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REVIEW ARTICLE

Selection of Obese Patients Undergoing Ambulatory Surgery: A Systematic Review of the Literature

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BACKGROUND: The incidence of obesity has increased over the past 2 decades. In recent years, several studies have assessed perioperative outcomes in obese patients undergoing ambulatory surgery. However, this evidence has not been reviewed and evaluated systematically.
METHODS: We conducted a systematic review of studies published between 1948 and May 2012, assessing perioperative outcome in adult obese patients undergoing ambulatory surgery. All studies were eligible for inclusion if they reported perioperative complications including unplanned hospital admission and readmission.
RESULTS: A literature search revealed 23 studies (13 prospective and 10 retrospective), and 1 systematic review assessing laparoscopic bariatric surgery. A total of 106,119 patients were included in the analysis with 62,476 patients included in the prospective trials and 43,643 patients included in the retrospective trials (not including the systematic review of laparoscopic bariatric surgery). Of these, 39,548 patients underwent bariatric surgery. The super obese (body mass index [BMI] >50 kg/m^2) appear to be at higher risk of complications. Patients undergoing nonbariatric surgery had a lower degree of obesity (BMI approximately 30 kg/m^2). Patients undergoing bariatric surgery were morbidly obese (BMI >40 kg/m^2), which is associated with a higher comorbidity burden. However, the lack of increase in unanticipated admission rate in this patient population may be related to thorough preoperative assessment and avoidance of patients with comorbid conditions.
DISCUSSION: The literature lacks adequate information to make strong recommendations regarding appropriate selection of the obese patients scheduled for ambulatory surgery. The literature does indicate that the super obese (BMI >50 kg/ m^2) do present an increased risk for perioperative complications, while patient with lower BMIs do not seem to present any increased risk as long as any comorbidities are minimal or optimized before surgery. This review also identifies knowledge gaps and recommends future research required to guide optimal selection of obese patients scheduled for ambulatory surgery. (Anesth Analg 2013;117:1082–91)

The incidence of obesity has increased significantly over the past 2 decades. A recent report estimated that almost 40% of adults in the United States are obese[1] Body mass index (BMI) is commonly used to define the severity of obesity. A BMI of 25.0 to 29.9 kg/m^2 is defined as overweight, BMI of 30 to 40 kg/m^2 is defined as obese, and BMI >40 kg/m^2 is generally considered morbid obesity. A BMI >50 kg/m^2 is considered super obesity. Obesity is associated with an increased prevalence of comorbidities,[2] which may influence perioperative outcome. Increased prevalence of obesity combined with the trend toward increasingly complex and invasive surgical procedures creates uncertainty for anesthesiologists, who must determine whether they can provide a safe anesthetic and avoid an unanticipated hospital admission if the surgery is performed in an outpatient setting.

The Society for Ambulatory Anesthesia Committee (SAMBA) on Clinical Practice Guidelines was formed due to demands from the membership to develop practice guidelines for controversial and challenging situations in the ambulatory anesthesia environment.[3–5] SAMBA committee was asked to provide guidance regarding the optimal selection of obese patients undergoing ambulatory surgery. Therefore, a systematic review of published literature assessing perioperative complications and risk factors that may influence the perioperative outcome in obese patients undergoing ambulatory surgery was performed.[6–29] On completion of the review of published literature, it was determined that there was insufficient evidence to create specific guidelines for selection of obese patients undergoing ambulatory surgery. Nevertheless, the purpose of this review is to inform practitioners of ambulatory anesthesia regarding the currently available knowledge and knowledge gaps as well as recommend future research required to guide optimal selection of obese patients scheduled for ambulatory surgery.

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METHODS

A systematic review of the literature was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using the Cochrane CENTRAL Register of Controlled Trials (May 2012), Cochrane Database of Systematic Reviews (2005–May 2012), MEDLINE (R) (1948–May 2012), and EMBASE (1980–May 2012).[30] A reference librarian familiar with literature search protocol of the Cochrane Collaboration conducted the electronic search strategy with input from members of the consensus panel. The keywords used for the literature search included "ambulatory surgery," "ambulatory anesthesia," "outpatient surgery," "daycase surgery," "same day surgery," "bariatric surgery," "preoperative assessment," "screening," "patient selection," "obese," "obesity," "overweight," "morbidly obese," "morbid obesity," "super obese," "body mass index," "perioperative management," "anesthesia," "anaesthesia," "postoperative complications," "postoperative adverse events," "unanticipated admission," "hospital admission," "patient readmission," and "hospital readmission." We hand-searched reference lists from retrieved articles to identify further trials. The search was limited to only English language and human trials in adults. Finally, duplicate records were deleted.

