Title in English: Anesthetic Management of Patients Undergoing Bariatric Surgery

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Abstract/Resumo

Anesthetic Management of Patients Undergoing Bariatric Surgery

Background: Obesity represents a significant and growing problem around the globe, which justifies the increase of the demand for an effective intervention to solve such issue. The only evidence-based method to treat severe obesity and to cure obesity-related comorbidities is the bariatric surgery.

However, the anesthesiologist as a key element of a multidisciplinary team should put into practice the recognized scientific and technological advances which enable it to intervene correctly in all stages of the perioperative setting.

Objective: The aim of this review is to summarize which practices must be developed in such phases by anesthesiologists in order to achieve an uneventful recovery process.

Methods: Therefore, this work has been undertaken as a narrative literature review, analyzing several scientific publications related to bariatric surgery and obesity, in order to answer the question related to the assessment of how should anesthesiologists deal with obese patients within a surgery setting to maintain patients' safety and to enhance their recovery process. All selected publications present crucial information and recommendations to anesthesiologists, which highly emphasizes their validity and relevance.

Conclusion: With this review, we conclude that a multidisciplinary approach to this problem is crucial, and that obese patients may have their recovery process enhanced and associated with fewer complications if the actions recommended for the different stages involving bariatric surgery are taken into consideration.

Keywords: Anesthesiologists; bariatric surgery; best practices; obesity; recovery process.

Abordagem Anestésica de Pacientes Submetidos a Cirurgia Bariátrica

Introdução: A obesidade representa um problema significativo e crescente em todo o mundo, o que justifica o aumento da demanda para uma intervenção eficaz para resolver este problema. O único método baseado na evidência para o tratamento da obesidade mórbida e para curar co-morbilidades relacionadas com a obesidade é a cirurgia bariátrica. No entanto, o anestesiologista como elemento fulcral de uma equipa multidisciplinar deve colocar em prática os avanços científicos e tecnológicos reconhecidos que lhe permitem intervir corretamente em todas as fases deste cenário perioperatório.

Objetivo: O objetivo deste trabalho é resumir quais práticas devem ser desenvolvidas pelos anestesiologistas nas fases supracitadas, para que se possa providenciar a estes doentes um processo de recuperação sem intercorrências.

Métodos: Portanto, este trabalho foi realizado como uma revisão da literatura narrativa, analisando várias publicações científicas relacionadas com a cirurgia bariátrica e obesidade, a fim de responder à questão relacionada com a melhor forma que os anestesiologistas devem lidar com pacientes obesos dentro deste cenário cirúrgico de modo a manterem a segurança dos pacientes e para melhorar o seu processo de recuperação. Todas as publicações selecionadas apresentam informação crucial e recomendações aos anestesiologistas, que enfatizam a sua validade e relevância.

Conclusão: Com esta revisão, podemos concluir que uma abordagem multidisciplinar a este problema é fundamental e que os doentes obesos poderão ver o seu processo de recuperação otimizado e associado a menos complicações se forem tidas em consideração as atitudes recomendadas nas diferentes etapas que envolvem a cirurgia bariátrica.

Palavras-Chave: anestesiologistas; cirurgia bariátrica; melhores práticas; obesidade; processo de recuperação.

Introduction

Obesity represents a significant and growing problem around the globe[1]. Aside from the impairment of an individual patient, the negative consequences impose a significant economic burden for many health care systems[2]. Statistics for 2013 from the UK Health and Social Care Information Center show that in adults, 24% of men and 25% of women are obese[3]. Between 2001-2002 and 2011-2012, there was an eleven-fold increase in the number of patients (from 1019 to 11736) of all ages admitted to the NHS hospitals with a primary diagnosis of obesity[3]. As these numbers are growing, so is the demand for an effective intervention to solve this problem, being the bariatric surgery the only evidence-based method to treat severe obesity and to cure obesity-related comorbidities[4]. It is estimated that 220,000 bariatric surgery procedures are performed annually[5] in the United States. With the increasing demand for bariatric surgery, due to this new challenge in the current practice, dealing with obese patients in the surgical setting is now a common situation for the anesthesiologist. Obesity and its anatomical changes create unique challenges for clinicians when caring for bariatric surgery patients[6]. From the anesthesiologist's perspective, these morbidly obese patients represent a new type of population, which was extremely rare thirty years ago[7]. There is a large volume of information and multiple recommendations about this matter in the current literature[8,9,10], as well as evidences that substantiate that there are differences in the perioperative process[11,12,13]. Since bariatric surgery is being widely used, caring for morbidly obese patients is becoming more common for many institutions[14]. These patients require specific knowledge from the medical staff responsible for them, since anesthesia for morbidly obese patients is regarded as being associated with increased risks[15]. The constant and fast evolution of such problem of obesity creates the urgent need for medical staff to keep up-to-date, since an increasing percentage of their practices will be related to this specific population. In the bariatric surgery setting, perioperative management

should be planned according to the specifics of these patients, more precisely in order to obtain the best possible outcome for the patient. To achieve such objective, it is of significant importance that the anesthesiologist dealing with these patients maintains the trustworthy information concerning the bariatric patient's management. Some of the most important contributions for a more informed approach for these patients include the preoperative assessment, especially with regards to the airway management and monitoring strategies, the intra-operative phase, the emergence from anesthesia and the postoperative phase[16].

In this paper we aim to review some of the most recent literature regarding anesthetic management of bariatric patients, focusing on the existing evidence about the best practice to deal with these patients. In order to obtain a thorough knowledge about such practice, we will discuss some key aspects of perioperative phases regarding the bariatric patient's management. The goal is to summarize important recent information in the specific area of the anesthetic management.

Methods

This study has been undertaken as a narrative literature review based on publications related to bariatric surgery and obese patients.

The studies were identified by searching MEDLINE and EMBASE databases.

In this particular case, the goal of the review is to assess narrative and systematic literature reviews in order to obtain knowledge regarding the current practices in bariatric surgery. Therefore, the main research question of the study is related to the assessment of the anesthetic management for obese patients in the context of bariatric surgery in order to maintain and ensure patients' safety and to enhance their recovery process.

According to the research question presented above, this study was conducted through a literature review based on several procedures and factors capable of influence the

anesthesiologist practice in this context. This study also provides some scientific recommendations to a safe and quick recovery process of such patients.

The search process was a manual search of specific scientific publications, which were selected because they were known to include wither empirical studies or literature surveys, and to have been used as sources for other systematic and narrative literature reviews related to bariatric surgery and obese patients. Each journal and conference proceedings was reviewed individually, being only selected the most relevant ones to obtain a greater insight regarding the main research question of this study.

The scientific publications included in the study followed these particular parameters:

1) Written in English or Portuguese;
2) Related to surgery procedures;
3) Related to obese patients;
4) Meta-analyses.

