm and need for supplemental oxygen after surgery. Obese patients with a mean BMI of 44.5 kg m$^{-2}$ undergoing gastric banding were successfully treated as outpatients with only nine of 343 patients having significant complications, the most common being stoma occlusion. The study included ASA I and II patients; however, patients with severe sleep apnoea were also enrolled, provided they were treated with appropriately titrated CPAP and were compliant with their machines.

In contrast to these findings, other studies indicate that obese patients experience frequent perioperative complications including postoperative oxygen desaturation, even with supplemental oxygen, necessitating increased preventative measures for hypoxaemia. Even minor ambulatory procedures, such as dental surgeries, demonstrate obesity-related complications. In a closed-claim study based on office-based dental anaesthetic procedures, obesity was cited as one of the most frequent risk factors associated with increased morbidity and mortality.

**Obstructive sleep apnoea**

OSA can be a problem with serious implications for anaesthetic management. It is a syndrome characterized by some form of upper airway obstruction during sleep, often leading to respiratory interruptions and excessive daytime somnolence. Two separate entities have been documented: OSA, a complete cessation of airflow for more than 10 s (apnoea), and obstructive sleep hypopnoea (OSH) characterized by an airflow reduction of more than 50%, despite continuing breathing efforts resulting in hypoxaemia and hypercapnia. The accepted minimal clinical diagnostic criteria for OSA is an apnoea–hypopnoea index (AHI) of 10 plus symptoms of excessive daytime somnolence; AHI is the number of episodes of apnoea or hypopnoea per hour during sleep. Overt OSA has been reported in 2% of women and 4% of men; however, these numbers are expected to increase as the population grows older and more obese.

**Pathophysiology**

The pathophysiology of OSA depends on pharyngeal anatomy and the stage of sleep. Normally during inspiration, the contraction of the diaphragm creates a negative intra-airway pressure that can narrow the collapsible segments of the pharynx as a result of the lack of bony support. In REM sleep, the tone of the upper airway muscles decreases, increasing upper airway resistance. Any further diaphragmatic contraction during inspiration produces additional negative pharyngeal pressure, collapsing the pharynx even more. The relationship between OSA and obesity is emphasized by the observations that obesity has an inverse relationship with pharyngeal area, and the patency of the collapsible pharynx is determined by the difference between the extraluminal and the intraluminal pressures and by wall compliance, both of which are adversely affected by the fat mass in obese people. The effect of obesity on OSA is simply demonstrated by the fact that dietary and surgical weight reduction strategies reduce its severity.

The systemic effects of OSA are primarily the result of hypoxaemia and hypercapnia occurring during apneic episodes. These changes can not only cause arousal and disturbed sleep but also lead to cardiac arrhythmias and ischaemia, pulmonary hypertension and right ventricular hypertrophy, and systemic hypertension and left ventricular hypertrophy. Fat distribution is not uniform in obese patients, and recent studies indicate that abdominal circumference is a better predictor of OSA than neck circumference or BMI. Leptin, an adipose tissue-derived hormone, regulates caloric intake, body weight, and fat distribution. Leptin resistance, causing increased serum leptin levels, is a contributing cause of obesity. Interestingly, OSA patients on continuous positive airway pressure (CPAP) demonstrate a decrease in serum leptin levels, suggesting a possible association with OSA.

**Anaesthetic considerations**

Polysomnography (an overnight sleep study) is the best method for diagnosis of sleep apnoea; however, it is expensive, time-consuming, and clearly unsuitable for general screening purposes. Therefore, questionnaire-based tools have been developed to identify symptoms of OSA. The ASA has published a set of guidelines that help diagnose OSA based on elevated BMI, neck circumference, craniofacial alterations that obstruct the airway, snoring, airway exam anomalies, and hypersomnolence. The ASA has also developed a scoring system to assess the perioperative risk of complications from OSA (Table 1). The Berlin questionnaire is another aid to diagnose OSA before operation and uses three categories: (i) snoring, (ii) sleep and fatigue, and (iii) arterial pressure, weight, and height. A patient is at increased risk of OSA if significant symptoms are present in two out of the three categories. Recently, Chung and colleagues formulated an excellent tool for the screening of OSA. The STOP questionnaire includes four questions with yes/no answers: Snoring, Tiredness during daytime, Observed apnoea, and high arterial Pressure. To further improve its sensitivity,
they incorporated questions concerning: BMI, Age, Neck circumference, and Gender to make the STOP-BANG questionnaire. Clinical prediction formulas can help evaluate an obese patient’s risk for OSA which is often under-diagnosed. Sleep apnoea scoring systems, similar to that developed by the ASA, have been published which help predict the likelihood of OSA. For example, in one scoring system, patients with a score of 15 or higher have an 81% chance of having OSA. This category of patients can also experience increased adverse events in the post-anaesthesia care unit (PACU) and increased frequency of unplanned intensive care unit (ICU) admissions. Patients with high scores experience notably fewer adverse PACU events, if regional anaesthesia is used. Since a diagnosis of OSA in an obese patient affects anaesthetic care, the presence of a history consistent with OSA (i.e. hypertension, a neck circumference >40–42 cm, and snoring) is valuable. The ASA practice guidelines recommend a sleep study in patients with a probability of sleep apnoea in order to assess severity.