The search results were screened in a stepwise manner to identify eligible studies. Two reviewers (SA and SE) independently assessed titles, abstracts, and/or the full-text articles retrieved from the electronic database and manual searches for possible inclusion according to the predefined selection criteria. Another author (GJ) resolved any disagreements between the reviewers. In the first phase of the review, irrelevant articles were excluded by reviewing the title of the search results. In the next phase, the abstract and/or full-text articles were evaluated to determine whether the eligibility criteria were met. The number and reason of excluded studies in this step were recorded.

All randomized controlled trials, prospective observational trials, and retrospective trials were eligible for inclusion if they reported intraoperative complications, postoperative complications, hospital admission, and mortality rates in adult obese patients undergoing ambulatory surgery. Studies not reporting at least one of these outcomes were excluded. All included studies were graded for strength of evidence according to the Scottish Intercollegiate Guideline Network (SIGN) scale (Table 1).[31] Data extracted from these studies included type of study, level of evidence, demographic data, BMI, associated comorbidities, type of procedure, type of anesthetic technique, intraoperative and postoperative adverse events, unanticipated hospital admission, readmission after discharge home, and mortality.

Unanticipated hospital admission was selected as a primary outcome measure, because it captures more severe and clinically relevant events after ambulatory surgery. Although obstructive sleep apnea (OSA) is a major comorbidity associated with obesity, it was not included in the analyses because it has been recently reviewed.[5]

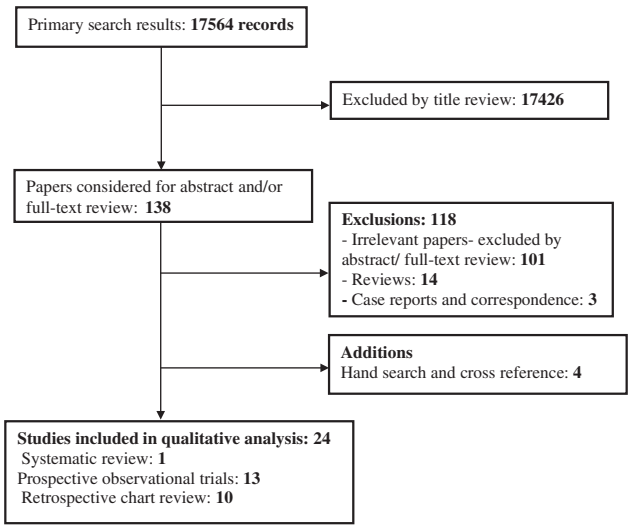

Figure 1. Flow chart of screened, excluded, and analyzed papers.

RESULTS

The Quality of Reporting of Meta-analysis (PRISMA) guidelines were followed for the description of this study. Our search strategy yielded 17,564 articles. Of these, 17,426 irrelevant studies were excluded after title review leaving 138 studies for consideration. Subsequently, 118 studies were excluded for reasons given in Figure 1. The literature search revealed 20 studies (11 prospective cohorts and 9 retrospective chart reviews).[6–25] Four studies (2 prospective cohorts, 1 retrospective study, and 1 systematic review assessing laparoscopic bariatric surgery) were added after hand-searching and cross-referencing.[26–29] All the studies were graded as II+ (well-conducted case-control or cohort studies with a low risk of confounding or bias and a high probability that the relationship is causal), while the systematic review was graded as II++ (high-quality systematic reviews of case-control or cohort studies) for strength of evidence. Quantitative analyses (i.e., meta-analysis) were not performed because the included studies were heterogenous.

Data from the included studies are summarized in Tables 1–4. A wide variety of ambulatory surgical procedures were included in the assessed trials (Table 2 and 4). Similarly, a wide variety of anesthetic techniques ranging from sedation/analgesia to general anesthesia with or without regional analgesia was included in the assessed trials. A total of 106,119 patients were included in the analysis with 62,476 patients included in the prospective trials and 43,643 patients included in the retrospective trials (not including the systematic review of laparoscopic bariatric surgery). Of these 39,548 patients underwent bariatric surgery (i.e., laparoscopic adjustable gastric banding [LAGB]), with 37,320 patients in the prospective studies and 2228 patients in the retrospective studies. Patients undergoing bariatric surgery had BMIs of higher than 40 kg/m^2, while the BMIs of the nonbariatric surgical population were approximately 30 kg/m^2.