Hence, the exclusion criteria of scientific publications were the following ones:

1) Written in other language than English or Portuguese;
2) Not related to surgery procedures per se;
3) Not related to obese patients in particular;
4) Not including a meta-analysis.

Furthermore, the data extracted from each publication were related to:

- The source and full reference;
- Classification of the study type (empirical and meta-analysis); Scope;
- Main topic area;
- Summary of the study including the main research questions and the answers;
- Research question/issue;
- Whether the study proposed practitioner-based guidelines.

All selected scientific publications are related to the study's research question, approaching different parameters of the anesthesiologist practice with obese patients. The study only focused on scientific publications.

Patophysiology of Obesity

All obese patients have lung volumes reduced due to a decrease in the chest and lung compliance related to the fat accumulation in the intra-abdominal region. This will cause an impaired lung expansion, which in turn results in a permanent and significant hypoventilation and atelectasis state. The obesity related need for Continuous Positive Airway Pressure (CPAP), Positive End Expiratory Pressure (PEEP) or recruitment maneuvers in the perioperative phase is related to the atelectasis formation caused by the mechanisms mentioned above[17]. These patients will have rapid decreases in the arterial blood oxygen, following breathing cessation[3], which will have a significant impact in the anesthetic management for the bariatric surgery. This effect is observed when the presence of multiple and prolonged oxygen desaturations increase the sensitivity to opioid-induced respiratory depression[18], which may precipitate acute hypoventilation in the early postoperative period[19]. It has been described that, amongst patients who underwent to a weight-loss surgery, respiratory failure is the second respiratory cause of death, being reported in 11.8% of the fatalities[7]. Weight loss improves pulmonary gas exchange[17] and will have a determinant role in the preoperative preparation of the bariatric patient.

With this modified respiratory physiology, some obese patients develop obstructive sleep apnea (OSA), a condition that affects 10-20% of patients with BMI > 35 $kg.m^{-2}$ and is often undiagnosed[3], turning it into one potential target for improvement in the postoperative care of this population. OSA is associated with the twofold of the incidence of postoperative desaturation, respiratory failure, postoperative cardiac events and Intensive Care Unit (ICU)

admission[20]. It is also associated with a difficult airway assessment and to the risk of a complicated laryngoscopy[3].

Obesity leads to increased blood pressure, cardiac output and cardiac workload[3]. Pulmonary and arterial hypertension is developed[17]. The increased fat mass and extra-vascular fluid modifies the pharmacokinetic profile of hydrophobic and hydrophilic drugs[17]. Ischemic heart disease and heart failure are more prevalent within the obese population, being this last one a condition that presents a predominant risk factor for postoperative complications[3].

Obesity is a pro-thrombotic state, which justifies why it is associated with increased morbidity and mortality from thrombotic disorders, such as myocardial infarction, stroke and Venous Thromboembolism (VTE)[21]. VTE, encompassing both Pulmonary Embolism (PE) and deep vein thrombosis, is one of the leading causes of death after bariatric surgery[22,23]. The risk of VTE continues months after bariatric surgery, reaching its highest range in the first or second subsequent month[24].

The patients at higher risk of perioperative complications are those with central obesity and metabolic syndrome[25]. Intra-abdominal fat accumulation, a determinant of the metabolic syndrome together with dyslipidemia, elevated blood pressure and impaired blood glucose tolerance is the most important risk factor for anesthesia[17].

Pre-operative Management

General Management

When approaching the literature about anesthetic considerations for a bariatric surgery management, it becomes obvious that the perioperative care of bariatric surgery requires a multidisciplinary approach in order to optimize recovery and long-term outcomes[4].

Therefore, and apart from the fundamental role of both the surgeon and the anesthesiologist,

it is quite beneficial to coordinate efforts with other professionals of different areas, namely those that establish their practice within Internal Medicine, Psychiatry and Physical Therapy[14].

Particular attention should be directed to the screening of patients for sleep-disordered breathing and to those that present a particularly high risk of VTE[3]. The type and features of the surgery are important variables to consider, since there is data suggesting that there is a higher risk associated with open and aggressive procedures, such as thoraco-abdominal surgery, duration of the procedure and situations associated with great blood losses[26,27]. However, the types of procedures used during bariatric surgery have evolved in an effort to mitigate unintended effects[6]. There are some regional particularities and for instance, the Roux-en-Y gastric Bypass (RYGB) accounts for over 80% of bariatric surgeries performed in the United States, with nearly two thirds of these cases performed laparoscopically[28]. Vertical restrictive (sleeve) gastrectomy is now frequently proposed as a first-line treatment in replacement of adjustable gastric banding due to its better efficacy in terms of weight loss[29]. The Obesity Surgery Mortality Risk Stratification score (OS-MRS) assigns 1 point to each of the following five preoperative variables: age $\geq$ 45 years, male gender, body mass index (BMI) $\geq$ 50 kg/m^2, hypertension and known risk factors for pulmonary embolism or 'PE risk' (previous thromboembolism, presence of inferior vena cava filter placement, a history of right heart failure or pulmonary hypertension and obesity hypoventilation syndrome). Patients with score 0 to 1 are classified as class 'A' (lowest) risk group, score 2 to 3 as class 'B' (intermediate) risk group and score 4 to 5 as class 'C' (high) risk group [30].

Preoperative information and preparation for surgery, as well as hospital admission, induce more adaptability for postoperative instructions and create realistic expectations about hospitalization, analgesia, mobilization and discharge[31]. In order to optimize this process, preparing patients for the stress of major surgery by initiating the recovery process before

surgery, and hence enhancing their preoperative functional capacity[4], is important. This can be achieved through aerobic exercise and resistance training, optimization of nutrition and smoking and alcohol cessation[4]. In bariatric surgery, it is customary to initiate a preoperative 'liver shrinking' diet to reduce the size of the liver and to turn the access to the stomach technically easier[32]. There is evidence-based data suggesting that an intense preoperative weight-loss in a minimum of 2 weeks prior to surgery can improve respiratory function and facilitate laparoscopic surgery[32,33,34,35].

Since our current practice has become more about effectiveness, due to pressure from hospital administrators because of current economic situation, the amount of preoperative diagnostic tests should be based on the need to evaluate patient's comorbidities in a tailored for each patient fashion[3,13,36,37].

Respiratory Assessment

The respiratory function of morbidly obese patients is characterized by a restrictive pattern of pulmonary impairment, hypoxia, hipoxaemia and ventilation-perfusion mismatch, particularly evident in the supine position[38]. In the preoperative period, the first strategy to prevent Postoperative Respiratory Complications (PRC) should be stratifying the individual risk of the patient, more precisely to allow a correct allocation of both the resources and the treatment[39]. Identifying the functional limitations contributing to this risk enables a quick assessment and a subsequent planning of the possible optimization. They include some of the following factors: advanced age, obesity, lung disease, smoking history, congestive heart failure or OSA[40,41].