Despite advances in the pathophysiology of OSA and the release of practice guidelines by the ASA, no standard anaesthetic management strategy has been validated. Bolden and colleagues, in a limited study, concluded that developing and following a perioperative anaesthesia protocol is the best way to avoid an adverse outcome in patients suffering from OSA. Preoperative preparation is an important part in the management of OSA patients and is intended to optimize their physical status. The ASA recommends (i) CPAP, or non-intermittent positive-pressure ventilation (NIPPV) or bilevel positive airway pressure, (ii) preoperative weight loss, (iii) preoperative medication, and (iv) preoperative use of mandibular advancement or oral appliances. Patients using CPAP should be instructed to bring the machine with them if admitted to the hospital for any reason.

As a result of the propensity for airway collapse and the aforementioned pharyngeal pathophysiology, OSA predisposes to the respiratory depressant effects of sedatives, opioids, and inhaled anaesthetics. These drugs should be used judiciously in patients with a history of OSA. Short-acting drugs, such as remifentanil, and agents with limited respiratory depression, such as dexmedetomidine, should be favoured. Patients with OSA have an increased incidence of difficult intubation. If a difficult airway is suspected, the patient should be managed conservatively, with an awake fibreoptic intubation considered optimal. If induction before intubation is considered appropriate, a rapid sequence induction is advisable as the risk of aspiration in obese and OSA patients is high as a result of poor lower oesophageal sphincter tone. Because of these airway issues, complete recovery from neuromuscular block and awake extubation are considered appropriate. A semi-upright or lateral position for extubation has also been suggested to be of benefit irrespective of the patient position during surgery.

In patients with OSA, regional anaesthesia appears to carry significant benefits over general anaesthesia. If sedation for these patients is considered, it is appropriate to utilize continuous capnography. CPAP can also prove beneficial. The use of CPAP in moderate sedation might also allow more liberal use of sedatives to improve patient comfort and prevent airway collapse. For simple peripheral procedures, local anaesthesia should be the preferred choice.

Postoperative complications for patients with OSA include respiratory problems such as oxygen desaturation, apnoea, respiratory arrest, and cardiovascular problems such as hypertension, arrhythmias, and cardiac arrest. In order to minimize such complications, the ASA guidelines recommend supplemental oxygen until the patient is able to maintain a baseline saturation on room air. CPAP or NIPPV has been advised in patients who were receiving treatment before operation but remains controversial in those patients who were not. If frequent or severe obstruction or hypoxaemia occurs during postoperative monitoring, initiation of nasal CPAP or NIPPV should be considered. Either a semi-upright or lateral position can prove beneficial. Continuous oximetry monitoring in a step-down unit, until room air oxygen saturation remains above 90% during sleep, has been advised to reduce the risk of respiratory complications. Additionally, the use of regional anaesthesia and non-steroidal anti-inflammatory drugs to minimize the use of opioids for postoperative analgesia can also be beneficial. OSA was not an independent risk factor for postoperative hypoxaemia in the first 24 h after laparoscopic bariatric surgery. However, all obese patients with or without OSA experienced frequent desaturations, despite supplemental oxygen. In view of these findings, it has been suggested that perioperative

### Table 1 OSA scoring system

<table>
<thead>
<tr>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Severity of sleep apnoea based on sleep study (or clinical indicators if sleep study not available)</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
</tr>
<tr>
<td>0</td>
<td>Invasiveness of surgery and anaesthesia</td>
</tr>
<tr>
<td>1</td>
<td>Superficial under local or peripheral nerve block without sedation</td>
</tr>
<tr>
<td>1</td>
<td>Superficial with moderate sedation and general anaesthesia</td>
</tr>
<tr>
<td>1</td>
<td>Peripheral with spinal or epidural anaesthesia and moderate sedation</td>
</tr>
<tr>
<td>2</td>
<td>Peripheral with general anaesthesia</td>
</tr>
<tr>
<td>2</td>
<td>Airway surgery with moderate sedation</td>
</tr>
<tr>
<td>3</td>
<td>Major surgery with general anaesthesia</td>
</tr>
<tr>
<td>3</td>
<td>Airway surgery with general anaesthesia</td>
</tr>
<tr>
<td>0</td>
<td>Postoperative opioids</td>
</tr>
<tr>
<td>1</td>
<td>Low dose oral</td>
</tr>
<tr>
<td>3</td>
<td>High dose oral, parenteral, neuraxial</td>
</tr>
<tr>
<td>(0–6)</td>
<td>Estimation of perioperative risk is calculated by adding A to either B or C whichever is greater. The greater the score, the greater the risk of perioperative complications</td>
</tr>
</tbody>
</table>