The systematic review included in our study evaluated studies of LAGB surgery (1 randomized trial and 5 cohort studies) and found that 15 of 2549 (0.59%) patients had to be admitted.[29] The common causes for unanticipated admission were pain, nausea, and dysphagia. Five of the 6 studies reported a 0.55% (12 of 2181 patients) 30-day readmission rate. Dysphagia was the main reason for readmission. Of note, the studies included in the published systematic review were not included in this review to avoid duplication.

Table 1. Prospective Observational Trials (Demographic Data)

Studies	No. of patients			Age (y)	BMI (kg/m²)	Male gender, (% of total)
	Obese	Nonobese	Total			
Fortier et al.,[6] 1998	Not recorded	Not recorded	15,172	Discharged home = 46 ± 21 Unanticipated admission = 51 ± 20	Discharged home = 25 ± 0.5 Unanticipated admission = 24 ± 0.5	Discharged = 32% Unanticipated admission = 43.3%
Chung et al.,[7] 1999	2799 (15.9%)	14,839 (84.10%)	17,638	11–98	>30	32.90%
Nielsen et al.,[8] 2005	2166 (31.30%)	4754 (68.70%)	6920	48 ± 17	<25 = 34.8%, 25–29 = 34.0%, ≥30 = 31.3%	46.20%
Norman and Aronson,[9] 2007	51 (6.10%)	791 (93.90%)	842	Not available	Nonobese = 28.3 ± 5 Obese = 45.9 ± 3	Not recorded
Waisath et al.,[10] 2009	441 (36.50%)	764 (63.40%)	1205	No complications = 33.3 ± 14.9 Complications = 37.2 ± 14.9	No complications = 28.5 ± 7.8 Complications = 28.9 ± 7.8	Not recorded
Wani et al.,[11] 2011	286 (28%)	730 (72%)	1016	58 (46–68)	<30 = 72% 30–35 = 16% >35 = 12%	46.30%
De Waele et al. [12], 2004	10 (100%)	0	10	18–52	35.1–43.3	10%
Kormanova et al.,[13] 2004	20 (100%)	0	20	34	37.2–50.1	10%
Ramaswamy et al.,[14] 2004	193 (100%)	0	193	42 ± 10	50 ± 8	12%
Sasse et al.,[15] 2009	248 (100%)	0	248	45.57 ± 11.18	43.79 ± 6.41	18.10%
Flum et al.,[16] 2009	1198 (100%)	0	1198	46 ± 12.5	44.1 (40.5–49.0)	23.10%
Dorman et al.,[27] 2012	26,002 (100%)	0	26,002	45.9 ± 11.9	44.2 ± 6.7	20.20%
Karkala et al.,[28] 2011	9649 (100%) Morbidly obese = 7889 Super obese = 1760	0	9649	Morbidly obese = 45.76 Super obese = 44.66	Morbidly obese >40 Super obese ≥50	Super obese group had significantly more men than morbidly obese group: 3:2

Values are range or median (interquartile interval) or mean ± SD.
BMI = body mass index; Obese BMI >30 kg/m2; Morbidly obese = BMI >40 kg/m2; Super obese = BMI ≥50 kg/m2.

Overall, there were no differences in the rate of unanticipated admission between the obese and nonobese cohorts. Also, there were no differences in the rate of unanticipated admission between the studies of bariatric and nonbariatric surgical procedures. Two large studies (Fortier et al.[6] [n = 15,172] and Memtsoudis et al.[26] [n = 6942]) that included a variety of nonbariatric surgical population receiving a variety of anesthetic techniques did not report the number of obese and nonobese patients; however, the primary aim of these studies was to assess the incidence of unplanned hospital admission after ambulatory surgery. Both studies found that obesity was not a predictor of unplanned admission.[6,26]

A study using propensity matching to assess outcome after ambulatory surgery in a tertiary care center found that morbid obesity (BMI >40 kg/m^2) was not an independent risk factor for unanticipated hospital admissions or readmissions, despite the additional burden of comorbidity borne by the obese patients.[19] However, the unanticipated hospital admission rate in this study of 25% was significantly higher than the national benchmark of 3% to 5%.[32] Of note, the unanticipated hospital admission rates in other studies, including the systematic review,[29] were within the current national benchmark.