Therefore, the respiratory evaluation of these patients should include, at this phase, an assessment of the arterial saturation by pulse oximetry, and pulmonary function tests should be made through Spirometry[3,42]. Arterial blood gas analysis should be considered if any of

the following: arterial saturation < 95% on air; forced vital capacity < 3l or forced expiratory volume in 1s < 1.5l; respiratory wheeze at rest; serum bicarbonate concentration > 27 $mmol.l^{-1}$ [43].

A higher prevalence of OSA is present, with rates of 30 - 93% in bariatric patients[44], which justifies the significant importance of the screening of such condition in this particular setting. The STOP-BANG screening questionnaire is used to find patients with OSA, being widely validated for this patient's population[45,46]. The American Association of Clinic Endocrinologists (AACE), The Obesity Society (TOS) and the American Society for Metabolic and Bariatric Surgery (ASMBS) advocate preoperative screening with polysomnography and preoperative CPAP in at-risk patients[42,47]. Patients should receive adequate treatment for this condition with CPAP before performing the surgery, otherwise they are at higher risk of adverse outcomes, such as postoperative complications or prolonged anesthesia recovery[33,48].

Cardiac Assessment

This aspect of the preoperative workup for bariatric patients should be no different from that of non-obese patients at this point. Careful history taking with regard to known criteria will establish the baseline cardiac risks and stress echocardiography with contrast or SPECT scan of the heart with attenuation correction can overcome the impaired visualization of the obese patient and provide accurate myocardial assessment[49]. These patients should have an electrocardiogram as a base screening test, with more detailed assessment (echocardiogram) being guided by specific risk factors of each patient[47]. Features of the metabolic syndrome should be actively identified as there is a strong relationship with cardiac morbidity[50]. Cardiopulmonary exercise testing (CPET) may predict those at a higher risk of postoperative complications and increased length of admission[51,52].

In fact, the echocardiogram is currently the most used method to diagnose the left ventricular hypertrophy, which is quite common in obesity and arterial hypertension. In sum, this diagnosis' method is based on the left ventricular mass calculation, which can be estimated by several formulas. Nonetheless, the most used formula to asses such mass is the Devereux's formula. Additionally, the echocardiography has also been used to assess the Left Ventricular (LV) systolic and diastolic functions in the obese[53].

Intra-operative Management

General Considerations

The lack of data on the literature regarding drug dosage for the obese is recognized and a quick investigation in some of the relevant literature confirms that assumption[3,54]. While lipophilic drugs will have a larger volume of distribution than hydrophilic ones, the current evidence indicates that changes in the volume distribution in the obese are drug-specific, so generalizations are difficult[55], which contributes to the lack of data. The use of Total or Ideal Body Weight (TBW, IBW) to calculate dosis for drugs administered to these patients is not completely clarified, despite the existence of some recommendations related to certain substances. The significance of such matter is related to the risk of administering an inadequate dosage to the patient, more precisely an elevated dosage needed to anesthetize him, or the risk of occurrence of an accidental awareness during the surgery. For most anesthetic agents, the dosage according to the total body weight is rarely appropriate and the recommendation, based on current practice amongst experts in bariatric anesthesia, is that lean or adjusted body weight is used[3]. However, there is not a consensus on this matter, since muscle relaxants are dosed based on IBW and most analgesics are dosed based on lean body

weight (LBW)[54]. Table 1 summarizes some of the parameters used to determine the dosage of the most frequent drugs administered on this setting.

The perioperative monitoring of these patients is crucial, since there are large amounts of drugs in the patient system, may represent a higher risk of impairment of their vital functions. A part from the regular monitoring care (basal monitoring, bispectral index of electroencephalogram (BIS), neuromuscular function monitor (train-of-four watch (TOF), end-tidal CO_2 ($EtCO_2$), and anesthetic concentration)[56], there are some anesthesiologists that advocate the insertion of an arterial cannula for blood pressure measurement[10,13,37]. The objective is to control anesthetic administered in order to improve the quick reversal of anesthesia and to enhance the immediate recovery period, while giving the surgeon the ideal setting for a successful surgical technique.

The length of the anesthetic period is deeply related to the choice of the procedure and, therefore, to the choice of the anesthetic protocol. The longer the surgical period, the higher the risk of developing postoperative complications, which will lead to a longer recovery period and to an increased length of hospital admission[56]. Hence, early mobilization is an important modality to prevent these complications[57]. Accordingly, there is a lot of research approaching this question and supporting that measures such as standardization of the surgical procedure to a less invasive and less consuming time technique, the use of short-acting agents, avoidance of general anesthesia and sedatives, maximal use of local anesthetic and multimodal opioid-sparing analgesia should be considered to achieve a better outcome for the patient and to shorten the hospital admission period[3,12,48,57,58,59].

Anesthetic Management

Any anesthetic regime in the morbidly obese patients should aim a rapid recovery, optimizing respiratory function in the postoperative period, since these patients are especially

predisposed to postoperative atelectasis and present a significantly higher morbidity and mortality in the ICU, which justifies the importance of an uneventful recovery[60].

Airway Management and Pulmonary Function

Important focus should be directed towards Airway Management of these patients, as they are particularly sensible to respiratory complications. Although increased BMI does not predict any difficulty with laryngoscopy or tracheal intubation, larger neck circumference (>40 cm) and higher Mallampati score (>3) are considered better predictors of a difficult intubation with obese patients, having a 13% higher incidence of difficult intubation[4,54]. The ramping position is recommended for this phase in the obese, as there is evidence that supports that it provides a better view for laryngoscopy[3], despite the fact that there is evidence to suggest that awake fiber-optic intubation in the reverse Trendelenburg position may be safer and more effective [4,9]. An emergency airway plan should be available and any failure or intercurrence with intubation should be managed following the Difficult Airway guidelines of the Royal College of Anaesthetists[61] or the ASA Difficult Airway Management Guidelines of the American Society of Anesthesiologists[62]. Anesthesia drops functional residual capacity by 50% in obese patients[38]. Therefore, pre-oxygenation to FiO_2 >90% and use of positive pressure (CPAP or PEEP) are extremely important to prevent PRC[37,63], existing evidences in the literature that support that a PEEP at 5 or 10 cm/H_2O prevents the formation of atelectasis and other postoperative complications, namely by improving the oxygenation[4,34,38,42]. Regarding the physiology of these patients, tracheal intubation with either volume or pressure controlled ventilation should be used, since there is not a recommendation related to the use of a better mode of ventilation. The proper positioning of the patient is important and there is an advantage if the patient can position him/herself on the table and help to identify pressure

points for protection, due to the increased incidence of pressure ulcers and neural injuries in these patients and also to prevent from rhabdomyolysis[3,4].