*Notes: A severity of sleep apnoea based on sleep study (or clinical indicators if sleep study not available)*
management of bariatric surgeries should include strategies to detect and prevent postoperative hypoxaemia, but additional measures in OSA patients might not be required.4

**Ambulatory patients**

A number of factors must be considered before posting a patient with OSA for an ambulatory (day-case) procedure. These include sleep apnoea status, anatomical and physiological abnormalities, coexisting diseases, type of surgery, type of anaesthesia, need for postoperative opioids, age, adequacy of postoperative observation, and the capabilities of the out-patient facility.9 There is general agreement that superficial surgeries using local or regional anaesthesia, minor orthopaedics procedures with local or regional anaesthesia, and lithotripsy can be performed in outpatient settings.9 20 The ASA guidelines do not recommend performance of airway procedures, including tonsillectomies, in patients with OSA in an ambulatory setting. They do recommend ambulatory facilities for patients with OSA have emergency difficult airway equipment, CPAP capabilities, nebulizer and ventilator equipment, a radiology facility, clinical laboratory access, and a transfer arrangement to a nearby in-patient facility. Furthermore, monitoring for at least 3 h more than non-OSA patients and for at least 7 h after the last episode of apnoea or airway obstruction has been recommended for all ambulatory OSA patients.9

**Diabetes mellitus**

Diabetes mellitus is a chronic disease characterized by a decrease in insulin production (type 1) or impaired utilization of insulin as a result of peripheral insulin resistance (type 2) causing hyperglycaemia.57 The current diagnostic criteria for diabetes, as indicated by American Diabetes Association, are listed in Table 2.54 According to WHO statistics, ~180 million people in the world suffer from diabetes at present and this number is likely to double by 2030. The reason for this dramatic increase in diabetes is thought to be the ageing of the population, increased prevalence of obesity, sedentary lifestyle, and dietary changes.54 The major risk factor for type 2 diabetes is obesity with 90% of these patients being overweight.16 Of note, it appears that the development of type 2 diabetes can be delayed or sometimes prevented from manifesting in individuals with obesity who are capable of losing sufficient weight.21

**Pathophysiology**

The relationship between obesity and diabetes is emphasized by the fact that they both are important components of the metabolic syndrome,11 a syndrome characterized by central obesity, atherogenic dyslipidaemia, elevated arterial pressure, insulin resistance, and prothrombotic and proinflammatory states.6 38 Obesity is strongly associated with insulin resistance and diabetes. In a study of the impact of intra-abdominal fat and age on insulin sensitivity, visceral fat was a strong determinant of insulin sensitivity and B-cell function.55 In a retrospective cohort study of patients undergoing coronary artery bypass surgery, obesity in non-diabetic patients was not independently associated with an increased risk of adverse postoperative outcomes. In contrast, obesity in diabetic patients was independently associated with a significant increased risk of postoperative respiratory failure, ventricular tachycardia, atrial fibrillation, atrial flutter, renal insufficiency, and leg wound infections.43 Another study of the impact of bariatric surgery on type 2 diabetes concluded that clinical and laboratory (fasting glucose and HbA1c) parameters related to type 2 diabetes resolved or improved after bariatric surgery with 78% of the study group showing complete resolution of diabetes and 87% showing either resolution or improvement. The same study also demonstrated that weight loss and improvement of diabetes were related to the type of surgical procedure with a maximum impact associated with a biliopancreatic diversion.16

Diabetes is not only associated with obesity but also with OSA. A study of the association between OSA and impaired glucose metabolism in normal weight and obese individuals concluded that OSA is associated with occult diabetes, impaired fasting glucose, and impaired fasting glucose plus impaired glucose tolerance. The magnitude of this association was similar for obese and non-obese patients with OSA. Thus, OSA is an important risk factor for diabetes irrespective of weight.47