Some studies reported the incidence of comorbidities for the whole group, rather than separately for the obese and the nonobese (Tables 3 and 5). Some of the included studies reported a statistically significantly higher incidence in respiratory events in the form of oxygen desaturation, bronchospasm, stridor/laryngospasm, airway obstruction, and need for oxygen supplementation[7,19] or increased airway complications in the obese.[11,18] However, these studies did not report an increase in unanticipated admission rate in the obese, suggesting that these "surrogate" measures may not be clinically significant. Prolonged postanesthesia care unit stay was observed in the morbidly obese patients in 1 small study (n = 51),[9] while this was not reported by other large studies.

A study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database comparing 30-day perioperative morbidity and mortality in the super obese (BMI >50 kg/m^2) and the morbidly obese (BMI = 40–49 kg/m^2) undergoing laparoscopic bariatric procedures found that the super obese had more comorbidities and significantly longer operating times (74.5 minutes vs 81.1 minutes, respectively).[28] The overall 30-day mortality rates in the 2 groups were very low. Compared with the morbidly obese (n = 7889), the super obese (n = 1760) had a significantly more frequent incidence of superficial (1.65%, odds ratio [OR] 2.18, P = 0.0013) and deep (0.23%, OR 2.56, P = 0.035) wound infections, sepsis, septic

Table 2. Prospective Observational Trials (Perioperative Outcome)

Studies	Type of surgery	Anesthetic technique	Complications		
			Surgical	Perioperative	Unanticipated admission
Fortier et al.,[6] 1998	Ear, nose, and throat Dental General Urology Neurosurgery Gynecology Plastic Ophthalmology Orthopedic	GA MAC Regional	Not recorded	Not recorded	Obesity (BMI >30 kg/m^2) not a predictor of unanticipated admission
	Chronic pain blocks Ophthalmic Gynecology Orthopedic Plastic Neurosurgery Ear, nose, and throat Dental Urological Chronic pain blocks				Overall incidence 1.42%
Chung et al.,[7] 1999	Ophthalmic	GA	Not recorded	Obese 4x greater perioperative respiratory events	Not recorded
	Gynecology Orthopedic Plastic Neurosurgery Ear nose and throat Dental Urological Chronic pain blocks	MAC Regional		OR 3.89 (CI, 1.13–13.3) Desaturation = 38.9% Bronchospasm = 36.1% Laryngospasm = 16.7% Aspiration = 5.6% Pneumothorax = 2.8%	
Nielsen et al.,[8] 2005	Orthopedics General Urology Plastics Gynecology	Not recorded	Not recorded	Higher block failure in obese. PNB: $P = 0.04$ Lumbar plexus block: 9.5% vs 8.4%, $P = 0.04$ Interscalene block: 15.2% vs 9.0%, $P = 0.02$	No difference between obese and nonobese
Norman and Aronson,[9] 2007	Parathyroid surgery	GA	Longer operative times in obese versus nonobese (45.5 min vs 21.8 min), $P < 0.001$	Longer PACU stay in obese versus nonobese, 2.2 h vs 1.3 h, $P < 0.05$	No readmissions
Waisath et al.,[10] 2009	Dento-alveolar surgery	Deep sedation	Infection: 3.8% Bony sequestration: 1.3% Dry socket#8232;: 1.24% Wound dehiscence: 1% Retained tooth#8232;: 0.6% Oral antral fistula: 0.4% Soft tissue defect: 0.08% TMD exacerbation: 0.08%	Pain: 1.24%	Not recorded
		GA	Irregular alveolar ridge: 3.1% Nerve damage: 1.7%	PONV: 0.08% Constipation: 0.08%	
Wani et al.,[11] 2011	Gastrointestinal endoscopy ERCP Endoscopic Ultrasound procedures	Propofol sedation	Not recorded	Obese: Higher need for airway maneuvers (BMI <30 = 10.5%; 30–35 = 18.9%; >35 = 26.8%; $P < 0.001$); Higher hypoxemia (BMI <30 = 5.3%; 30–35 = 9.4%; >35 = 13.4%;$P < 0.001$)	Not recorded
De Waele et al.,[12] 2004	Laparoscopic gastric banding	GA	No complications	No complications	No readmissions
Kormanova et al.,[13] 2004	Laparoscopic gastric banding	GA	Port site infection (1 patient)	No complications	Not recorded

(*Continued*)