Anesthesia and analgesia agents

The use of drugs which are easily reversible, that have a short and fast onset and have the most trustable recovery profile are the ones recommended for this population. Anesthetics with shorter duration of action reduce the Immediate Recovery Time after anesthesia and improve lung function, oxygenation, and ventilation of obese patients at post-anesthesia care unit[56,64]. Induction of general anesthesia usually is made with propofol combined with remifentanil. Propofol is commonly used for total intravenous anesthesia (TIVA) due to its characteristic ease of titration, rapid onset and offset of action, reduced incidence of postoperative nausea/vomiting and emergence agitation[65]. Fentanyl and its analogues can be used, but remifentanil is the drug of choice because it does not accumulate in the fat[54]. For maintaining anesthesia there is evidence suggesting that the use of sevoflurane in super obese patients undergoing bariatric surgery is an effective alternative to propofol and remifentanil combination, offering excellent hemodynamic stability and pain management intraoperatively and faster recovery from general anesthesia[60]. There is a limited range of evidence-based data about which drug should be used to maintain general anesthesia in these patients, and while most part uses volatile agents or balanced anesthesia, there is data of propofol-based anesthesia protocols[3,12,13,37,66]. However, due to the increased risk of accidental awareness during general anesthesia (AAGA) in the obese, it is important to monitor depth of anesthesia during anesthesia[67]. Volatile anesthetics such as isoflurane and sevoflurane have been used for many years in the surgical setting due to their fat-insoluble composition, which in this particularly setting is quite valuable. However, in the bariatric surgery the use of desflurane seems to be acquiring more and more supporting evidence, due to the latest works on its

characteristics. Desflurane is described as consisting in the inhaled anesthetic agent of choice in patients undergoing bariatric surgery, particularly due to its faster onset and reliable recovery profile and for being the least soluble agent as well[3,4,48,54,56]. There is evidence of faster return of airway reflexes with desflurane when compared to sevoflurane in the obese, and that immediate and intermediate postoperative recovery is more rapid after desflurane anesthesia in morbidly obese patients, when compared to the use of propofol or isoflurane[60,68]. Despite their broad use for these patients, volatile agents such as desflurane have their limitations. One of the major problems of anesthetizing this population is the drug saturation of adipose tissue; in what concerns the volatile agents' there is evidence that this effect may delay the recovery time from anesthesia, and that it might be longer in morbidly obese patients[56]. Also, the use of volatile anesthetics on these procedures has been associated to a higher risk of postoperative nausea and vomit (PONV)[69,70]. As part of anesthesia management, a neuromuscular blocking agent (NMBA) is often administered to induce muscle relaxation, facilitate airway management, and minimize the risk for laryngeal trauma for tracheal intubation[71]. The dosage of succinylcholine should be based on total body weight, because obese patients recover more rapidly secondary to increased pseudocholinesterase activity[72]. For intubation, rocuronium have been studied and is commonly used as it is a short-acting desirable agent for this setting. However, the use of NMBAs is associated with the risk for residual neuromuscular blockade (RNMB), which may result in respiratory complications, muscular weakness, prolonged admission in the postanesthesia care unit (PACU) and hospital, and delayed extubation[73,74]. It is essential that the full reversal of the muscle relaxant is performed, because inadequate reversal can lead to RNMB [72].Neostigmine, combined with atropine or glycopirrolate, has been broadly used for NMB reversal in the bariatric surgery setting due to its safety pattern and its considerable affordable price. However, recent data published by Carron et al[75], showed that sugammadex

has considerably shorter NMB reversal times when compared with neostigmine. Accordingly, with the advent of Enhanced Recovery After Surgery (ERAS) postoperative protocols in the bariatric surgery setting, slower NMB reversal times of neostigmine are unbearable even despite their cheaper cost. The evidence in the literature state that sugammadex provides, indeed, a safer, faster and easier recovery in comparison to NMB such as rocuronium, and that their attributes allow it to have a role in the recent concept of fast track bariatric surgery[75,76,77]. Additionally it has been discussed that NMB reversal with suggammadex provides a less painful recovery for the patients having an opioid-sparing effect, which is a considerable advantage for a faster recovery as it reduces the risk of PONV, thus enhancing the recovery of the patients[77]. As to the extubation moment, there are some parameters to guide a safe and uneventful extubation and, if they are properly followed, a lower probability of complications is obtained. To confirm that the referred complete reversal of the muscle relaxation is achieved some authors advise that it is mandatory to ensure that some parameters are achieved : Spontaneous Ventilaton; $EtCO_2$ < 50mmHg; $SatO_2$ > 90% without additional O_2; TOF ratio > 0.9; BIS value > 90; [56].

Analgesia and PONV

According to the Consensus Guidelines for the management of PONV published in 2013, new evidence suggests that a laparoscopic approach is associated with an increased risk of PONV when compared to general surgery[70]. Analyzing the risk factors related to anesthesia for PONV, the use of volatile anesthetics was the strongest predictor, followed by the duration of anesthesia and postoperative opioid use[69,78]. Given the recent interest of the bariatric surgery community for the ERAS principles, these risk factors are a real threat to the faster and optimal recovery desired by the new conduct. Weingarten et al. studied, in a retrospective analysis, the factors associated with prolonged anesthesia recovery following

laparoscopic bariatric surgery in 781 patients, and concluded that, besides the high prevalence of OSA among these patients, the most common cause of prolonged anesthesia recovery was PONV[48]. These facts can be related to the risk factors associated with the bariatric procedure, allowing the knowledge that several methods and approaches are being studied in order to prevent such circumstances and to achieve a better management of the PONV.

The pain management of these patients is made by administering opioids, which consists in a crucial phase to achieve a faster and safer recovery. However, it is important to emphasize that PONV is often described by the patients as being fairly worse than the pain itself. The use of opioids such as morphine or fentanyl is common in these patients, even though they increase the risk of PONV[6,70]. There is no current data supporting the use of one opioid over another, and even if the opioid use is a risk factor for PONV, there is no difference in using one or another on this procedure[6,70]. Obese patients have a very specific set of characteristics regarding the opioid management, as they influence the distribution and excretion of opioid saturation[79]. Therefore, managing these patients with opioids is a challenge, since one must balance the need for higher dosages with dose-limiting effects, such as respiratory depression or PONV[6].