**Anaesthetic considerations**

Diabetic patients suffer from an increased incidence of perioperative adverse cardiac events, including unexplained hypotension, arrhythmias, hypoxaemia, electrophysiographic changes, and myocardial infarction, which have a peak incidence at 48–72 h after surgery.8 More severe diabetics can suffer from autonomic dysfunction and these patients often do not experience pain with myocardial ischaemia. The presence of orthostasis (heart rate increase >15 beats min⁻¹, or systolic arterial pressure decrease >20 mm Hg 5–10 min after changing position from supine to upright) is a sign of autonomic neuropathy and indicates potential operative haemodynamic instability.7 Preoperative β-block has been shown to decrease the risk of myocardial infarction and had been advised in diabetic

**Table 2 The American Diabetic Association diagnostic criteria for diabetes**

| 1 | Symptoms of diabetes (polydypsia, polyuria, and unexplained weight loss) plus a casual (non-fasting) glucose concentration of ≥200 mg dl⁻¹, or |
| 2 | A fasting (>8 h) glucose concentration ≥126 mg dl⁻¹ (normal <100 mg dl⁻¹), or |
| 3 | A glucose concentration ≥200 mg dl⁻¹ 2 h after ingestion of 75 g of glucose (normal <140 mg dl⁻¹) |
patients, despite previous concerns regarding the masking of symptoms of hypoglycaemia and worsening glucose intolerance. However, the use of β-blockers in all at-risk patients in the perioperative period was recently called into question by the Peri Operative Ischemic Evaluation (POISE) trial which showed an increased risk of death and stroke in patients started on β-blockers in the perioperative period. Although the exact handling of β-blockers is controversial, it is clear that patients who are currently taking these agents should have them continued in the perioperative period. Microvascular changes, secondary to diabetes, can make a diabetic patient more prone to cardiomyopathy with subsequent diastolic dysfunction. This dysfunction can respond well to β-blockers and calcium channel blockers that act by decreasing the heart rate and increasing diastolic relaxation.

Reviewing the medication history of diabetic patients is an important part of the preoperative assessment. Poorly controlled diabetes is associated with worsening organ damage. For instance, long-term uncontrolled hyperglycaemia is an important risk factor for development of end-stage renal disease. Angiotensin-converting enzyme (ACE) inhibitors are commonly prescribed for the prevention of renal complications in diabetic patients; however, patients with a creatinine concentration >3.0 mg dl⁻¹ or creatinine clearance of <30 ml min⁻¹ should probably not receive ACE inhibitors because of an increased risk for deterioration of renal function. Biguanides, such as metformin, should also be discontinued in patients with compromised renal function or who will undergo large or extensive surgical procedures because of their propensity to cause lactic acidosis.

Diabetic patients are at increased risk for various other perioperative complications. Hyperglycaemia decreases leucocyte chemotaxis and function. Increased susceptibility to delayed wound healing and wound infections, feared complications in diabetics, can be reduced by keeping blood glucose (BG) concentrations <250 mg dl⁻¹. In addition to the tendency to diabetic ketoacidosis and non-ketotic hyperosmotic state, hyperglycaemia produces hyperosmolarity and hyperviscosity which can lead to thrombogenesis and increased perioperative complications. As a result of the frequent presence of microvascular disease, diabetic patients have an increased susceptibility to soft tissue ischaemia in addition to nerve injury, so pressure points must be well padded during positioning. For similar reasons, epinephrine should probably be avoided in diabetic patients when local anaesthetics are injected into areas of marginal blood supply. Diabetic patients are also at risk for pulmonary aspiration secondary to delayed gastric emptying. While not a first-line drug for postoperative nausea and vomiting, metoclopramide can be effective for aspiration prophylaxis in patients with gastroparesis. While several other agents are effective for the prevention of postoperative nausea and vomiting in diabetics, dexamethasone should be used with caution due to its exaggerated effect on glucose in diabetics compared to non-diabetics.

Approaches to managing of insulin dosing in the perioperative period vary by institution. In general, patients with type 1 diabetes and type 2 diabetes on chronic insulin therapy are treated similarly, with half of the usual long-acting insulin given the morning of surgery (basal insulin), supplemented by a regular insulin sliding scale titrated according to hourly glucose measurements. Alternatively, a regular insulin infusion of 0.5–2 U h⁻¹ can be used to meet basal metabolic needs. With either method, a slow glucose infusion will prevent hypoglycaemia while the patient is fasting. For type 2 diabetes undergoing short procedures, insulin is sometimes simply held the morning of surgery. No specific intraoperative recommendations regarding drug or fluid administration exist for diabetics. However, decision-making should rely on regular intraoperative blood sugar monitoring. If an infusion is required for glucose control, regular insulin in 5% dextrose with or without potassium may be used to ensure a gradual decrease of the serum glucose level.