Table 2. Continued

Studies	Type of surgery	Anesthetic technique	Complications		
			Surgical	Perioperative	Unanticipated admission
Ramaswamy et al.,[14] 2004	Bariatric surgery	GA	Not recorded	No complications	Not recorded
Sasse et al.,[15] 2009	Laparoscopic gastric banding 210 (84.6%) Laparoscopic gastric bypass 38 (15.3%)	GA	Small bowel obstruction, port infecxxxtion, gastric outlet obstruction	Not recorded	No unanticipated admission
Flum et al., 2009[16]	Laparoscopic gastric banding	GA	30-d adverse event DVT = 0.3%, tracheal reintubation = 0.2%, abdominal operation 0.8%	Not recorded	Not recorded
Dorman et al.,[27] 2012	Laparoscopic gastric banding	GA	Complications reported at readmission Nausea/vomiting Dehydration GI bleeding Stricture Anastomotic leakage Wound infection Intra-abdominal abscess	Not recorded	30-d readmission rate 1.2%
Karkala et al.,[28] 2011	Laparoscopic gastric banding	GA	Not recorded	Morbidly obese versus superobese: higher sepsis and septic shock in super obese	Not recorded

GA = general anesthesia; MAC = monitored anesthesia care; PONV = postoperative nausea and vomiting; TMD = Temporomandibular joint dysfunction; DVT = deep vein thrombosis; PNB = peripheral nerve block; ERCP= Endoscopic retrograde cholangiopancreatography; OR = odds ratio; CI = confidence interval; PACU = postanesthesia care unit.

Table 3. Demographic Data from Studies that Performed Retrospective Chart Review

Studies	No. of patients			Age (y)	BMI, (kg/m²)	Male gender
	Obese	Nonobese	Total			
Davies et al.,[17] 2001	258 (2.4%)	10,522 (97.60%)	10,780	Not recorded	Nonobese <35 Obese ≥35	Not recorded
Bamgbade et al.,[18] 2007	2232 (33%)	4541 (67%)	6773	Not recorded	Nonobese <30 Obese ≥30	Obese: 30% Nonobese: 70%
Hofer et al.,[19] 2008	235 (50%)	235 (50%)	470	48.1 ± 14	Obese 44.2 ± 4.4 Nonobese 22.5±1.6	Obese: 67.2% Nonobese: 67.2%
Walid et al.,[20] 2010	45 (42.9%)	52 (57.1%)	97	49	Not reported	Not reported
Buerba et al.,[21] 2011	Morbid Obese: 3501 (18.6%)	5535 (29.40%)	18,825	18–80	Morbid obese: ≥35	Morbidly obese: 15.7%
	Obese: 3924 (20.80%)				Obese: 30–34.9	Obese: 22.6%
	Overweight 5865 (31.2%)				Overweight: 25–29.9	Overweight: 15.9%
					Nonobese: 18.5–24.9	Nonobese: 12.2%
Schroeder et al.,[22] 2012	Obese: 188 (35.6%)	124 (23.50%)	528	Obese: 48.30 (13.5)	Obese: ≥30	Obese: 70.2%
				Overweight: 48.41 (14.5)	Overweight: ≥25<30	Overweight: 78.2%
	Overweight: 216 (40.9%)			Normal: 40.98 (16.4)	Nonobese: <25	Nonobese: 58%
Montgomery et al.,[23] 2007	320 (100%)	0	320	45 (19–69)	55.4 (50.0–71.1)	18.40%
Cobourn et al.,[24] 2010	1641 (100%)	0	1641	44 (18–73)	46.7 (35–79)	19.30%
Iyer et al.,[25] 2011	267 (100%)	0	267	35.7 + 9.2	42.0 + 7.2	36%
Memtsoudis et al.,[26] 2012	Not recorded	Not recorded	6942	15–64	Not recorded	Knee 54.9% Shoulder 57.6%

Values are range or median (interquartile interval) or mean ± SD.
BMI = body mass index.