Optimizing the analgesic effect is of major importance, more precisely to improve and to accelerate the recovery process in the bariatric population. Analgesia protocols should be proactive and should be administered from the very beginning in the intraoperative time to improve patient comfort and also to achieve early mobilization. Therefore, the goal for analgesia in these patients is to use a multimodal approach to provide pain control and, at the same time, to reduce the use of opioids to do that[4,6,34]. To achieve this goal, strategies such as increased use of local anesthesia when possible or other opioid-sparing therapies should be applied[79]. Despite the increased risk of regional anesthesia and the bigger challenge it is associated to obese patients, there is evidence that proves that this strategy can be used with

success in this population[80-82]. A recent systematic review looking at the use of Intraperitoneal Local Anesthetic (IPLA) in laparoscopic gastric surgery found that IPLA, given before visceral dissection at the trocar sites, can help to reduce postoperative abdominal pain by blocking visceral afferent pathways[59]. Dogan et al. used this concept in a Fast Track Bariatric Surgery program experience and were able to reduce by 50% the use of intraoperative morphine[63]. The use of intravenous acetaminophen is another opioid-sparing strategy proposed[82]. Evidence regarding this therapy is on a recent retrospective trial of patients undergoing RYGB, which showed a reduction of 14.6% in the frequency of postoperative antiemetic rescue therapy allied to a decreased need for postoperative opioid use[83]. A prospective, double-blind, placebo controlled study showed that systemic lidocaine given during laparoscopic bariatric surgery reduced total 24-hour opioid use when compared to placebo (0.9% sodium chloride injection) in 50 patients[80]. A prospective randomized study demonstrated that an opioid-free total intravenous anesthesia (TIVA) using dexmedetomidine (a highly selective alpha-adrenergic agonist with sedative, amnestic, and analgesic properties without the respiratory depressive side effect[72]) was able to reduce the absolute risk of developing PONV and the severity of PONV compared with a general anesthesia (GA) protocol using volatile anesthetics and opioids in patients undergoing bariatric operations[66]. However, the hypothetical use of dexmedetomidine in bariatric surgery patients is still limited by the need to administer it in a closely monitored unit. Therefore, further research on the feasibility of its use on this population should be done[6].

Dexamethasone or ondansetron are some of the most common substances administered in PONV prophylaxis intraoperatively[66]. Data published by Sinha et al from a double-blind, placebo-controlled trial of 125 morbidly obese patients undergoing a laparoscopic bariatric procedure, showed that addition of aprepitant to ondansetron can reduce the incidence of PONV in this setting[84]. However, better results are obtained with a triple prophylaxis

strategy, which starts intraoperatively and goes during the immediate recovery. The combination of haloperidol, dexamethasone, and ondansetron was shown to reduce PONV, the necessity of rescue anti-emetics and also the morphine consumption in patients undergoing a sleeve gastrectomy[85]. Therefore, bariatric patients will probably benefit from PONV prophylaxis in order to improve their recovery and achieve a shorter hospital stay.

Postoperative Management

As it has been discussed, obese patients present an increased risk of postoperative complications, fact that is on the focus of the management of these patients. All strategies should aim to obtain an uneventful recovery process and the postoperative care is no exception. Accordingly, the bariatric surgery community has been studying and testing the ERAS programs and their feasibility and safety in the obese population. These programs are based on a multidisciplinary approach to the patients, in order to have a complete assessment of their condition. Although their focus is on the postoperative recovery, these programs presume a vast number of actions through all the perioperative management. They aim, and through a more standardized approach to these patients, to achieve more valuable outcomes, which will hopefully lead to an enhanced recovery for these patients. Some interventions of these programs consist on emphasizing the encouragement of patients to be actively involved in their recovery process, more precisely to achieve goals such as early mobilization and optimal pain control in the postoperative period. Other interventions focus on standardized anesthetic protocols with short-acting agents and with the least invasive means possible, all aiming a faster recovery of the patient's functions. The oral intake is early commenced and as soon as the patient tolerates it. The goal is to involve the patient as much as possible in his recovery, in order to have a better compliance with the postoperative interventions needed for his enhanced outcome. There is data in the literature stating that these programs can be

implemented in the bariatric surgery, providing better outcomes for the patients, faster recoveries and cost-efficient results for the health institutions[3,4,34,63,33]. Therefore, while planning the postoperative care for these patients, one should base his/her conduct accordingly to the ERAS principles, more precisely in order to provide the best possible outcome for the patient in his recovery.

Respiratory Management

A prospective control study conducted by Mendonça et al showed that obese patients have a higher incidence of Adverse Respiratory Events (AREs) than matched non-obese surgical patients[86]. Additionally, they showed that obesity and residual neuromuscular block were independent risk factors for AREs in the PACU[86]. Given such fact, it is quite crucial to implement an intervention in this particular area, to enhance the recovery of such patients. The oxygen saturation monitoring of the patient should be continued in the ward and maintained, more precisely until the patient is able to move by himself. Nonetheless, it is important to add that such monitoring is also used to detect sub-clinical desaturations that might escape to the medical staff otherwise. It is important to keep a close monitoring of the respiratory function of these patients at this moment to enable oxygen therapy and keep the pre-operative levels of arterial oxygen saturation[3]. This therapy should continue until the patient is capable of mobilization.

Patients that used preoperative CPAP should restart this therapy with preoperative settings on the device. However, even on patients that did not use CPAP preoperatively and do not have a diagnosed OSA, postoperative CPAP oxygen therapy was shown to reduce the risk of pulmonary restrictive disease, acute respiratory distress syndrome[72] and improve the arterial blood gas, reducing the need for postoperative intubation[47] and therefore, contributing to an uneventful recovery. There is some debate on the literature regarding to how long the oxygen

should be maintained. While Nightingale et al. advocate that the therapy should continue until the patient is able to move[3], Leonard et al. argue that it is not until the patients' oximetry is > 90% and sleeping and narcotics iv drugs are no longer needed that the therapy could be interrupted [54]. For Cullen et al., the treatment should continue for 24 to 48 hours[72].

Pain Management

Postoperative optimal pain control is one of the hallmarks involved in the ERAS programs concept given the fact that impaired pain management could compromise and slow the recovery of the patient, namely by affecting the inspiratory force and thus predisposing to hypoventilation and atelectasis. A multimodal approach to postoperative analgesia is the most effective method to adequate pain control as it minimizes opiate consumption[57], which is a confirmed advantage when caring for these patients. Promoting mobility is another principle of ERAS and even though epidural catheter has been proven to be useful on the control of pain in this setting[56], its use can be counterproductive, as it impairs the early mobilization of the patient because of its invasive need.

In the fast-track bariatric surgery plan, a patient controlled analgesia (PCA) regime is usually applied to enable the early mobilization of the patient and to obtain a better control of the pain[3,34]. However, one should never dismiss a close monitoring of the patient while on PCA regime, more precisely due to the risk of unknown sleep-disordered breathing, which, with the use of opioids to analgesia, increases the risk of respiratory complications. After that, an oral analgesia regime should be commenced, using opioid-sparing drugs, such as NSAIDS or acetaminophen, to optimize the use of opioids[6], and thus improving the probability of an uneventful and short hospital admission.

Thromboprophylaxis

The rate of Venous Thromboembolism (VTE) ranges from 0.3% to 3%, with PE-associated mortality as high as 30%, which justifies why this is one of the most common causes of mortality after bariatric surgery[22,87]. The risk of VTE in bariatric patients is related not only to the obesity status per se, but also to factors associated to this setting, as OSA or prolonged surgical time. This risk exists not only in the immediate recovery period, but it is also prolonged for months after the procedure, presenting its higher rate of risk in the two following months[24]. Despite the low frequency of VTE, associated morbidity and mortality rates remain high, making VTE prophylaxis a priority[6].