While the hallmark of diabetes is hyperglycaemia, diabetic patients can also suffer from hypoglycaemia, defined as serum BG concentration <50 mg dl⁻¹ in adults, usually related to treatment with medications such as insulin. Prolonged severe hypoglycaemia can cause seizures, focal neurological deficits, coma, and death. Confusion, irritability, fatigue, headache, and somnolence are manifestations of hypoglycaemia. An adrenergic response can result in restlessness, diaphoresis, tachycardia, hypertension, arrhythmias, and angina. Anaesthetic drugs, analgesics, sedatives, and sympathetic agents can interfere with symptom presentation. Administration of dextrose 50% (50 ml) is the initial therapy for significant hypoglycaemia. Additional bolus doses might be necessary, and continuous evaluations of BG should be performed.

Surgery and critical illness activate the metabolic response to stress, which includes alterations in both hormone and cytokine concentrations. These in turn lead to both increased glucose production and a state of insulin resistance that can be additive to the defects in carbohydrate metabolism already present in the diabetic patient. Preoperative glucose control can be achieved by oral hypoglycaemic drugs or insulin. The importance of preoperative glucose control was noted in a prospective study evaluating the impact of preinduction hyperglycaemia and BMI in the perioperative management of cardiac surgical patients. A preinduction glucose above 110 mg dl⁻¹ was associated with a higher perioperative insulin consumption than in patients with a preinduction BG of 110 mg dl⁻¹ or less. When the glucose was above 110 mg dl⁻¹, insulin requirements were not different between patients with or without a history of diabetes. Intraoperative insulin management was more difficult in patients with a higher preinduction glucose, requiring more adjustments in the rate of insulin infusion and more periods of BG levels below 80 mg dl⁻¹ or above 200 mg dl⁻¹.
Interventions other than medications have also been reported to be useful in controlling blood sugar levels. Studies have demonstrated the beneficial effects of CPAP on hyperglycaemia in diabetic patients with OSA. After a mean treatment period of 83 days, 1 h postprandial glucose values and elevated levels of HbA1c were significantly reduced in patients using CPAP. Additionally, patients who were noted to have elevated levels of HbA1c (>7%) had a significant reduction in those levels as well. In support of these findings, CPAP treatments increased insulin sensitivity significantly in non-diabetic patients with OSA after two nights of treatment and beneficial effects were preserved even after 3 months of CPAP therapy. CPAP when used regularly and with effective pressures improved insulin sensitivity over longer time periods (mean 2.9 yr). Despite the knowledge of the adverse effects of hyperglycaemia, the question remains as to how tightly glucose levels should be controlled in the perioperative period. In this past decade, studies had been conducted to support tight glucose control (TGC). In 2001, a landmark randomized controlled trial on 1500 surgical ICU patients showed that intense insulin therapy (IIT) (target BG, 80–110 mg dl⁻¹) reduced in-hospital mortality by 34% compared with standard therapy (target BG, 180–200 mg dl⁻¹) and significantly decreased morbidity, including bloodstream infections, acute renal failure, red-cell transfusions, and critical-illness polyneuropathy. Recently, however, an evidence-based review on perioperative glucose control reported that the current criteria for TGC should be interpreted with care, since the major studies in favour of TGC were in surgical intensive care settings and might not apply to other settings. In general, careful and stepwise implementation of IIT protocols to maintain BG <150 mg dl⁻¹ and reduce BG variability can be both safe and effective in reducing adverse events. There are subpopulations that might benefit from TGC, but until those patients are identified IIT should be avoided in most surgical patients.

**Ambulatory patients**

The pre- and perioperative anaesthetic considerations for diabetic patients in day-case surgery do not differ significantly from inpatient procedures with the exception that in almost all ambulatory procedures, food intake is resumed fairly quickly after surgery. Importantly, this can allow for the timely resumption of routine diabetic medications. Medications should not, however, be resumed at normal levels until the patient has recovered sufficiently to maintain good oral intake and, while typically true for any patient, special consideration for admission after surgery should be given to patients who suffer from severe diabetes and have difficulty eating. In general, however, with the exception of patients who have significant autonomic dysfunction and tend to manifest haemodynamic instability, outpatient surgery can be safely considered for most diabetics.

**Conclusions**

As the obese populations of many countries continue to grow so will the frequency of their presentation for surgery. With proper training and education, good care for these patients, while perhaps more complex, is obtainable. While many physicians in practice today see a large number of obese patients, they often do not fully recognize all the implications of obesity and its related disease states, OSA and diabetes. It is through this increased awareness that the care of obese patients can be improved.

**References**