Table 4. Perioperative Outcome from the Studies that Performed Retrospective Chart Review

Studies	Type of surgery	Anesthetic technique	Complications		
			Surgical	Perioperative	Unanticipated admission
Davies et al.,[17] 2001	Gynecology General surgery Orthopedic Maxillofacial ENT Urology Pain Ophthalmology Dermatology Plastic surgery	Not recorded	Not recorded	No differences PONV ($P = 0.5$) Pain ($P = 0.6$) Bleeding ($P = 0.2$)	Morbid obese 3% vs nonobese 2.7% ($P = 0.98$)
Bamgbade et al.,[18] 2007	Plastics ENT Gynecology Urology GIT Transplant Endocrine Thoracic Trauma Burn Maxillofacial Neurosurgery Vascular	Not recorded	Wound infection: Obese vs nonobese 6% vs 3.5% ($P = 0.001$) Urinary tract infection: Obese versus nonobese 3.9% vs 2.6 % ($P = 0.004$)	Myocardial infarction: Obese versus nonobese 0.5% vs 0.1% ($P = 0.001$) Peripheral nerve injury: Obese versus nonobese 0.4% vs 0.1% ($P = 0.039$) Morbid obese had higher prevalence of tracheal reintubation ($P = 0.009$) Cardiac arrest ($P = 0.015$) Mortality rate: obese versus all others 2.2 % vs 1.2% ($P = 0.034$)	Not recorded
Hofer et al.,[19] 2008	Ambulatory surgery	GA SA	Not recorded	Intraoperative: bronchospasm Obese 12 (5.1) vs nonobese 2 (0.9%) $P = 0.02$ Postoperative: oxygen supplementation Obese 12.3% vs nonobese 1.7% $P =<0.001$ Higher PONV treatment Obese 16.2% vs nonobese 9.4% $P = 0.03$	Obese 26% vs nonobese 22% ($P = 0.3$; OR = 1.3; 95% CI, 0.8–2.0)
Walid et al.,[20] 2010	Spine surgery	Not recorded	Infection rates were not statistically different	Not recorded	Obesity predictor of readmission with infection
Buerba et al.,[21] 2011	Thyroidectomy Parathyroidectomy	GA Local MAC Regional	Obese have significant: wound infection ($P < 0.01$) Longer surgical duration ($P < 0.01$) Urinary complication (Odds ratio [95% CI]: 2.2 [1.1–4.4])	Not recorded	Not recorded
Schroeder et al.,[22] 2012	Shoulder surgery	GA Interscalene block	Not recorded	Obesity is associated with longer block placement time ($P = 0.018$), Higher intraoperative fentanyl use ($P = 0.004$), higher PACU opioid use ($P = 0.001$), more PONV ($P = 0.042$)	Not recorded
Montgomery et al.,[23] 2007	Gastric banding	GA	Early: 4 (1.25%) Stomal occlusion/ obstruction 3 (0.1%) Bowel perforation 1 (0.3%) Late: 10 (3.1%) Slip/eroded band 3 (0.9%) Port problem 7 (2.2%)	Not recorded	No unanticipated admission

(*Continued*)

Table 4. Continued

Studies	Type of surgery	Anesthetic technique	Complications		
			Surgical	Perioperative	Unanticipated admission
Cobourn et al.,[24] 2010	Gastric banding	GA	Total: 0.91% DOS: 5 (0.3%) 30 d: 10 (0.61%)	None of the complications were serious, and all were resolved. The average time from sedation to discharge was <4 h	4 patients required transfer to hospital, and 3 were admitted.
Iyer et al.,[25] 2011	Gastric banding	GA	Not recorded	Significant correlation between difficult intubation with severe OSA ($P = 0.002$) Neck circumference >44 cm ($P = 0.03$) BMI >50 associated with postoperative complications (asthma exacerbation, desaturation) (OR 2.64, 95% CI, 1.14–6.12, $P = 0.02$)	No unanticipated admission
Memtsoudis et al.,[26] 2012	Knee and shoulder surgery	GA Neuraxial Block MAC Sedation Topical	Not recorded	Not recorded	Unanticipated admission rate 3.8%–7.9% Not influenced by patient-related factors (e.g., obesity)

GA = general anesthesia; MAC = monitored anesthesia care; SA = spinal anesthesia; PONV = postoperative nausea and vomiting; OR = odds ratio; CI = confidence interval; BMI = body mass index; DOS = day of surgery.

shock, and 30-day mortality (0.17%, OR 13.4, $P = 0.0219$).[28] The predictors of increased mortality were BMI, ASA physical status, type of procedure (i.e., Laparoscopic Roux-en-Y Gastric Bypass versus LAGB), and operative time.