The mainstay of VTE prophylaxis in obesity is pharmacological, with the criteria for pharmacological prophylaxis including: prolonged immobilization; total theatre time > 90 min; age > 60 years; BMI > 30 $kg.m^{-2}$; cancer; dehydration; and a family history of VTE[3]. Guidelines for postsurgical VTE prophylaxis were published by the National Institute for Health and Care Excellence in 2010, and strategies such as early postoperative mobilization, mechanical compression devices, thromboembolic device (TED) stockings, anticoagulant drugs and vena cava filters were recommended[23].

Studies have found that Low Molecular Weight Heparin (LMWH), primarily in combination with sequential compression devices (SCDs), is more effective than Unfractionated Heparin (UFH) and it is not associated to a greater risk of bleeding[22,23]. Regarding the use of novel anticoagulants in this population, there is very limited data approaching this area. Accordingly with the cited guidelines, it is common practice to use SCDs and early ambulation in addition to pharmacologic interventions[23]. About the strategy used for inferior vena cava filters (IVCF), there is no conclusive evidence to support the customary use of these devices for primary prevention of VTE in bariatric surgery[6]. Thus, such strategies should be avoided in this particular setting.

Therefore, a multimodal prevention protocol for this problem should be applied, more precisely by using such evidence-based interventions, in order to reduce the risk of VTE in the bariatric patient.

Conclusion

Given the fact that obesity represents a growing problem around the globe, it is crucial to intervene in order to solve such substantial problem. Therefore, bariatric surgery is a quite recommended procedure, particularly due to the fact that it consists in the only evidence-based method to treat severe obesity and to cure several obesity-related comorbidities. However, with the increasing demand for such procedure, it became vital to obtain knowledge regarding the best conduct to deal with obese patients, more precisely within anesthesiologists, since anesthesia for morbidly obese patients is considered to be associated with increased risks.

Perioperative management, in the bariatric surgery setting, should be planned accordingly to the patients' individual needs in order to obtain the best possible outcome. A multidisciplinary approach to this problem is crucial, and obese patients may have their recovery process enhanced and associated with fewer complications if the actions recommended for the different stages involving bariatric surgery are taken into consideration. In the pre-operative phase, and in terms of general management, it is necessary to proceed to a multidisciplinary approach to optimize recovery and long-term outcomes. In other words, anesthesiologists should seek for coordination with other professional of different areas to better understand the clinical state of the patient. However, particular attention should be directed to screening of sleep-disordered breathing and to potential risks of VTE.

In the intra-operative phase, it is crucial to obtain knowledge regarding the patients' state and to more precisely to accurately titulate anesthesia needs and prevent awareness during the procedure.

Finally, in the postoperative phase, anesthesiologists must adopt several strategies to obtain an uneventful recovery process, more precisely ERAS programs, given the fact that they were designed to achieve more valuable outcomes, thus leading to an enhanced recovery of obese patients.

In sum, anesthesiologists must obtain a trustworthy knowledge regarding the adequate procedures they must develop when caring for obese patients, which should clearly aim an uneventful recovery process and an enhanced quality of patients' lives.

References

1. Bibiloni MdM, Pons A, Tur JA. Prevalence of overweight and obesity in adolescents: a systematic review. ISRN obesity 2013;**2013**.
2. Apovian CM. The clinical and economic consequences of obesity. The American journal of managed care 2012;**19**(10 Suppl):s219-28.
3. Nightingale CE, Margarson MP, Shearer E, et al. Peri-operative management of the obese surgical patient 2015: Association of Anaesthetists of Great Britain and Ireland Society for Obesity and Bariatric Anaesthesia. Anaesthesia 2015;**70**(7):859-76.
4. Lemanu DP, Srinivasa S, Singh PP, et al. Optimizing perioperative care in bariatric surgery patients. Obesity surgery 2012;**22**(6):979-90.
5. Elliott V. Bariatric surgery maintains, doesn't gain. American Medical News 2012.
6. Quidley AM, Bland CM, Bookstaver PB, et al. Perioperative management of bariatric surgery patients. American Journal of Health-System Pharmacy 2014;**71**(15):1253-64.
7. Montravers P, Augustin P, Zappella N, et al. Diagnosis and management of the postoperative surgical and medical complications of bariatric surgery. Anaesth Crit Care Pain Med 2015;**34**(1):45-52.
8. Brodsky JB. Anesthesia in Bariatric Surgery. Minimally Invasive Bariatric and Metabolic Surgery: Springer, 2015:109-18.
9. Konrad F, Kramer K, Schroeder T, et al. [Anesthesia and bariatric surgery]. Der Anaesthesist 2011;**60**(7):607-16.
10. Nishiyama T, Kohno Y, Koishi K. Anesthesia for bariatric surgery. Obesity surgery 2012;**22**(2):213-19.
11. Sanford JA, Kadry B, Brodsky JB, et al. Bariatric Surgery Operating Room Time—Size Matters. Obesity surgery 2015;**25**(6):1078-85.
12. Jacobsen H, Bergland A, Raeder J, et al. High-volume bariatric surgery in a single center: safety, quality, cost-efficacy and teaching aspects in 2,000 consecutive cases. Obesity surgery 2012;**22**(1):158-66.
13. Heinrich S, Horbach T, Salleck D, et al. [Perioperative anaesthesiological management in 167 patients undergoing bariatric surgery]. Zentralblatt fur Chirurgie 2011;**136**(6):604-11.
14. Carroll R, Hall R, Parry-Strong A, et al. Therapeutic options in the management of obesity. The New Zealand medical journal 2013;**126**(1386):66-81.
15. Greenstein AJ, Wahed AS, Adeniji A, et al. Prevalence of adverse intraoperative events during obesity surgery and their sequelae. Journal of the American College of Surgeons 2012;**215**(2):271-77. e3.
16. Lindauer B, Steurer MP, Müller MK, et al. Anesthetic management of patients undergoing bariatric surgery: two year experience in a single institution in Switzerland. BMC anesthesiology 2014;**14**(1):125.
17. Mulier JP, Garcia M, Dillemans B. Pathophysiology of obesity. Impact on laparoscopy. Acta Anaesthesiol Belg 2009;**60**:149-53.
18. Doufas AG, Tian L, Padrez KA, et al. Experimental pain and opioid analgesia in volunteers at high risk for obstructive sleep apnea. PLoS One 2013;**8**(1):e54807.
19. Leykin Y, Brodsky JB. *Controversies in the anesthetic management of the obese surgical patient*: Springer Science & Business Media, 2012.
20. Mutter TC, Chateau D, Moffatt M, et al. A Matched Cohort Study of Postoperative Outcomes in Obstructive Sleep ApneaCould Preoperative Diagnosis and Treatment Prevent Complications? The Journal of the American Society of Anesthesiologists 2014;**121**(4):707-18.
21. Blokhin IO, Lentz SR. Mechanisms of thrombosis in obesity. Current opinion in hematology 2013;**20**(5):437.

22. Birkmeyer NJ, Finks JF, Carlin AM, et al. Comparative effectiveness of unfractionated and low-molecular-weight heparin for prevention of venous thromboembolism following bariatric surgery. Archives of Surgery 2012;**147**(11):994-98.
23. Gould MK, Garcia DA, Wren SM, et al. Prevention of VTE in nonorthopedic surgical patients: antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians evidence-based clinical practice guidelines. CHEST Journal 2012;**141**(2_suppl):e227S-e77S.
24. Rajasekhar A, Streiff MB. Vena cava filters for management of venous thromboembolism: a clinical review. Blood reviews 2013;**27**(5):225-41.
25. Glance LG, Wissler R, Mukamel DB, et al. Perioperative outcomes among patients with the modified metabolic syndrome who are undergoing noncardiac surgery. The Journal of the American Society of Anesthesiologists 2010;**113**(4):859-72.
26. Canet J, Mazo V. Postoperative pulmonary complications. Minerva anestesiologica 2010;**76**(2):138.
27. Rujirojindakul P, Geater A, McNeil E, et al. Risk factors for reintubation in the post-anaesthetic care unit: a case–control study. British journal of anaesthesia 2012:aes226.
28. Pratt GM, Learn CA, Hughes GD, et al. Demographics and outcomes at American Society for Metabolic and Bariatric Surgery Centers of Excellence. Surgical endoscopy 2009;**23**(4):795-99.
29. Gagnon LE, Sheff EJK. Outcomes and complications after bariatric surgery. AJN The American Journal of Nursing 2012;**112**(9):26-36.
30. Thomas H, Agrawal S. Systematic review of obesity surgery mortality risk score—preoperative risk stratification in bariatric surgery. Obesity surgery 2012;**22**(7):1135-40.
31. Elliott JA, Patel VM, Kirresh A, et al. Fast-track laparoscopic bariatric surgery: a systematic review. Updates in surgery 2013;**65**(2):85-94.
32. Edholm D, Kullberg J, Haenni A, et al. Preoperative 4-week low-calorie diet reduces liver volume and intrahepatic fat, and facilitates laparoscopic gastric bypass in morbidly obese. Obesity surgery 2011;**21**(3):345-50.
33. El Chaar M, Claros L, Ezeji GC, et al. Improving outcome of bariatric surgery: best practices in an accredited surgical center. Obesity surgery 2014;**24**(7):1057-63.
34. Barreca M, Renzi C, Tankel J, et al. Is there a role for enhanced recovery after laparoscopic bariatric surgery? Preliminary results from a specialist obesity treatment center. Surgery for Obesity and Related Diseases 2016;**12**(1):119-26.
35. Livhits M, Mercado C, Yermilov I, et al. Preoperative predictors of weight loss following bariatric surgery: systematic review. Obesity surgery 2012;**22**(1):70-89.
36. Huschak G, Kaisers U. [Anesthesia for bariatric surgery. Comorbidity determines the quality of results]. Der Anaesthesist 2011;**60**(7):605-06.
37. Schumann R. Anaesthesia for bariatric surgery. Best practice & research Clinical anaesthesiology 2011;**25**(1):83-93.
38. Pelosi P, Gregoretti C. Perioperative management of obese patients. Best Practice & Research Clinical Anaesthesiology 2010;**24**(2):211-25.
39. Haines KJ, Skinner EH, Berney S, et al. Association of postoperative pulmonary complications with delayed mobilisation following major abdominal surgery: an observational cohort study. Physiotherapy 2013;**99**(2):119-25.
40. Olper L, Corbetta D, Cabrini L, et al. Effects of non-invasive ventilation on reintubation rate: a systematic review and meta-analysis of randomised studies of patients undergoing cardiothoracic surgery. Critical Care and Resuscitation 2013;**15**(3):220.
41. Branson RD. The scientific basis for postoperative respiratory care. Respiratory care 2013;**58**(11):1974-84.
42. Baltieri L, dos Santos LA, Rasera Junior I, et al. Utilização da pressão positiva no pré e no intraoperatório de cirurgia bariátrica e seus efeitos sobre o tempo de extubação. Brazilian Journal of Anesthesiology 2015;**65**(2):130-35.

43. Mandal S, Hart N. Respiratory complications of obesity. Clinical Medicine 2012;**12**(1):75-78.
44. Schachter L. Respiratory assessment and management in bariatric surgery. Respirology 2012;**17**(7):1039-47.
45. Chung F, Subramanyam R, Liao P, et al. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. British journal of anaesthesia 2012;**108**(5):768-75.
46. Chung F, Yang Y, Liao P. Predictive performance of the STOP-Bang score for identifying obstructive sleep apnea in obese patients. Obesity surgery 2013;**23**(12):2050-57.
47. Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient—2013 update: Cosponsored by american association of clinical endocrinologists, The obesity society, and american society for metabolic & bariatric surgery*. Obesity 2013;**21**(S1):S1-S27.
48. Weingarten TN, Hawkins NM, Beam WB, et al. Factors Associated with Prolonged Anesthesia Recovery Following Laparoscopic Bariatric Surgery: a Retrospective Analysis. Obesity surgery 2015;**25**(6):1024-30.
49. Katkhouda N, Mason RJ, Wu B, et al. Evaluation and treatment of patients with cardiac disease undergoing bariatric surgery. Surgery for Obesity and Related Diseases 2012;**8**(5):634-40.
50. Apovian CM, Gokce N. Obesity and cardiovascular disease. Circulation 2012;**125**(9):1178-82.
51. Hennis PJ, Meale PM, Grocott MP. Cardiopulmonary exercise testing for the evaluation of perioperative risk in non-cardiopulmonary surgery. Postgraduate medical journal 2011;**87**(1030):550-57.
52. Hennis P, Meale P, Hurst R, et al. Cardiopulmonary exercise testing predicts postoperative outcome in patients undergoing gastric bypass surgery. British journal of anaesthesia 2012;**109**(4):566-71.
53. Cunha LdCBP, Cunha CL, Souza AMd, et al. Evolutive echocardiographic study of the structural and functional heart alterations in obese individuals after bariatric surgery. Arquivos brasileiros de cardiologia 2006;**87**(5):615-22.
54. Leonard KL, Davies SW, Waibel BH. Perioperative Management of Obese Patients. Surgical Clinics of North America 2015;**95**(2):379-90.
55. Hanley MJ, Abernethy DR, Greenblatt DJ. Effect of obesity on the pharmacokinetics of drugs in humans. Clinical pharmacokinetics 2010;**49**(2):71-87.
56. Sudré EC, de Batista PR, Castiglia YM. Longer immediate recovery time after anesthesia increases risk of respiratory complications after laparotomy for bariatric surgery: a randomized clinical trial and a cohort study. Obesity surgery 2015;**25**(11):2205-12.
57. Schug SA, Raymann A. Postoperative pain management of the obese patient. Best Practice & Research Clinical Anaesthesiology 2011;**25**(1):73-81.
58. Management ASoATFoAP. Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. Anesthesiology 2012;**116**(2):248.
59. Kahokehr A, Sammour T, Srinivasa S, et al. Systematic review and meta analysis of intraperitoneal local anaesthetic for pain reduction after laparoscopic gastric procedures. British Journal of Surgery 2011;**98**(1):29-36.
60. Siampalioti A, Karavias D, Zotou A, et al. Anesthesia management for the super obese: is sevoflurane superior to propofol as a sole anesthetic agent? A double-blind randomized controlled trial. European review for medical and pharmacological sciences 2015;**19**(13):2493-500.
61. Frerk C, Mitchell V, McNarry A, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. British journal of anaesthesia 2015;**115**(6):827-48.