With respect to postdischarge complications, 2 studies found that wound and urinary tract infections were more common in morbidly obese patients undergoing ambulatory surgery.[18,21] In 1 study, the 30-day readmission rate after LAGB was 1.2% ($n = 322$) and the mortality was 0.02% ($n = 6$) with 3 myocardial infarction-related and 3 indeterminate deaths.[18] Analysis of data from patients ($n = 26{,}002$) undergoing LAGB found that the factors that influenced readmission after discharge home included male gender (50% higher odds), symptomatic asthma, gastroesophageal reflux disease, OSA, and history of deep vein thrombosis or pulmonary embolism.[27] Other factors that influenced readmissions included employment status of disabled and retired. Also, prolonged length of stay (>2 days) after unanticipated admission occurred in 4.6% ($n = 1183$) patients, and it doubled a patient's odds of readmission.[27]

DISCUSSION

This systematic review reveals that studies evaluating perioperative outcome in obese patients undergoing ambulatory surgery are of limited quality. The limitations of this review are related to the limitations of the included studies, particularly those inherent to observational cohort studies such as availability of complete information. The studies included in this systematic review involved a variety of surgical procedures and anesthetic techniques. We included all available studies to be comprehensive and allow a wider interpretation of the published data. Thus, the information from this systematic review is representative of a broad practice rather than being specific to a surgical procedure or an anesthetic technique. Also, most of the studies included in this systematic review were performed in North America and may not reflect practices in other geographic areas. Another criticism could be that only studies published in English were included. It is possible that data from non–English-language studies may have provided an alternate perspective.

Of note, anesthetic and surgical practices have evolved over time, and therefore, data from older studies may not reflect current practice. However, except for 2 studies that were published in 1998 and 1999,[6,7] all other studies were published after the year 2000. Of note, modern anesthetic practice for ambulatory surgery is relatively standardized and has minimal variations including use of short-acting anesthetics and prophylaxis for common complications such as postoperative nausea, vomiting, and pain. Although intraoperative and postoperative care may influence perioperative outcome, we did not focus on these factors.

Despite several limitations, the included studies provide useful information that is worth discussion. Critical analysis of the available evidence has allowed us to make several observations. Several studies reported a higher incidence of complications in the obese (e.g., hypoxemia, need for supplemental oxygen, need for airway maneuvers, laryngospasm, and bronchospasm). However, clinical relevance

of these adverse events may be limited, because it did not influence the incidence of unplanned admission or any other serious complications.

Another observation is that the patients undergoing nonbariatric surgery had a lower degree of obesity (BMI approximately 30 kg/m^2). This reflects a conservative approach to patient selection in these studies. Because there is a correlation between the degree of obesity and the occurrence of comorbidity,[2] one could assume that this cohort of patients had a modest burden of comorbidities. Therefore, the lack of differences in the unanticipated admissions rates between the obese and the nonobese undergoing nonbariatric surgery may be attributed to inclusion of patients with low degree obesity. It is possible that morbidly obese patients are currently excluded from undergoing nonbariatric ambulatory surgery due to concerns of increased perioperative risks. Therefore, we are unable at present to determine whether this group of patients truly has a higher risk of unplanned admissions after ambulatory surgery.

We also observed that patients undergoing bariatric surgery were morbidly obese (i.e., BMI >40 kg/m^2). Although morbidly obese patients have a higher burden of comorbid conditions, the bariatric surgical patient population typically undergoes rigorous preoperative assessment for obesity-related comorbidities including OSA. Most of the studies performed in the bariatric surgical population provided more details of postoperative complications and the associated risk factors. Thus, one could assume that the lack of increase in unanticipated admission rate in this patient population may be related to preoperative identification and optimization of comorbid conditions. Therefore, a morbidly obese patient may undergo ambulatory surgery if any comorbidities are identified and optimized before surgery.

Probably the most important finding from this review is that super obesity (BMI >50 kg/m^2) might influence outcomes after ambulatory procedures, particularly those with coexisting medical conditions. One study reported that factors influencing perioperative outcome after bariatric surgery included a BMI >53 kg/m^2, inability to walk >200 feet, history of deep vein thrombosis, history of OSA, coexisting medical conditions, and type (invasiveness) of surgical procedure.[16] Another large study found that super obesity (BMI >50 kg/m^2), ASA physical status, and operative time significantly increased mortality.[28] These 2 studies indicated that the super obese are at a higher risk of perioperative complications and thus need careful evaluation and consideration before having ambulatory surgery.

A major comorbidity associated with obesity is OSA. However, we did not assess the impact of OSA in this study because it has been recently reviewed in the ambulatory surgical population.[5] The systematic review of outpatients with OSA concluded that OSA alone is not a determinant of perioperative complications and carefully selected OSA patients can safely undergo surgery on an outpatient basis. However, preoperative identification of OSA and optimization of comorbid conditions as well as minimization/avoidance of opioids and use of continuous positive airway pressure in the postoperative period are critical for avoidance of adverse outcomes.[5]

The observations of our present systematic review are further strengthened by similar reports from several investigations that have assessed the effects of obesity on perioperative outcome in the hospitalized population. Risk factors for postoperative complications in hospitalized patients appear to be similar to the outpatient bariatric surgical population. Interestingly, a prospective study of 118,707 hospitalized patients found that overweight and moderately obese patients had a lower 30-day mortality compared with patients with normal body weight.[33] Although the reasons for this "obesity paradox" are not yet known, the observations of this study may not apply to the super obese. A study using the ACS-NSQIP database (n = 28,241) found that overall morbidity and mortality rates after bariatric surgery performed on an inpatient basis were very low (4.1% and 0.13%, respectively).[34] A multivariate analysis suggested that the predictors of increased risk of return to the operating room were history of bleeding disorder, patients receiving dialysis, low preoperative hematocrit, low albumin, and length of operation.[34] A clinically useful scoring system that predicts the risk of mortality in patients undergoing gastric bypass includes age >45 years, male gender, BMI >50 kg/m^2, hypertension, and risk for pulmonary embolism.[35]

Postdischarge complications that were observed in this systematic review, particularly in the bariatric surgical population include venous thromboembolism and wound infection. This suggests that there is a need for appropriate antibiotic and venous thromboembolism prophylaxes in this patient population.

Recommendations for Future Research

This review has identified several areas for future research where current data are insufficient or conflicting. There is a need for large, adequately powered, well-designed prospective trials to assess the suitability of morbidly obese patients for ambulatory surgery. These studies must assess clinically significant outcomes such as unplanned admission rate and readmission rate. In addition, the time from end of surgery to discharge home (or discharge readiness) should be recorded. Assessment of readmission rate is critical because it provides information of long-term outcome after ambulatory surgery. Assessment of "surrogate" complications alone (e.g., incidence of hypoxemia and need for supplemental oxygen) is not adequate, because they may not always have a correlation with above-mentioned clinical outcomes.

Factors that can influence appropriate patient selection for ambulatory surgery need to be determined. These include patient-related factors (i.e., presence and severity of coexisting comorbidities), surgery-related factors, anesthesia-related factors, and venue-related factors. The relationship between patients' comorbidities, anesthetic techniques, invasiveness of the surgical procedure, surgeon's experience, and relevant perioperative outcome in the obese population also need to be assessed. There is a need for evaluating differences in perioperative outcomes and efficiency between the obese and the nonobese with respect to venue at which the surgical procedure is being performed (i.e., hospital-based ambulatory surgery centers, freestanding ambulatory surgery centers, and office settings).

Selection of Obese Patients for Ambulatory Surgery

One of the most common questions posed with respect to selection of an obese patient for ambulatory surgery is: "Is there a weight limit above which ambulatory surgery may not be appropriate?" Some recommend that BMI or weight alone should not be used as the sole indicator of suitability for surgery or its location.[36,37] However, these recommendations are based on expert opinion rather than published literature. None of the studies included in this review have directly addressed this question. Thus, at present, there is insufficient evidence to provide strong recommendations regarding a "cutoff" weight or BMI for patients undergoing ambulatory surgery.

In the absence of high-quality evidence, decisions regarding appropriateness of obese patients undergoing ambulatory surgery may be guided by the available data from this systematic review. Because several factors, such as invasiveness of surgery, the surgeon's experience, and the anesthesia technique, can influence perioperative outcome, we agree with previous recommendations that BMI (or weight) alone should not be the only determinant of patient selection for ambulatory surgery. Nevertheless, it appears that the super obese (BMI >50 kg/m^2) may be at a higher risk of perioperative complications, and this patient population should be chosen carefully for ambulatory surgery. However, ambulatory surgery appears to be safe in patients with BMI ≤40 kg/m^2, assuming comorbid conditions, if any, are well controlled, because patients' comorbid conditions (e.g., ASA physical status) correlate with perioperative complications.[28,38] For patients with BMIs between 40 and 50 kg/m^2, thorough preoperative assessment should identify obesity-related comorbid conditions (e.g., obesity-related hypoventilation syndrome, OSA, pulmonary hypertension, resistant hypertension, significant coronary artery disease, and resistant cardiac failure). Patients with these comorbidities may not be suitable for ambulatory surgery.

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