62. Apfelbaum JL, Hagberg CA, Caplan RA, et al. Practice Guidelines for Management of the Difficult AirwayAn Updated Report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. The Journal of the American Society of Anesthesiologists 2013;**118**(2):251-70.
63. Dogan K, Kraaij L, Aarts EO, et al. Fast-track bariatric surgery improves perioperative care and logistics compared to conventional care. Obesity surgery 2015;**25**(1):28-35.
64. Zoremba M, Dette F, Hunecke T, et al. A comparison of desflurane versus propofol: the effects on early postoperative lung function in overweight patients. Anesthesia & Analgesia 2011;**113**(1):63-69.
65. Chidambaran V, Sadhasivam S, Diepstraten J, et al. Evaluation of propofol anesthesia in morbidly obese children and adolescents. BMC anesthesiology 2013;**13**(1):1.
66. Ziemann-Gimmel P, Goldfarb A, Koppman J, et al. Opioid-free total intravenous anaesthesia reduces postoperative nausea and vomiting in bariatric surgery beyond triple prophylaxis. British journal of anaesthesia 2014;**112**(5):906-11.
67. Pandit J, Andrade J, Bogod D, et al. The 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: summary of main findings and risk factors. Anaesthesia 2014;**69**(10):1089-101.
68. McKay R, Malhotra A, Cakmakkaya O, et al. Effect of increased body mass index and anaesthetic duration on recovery of protective airway reflexes after sevoflurane vs desflurane. British journal of anaesthesia 2010;**104**(2):175-82.
69. Apfel CC, Philip BK, Cakmakkaya OS, et al. Who is at risk for postdischarge nausea and vomiting after ambulatory surgery? The Journal of the American Society of Anesthesiologists 2012;**117**(3):475-86.
70. Gan TJ, Diemunsch P, Habib AS, et al. Consensus guidelines for the management of postoperative nausea and vomiting. Anesthesia & Analgesia 2014;**118**(1):85-113.
71. Murphy G, Kopman AF, Brull SJ, et al. Assessment and Reversal of Neuromuscular Blockade: Current and Emerging Strategies. 2015.
72. Cullen A, Ferguson A. Perioperative management of the severely obese patient: a selective pathophysiological review. Canadian Journal of Anesthesia/Journal canadien d'anesthésie 2012;**59**(10):974-96.
73. Murphy GS, Szokol JW, Avram MJ, et al. Postoperative residual neuromuscular blockade is associated with impaired clinical recovery. Anesthesia & Analgesia 2013;**117**(1):133-41.
74. Midões A, Sá A, Reis P, et al. Residual neuromuscular block in bariatric surgery: 9AP4 10. European Journal of Anaesthesiology (EJA) 2014;**31**:153.
75. Carron M, Veronese S, Foletto M, et al. Sugammadex allows fast-track bariatric surgery. Obesity surgery 2013;**23**(10):1558-63.
76. Raziel A. Comparison of Two Neuromuscular Anesthetics Reversal in Obese Patients Undergoing Bariatric Surgery-A Prospective Study. School of Medicine, Tel Aviv University, Tel Aviv, Israel, 2013.
77. Castro Jr DS, Leão P, Borges S, et al. Sugammadex reduces postoperative pain after laparoscopic bariatric surgery: a randomized trial. Surgical Laparoscopy Endoscopy & Percutaneous Techniques 2014;**24**(5):420-23.
78. Apfel C, Heidrich F, Jukar-Rao S, et al. Evidence-based analysis of risk factors for postoperative nausea and vomiting. British journal of anaesthesia 2012;**109**(5):742-53.
79. Lloret-Linares C, Lopes A, Declèves X, et al. Challenges in the optimisation of post-operative pain management with opioids in obese patients: a literature review. Obesity surgery 2013;**23**(9):1458-75.
80. De Oliveira Jr GS, Duncan K, Fitzgerald P, et al. Systemic lidocaine to improve quality of recovery after laparoscopic bariatric surgery: a randomized double-blinded placebo-controlled trial. Obesity surgery 2014;**24**(2):212-18.
81. Abu-Halaweh S, Obeidat F, Absalom AR, et al. Dexmedetomidine versus morphine infusion following laparoscopic bariatric surgery: effect on supplemental narcotic requirement during the first 24 h. Surgical Endoscopy 2015:1-7.

82. Gonzalez AM, Romero RJ, Ojeda-Vaz MM, et al. Intravenous acetaminophen in bariatric surgery: effects on opioid requirements. Journal of Surgical Research;**195**(1):99-104.
83. Ziemann-Gimmel P, Hensel P, Koppman J, et al. Multimodal analgesia reduces narcotic requirements and antiemetic rescue medication in laparoscopic Roux-en-Y gastric bypass surgery. Surgery for Obesity and Related Diseases 2013;**9**(6):975-80.
84. Sinha AC, Singh PM, Williams NW, et al. Aprepitant's prophylactic efficacy in decreasing postoperative nausea and vomiting in morbidly obese patients undergoing bariatric surgery. Obesity surgery 2014;**24**(2):225-31.
85. Benevides ML, de Souza Oliveira SS, de Aguilar-Nascimento JE. The combination of haloperidol, dexamethasone, and ondansetron for prevention of postoperative nausea and vomiting in laparoscopic sleeve gastrectomy: a randomized double-blind trial. Obesity surgery 2013;**23**(9):1389-96.
86. Mendonça J, Pereira H, Xará D, et al. Obese patients: Respiratory complications in the post-anesthesia care unit. Revista Portuguesa de Pneumologia (English Edition) 2014;**20**(1):12-19.
87. Froehling DA, Daniels PR, Mauck KF, et al. Incidence of venous thromboembolism after bariatric surgery: a population-based cohort study. Obesity surgery 2013;**23**(11):1874-79.