Advanced Care admission following bariatric surgery

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Abstract - Introduction: Obesity is a chronic disease with increasing prevalence. Bariatric surgery has proven to be an effective method for weight reduction and decreases the prevalence of various co morbidities like diabetes, hypertension, hyperlipidemia and obstructive sleep apnoea. Search strategy: A MEDLINE/PubMed search was conducted from 1980 until July 2009 using the search terms: obesity, bariatric surgery, critical illness, Intensive Care, Post Anaesthesia Care Unit, Medium Care and Advanced Care. Summary of findings: Four original studies and one abstract were found. The risk factors for ICU admission and prolonged mechanical ventilation were discussed. Conclusion: There are differences between Europe and the USA in the preferred type of bariatric surgery performed. There are also national and local differences between the organization and logistics of advanced care following bariatric surgery. Therefore, it is difficult to compare the literature on this subject. Almost all risk factors for advanced care admission following bariatric surgery are related to extreme weight; most of them are also related to age. Additionally, a need for extended mechanical ventilation en thus advanced care may be warranted in the following patients: males, heavier patients, those with pulmonary co morbidity and those in need of reoperation. Surgeons, anaesthesiologists and intensivists have to create clinical pathways both for the institute where they are working and their patients.

Keywords - bariatric surgery, postoperative complications, Advanced Care, Intensive Care, Medium Care, Post Aanaesthesia Care Unit, obesity.

Objective
Obesity is a chronic disease with increasing prevalence [1]. In 2007, in the Netherlands, 12% of women and 10% of men were obese (Table 1) [2]. There are many treatment possibilities for obesity such as: behavioural change, diet, exercise, medication and bariatric surgery. Unfortunately, in many cases conservative treatment modalities show only a minimal effect on weight loss. Bariatric surgery has proven to be an effective method for weight reduction and decreases the prevalence of various co morbidities like diabetes, hypertension, hyperlipidemia and obstructive sleep apnoea [2,3].

Regarding the complication rate and the possible severity of the complications, bariatric surgery requires critical care resources to be available. However, there is no particular algorithm for the elective admission of patients to advanced care units and the decision is generally based on discussions between the surgeon and anaesthesiologist regarding the individual patient's limitations. For emergency ICU admissions, most are based on surgical intra-operative problems, anastomotic leaks, prolonged respiratory failure and pneumonia [3].

In this review we will discuss the reasons for ICU admission following bariatric surgery.

Methods
A MEDLINE/PubMed search was conducted from 1980 until July 2009 using the following search terms: obesity, bariatric surgery, critical illness, Intensive Care, Post Anaesthesia Care Unit (PACU), Medium Care, Advanced Care.

Summary of the findings
Four original studies, and one abstract [5,7-10] were found (Table 2) and one review was not included in this table [4]. Many studies are performed on perioperative complications, but only a few mention the specific complications and complication rates that lead to ICU admission and/or prolonged mechanical ventilation. Problems regarding ICU admission are the national and local differences in the use and organization of postoperative, advanced, care utilities.

Table 1. BMI

<table>
<thead>
<tr>
<th>BMI</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>&lt; 25</td>
<td>Normal</td>
</tr>
<tr>
<td>25 – 30</td>
<td>Overweight</td>
</tr>
<tr>
<td>30 – 40</td>
<td>Obese</td>
</tr>
<tr>
<td>40 – 50</td>
<td>Morbidly obese</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>Super obese</td>
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Helling et al. described patients who were in need of ICU care and/or mechanical ventilation > 24 hours following bariatric surgery [5]. He identified the following risk factors for intensive care admission: intraoperative complications, cardiovascular disease, gender, age, BMI > 60, diabetes, obstructive sleep apnoea (OSA) and venous stasis [6]. Ezri et al. published data about pure restrictive bariatric procedures with standard postoperative care on a PACU, followed by ICU admission if necessary [7]. At a meeting of the American Society for Bariatric Surgery, Sosa et al. reported an ICU admission of 6% after gastric bypass surgery with a mortality rate of 2.3% [8]. Céndan et al. observed that patients following revisional surgery require more critical care than patients following primary surgery [9]. These risk factors were confirmed by Pieracci et al. [4] in 2006 [6]. Recently we described ICU admission following bariatric surgery in a teaching hospital in the Netherlands [10]. We observed an ICU admission rate of 8%. Of these admissions, 64% were elective, mainly due to OSA, and had a median ICU stay of 1 day. Emergent admissions were mainly due to surgical complications and had a median ICU stay of 8 days.

**Discussion**

Bariatric surgery can be divided into two varieties: 1. Restrictive procedures limit caloric intake by downsizing the stomach’s reservoir capacity; vertical banded gastroplasty, laparoscopic adjustable gastric band (Figure 1) and gastric sleeve resections (Figure 2). 2. Malabsorptive procedures decrease nutrient absorption by shortening the length of the functional small intestine; jejunoileal bypass, biliopancreatic diversion, with or without duodenal switch and Roux-en-Y gastric bypass (Figure 3).

Worldwide, Roux-en-Y gastric bypass (RYGB) and gastric banding (GB) are the procedures most commonly performed [3, 4]. Buchwald showed a remarkable difference between Europe and North America regarding the type of surgery performed [11]. A recent American review recommended RYGB, based on outcomes of weight loss. In Europe, GB is the type of surgery most performed. Although patients following GB had lower short term morbidity rates, re-operation rates were higher [12].

The consortium on the Longitudinal Assessment of Bariatric Surgery (LABS) identified the following independently associated risk factors for major adverse outcomes: a history of deep vein thrombosis or pulmonary embolus, OSA, an impaired functional status or extreme values of BMI [13]. In the Swedish Obese Subjects trial, 2,010 surgically treated obese patients were compared with 2,037 control subjects who were matched for 18 variables including age, sex, weight and several cardiac risk factors. Postoperative complications occurred in 13% of the patients and the mortality rate was 0.25% [14].

**Respiratory reasons for ICU admission**

Increased BMI leads to exponential decreases in expiratory reserve volume, forced expiratory volume, functional residual capacity, forced vital capacity and maximum voluntary ventilation [15]. Prior to the induction of anaesthesia, morbidly obese patients have a doubled atelectatic lung area compared to non-obese patients. This increases fivefold on the first postoperative day [16]. El Shobary et al. studied respiratory complications after laparoscopic gastric bypass. He compared patients admitted in 2004 (ICU admission for patients with a BMI >50, age >40 and OSA) with patients admitted in 2005 (ICU admission for patients with a BMI>60 and severe OSA), demonstrating that limiting ICU admission to more obese and sicker patients does not alter the profile or frequency of pulmonary problems in the total population [17].

A variety of techniques is used to reduce atelectasis, for example, elevating the patient’s head in reverse Trendelenburg position.

**Table 2. Studies on advanced care admission and mortality following primary bariatric surgery**

<table>
<thead>
<tr>
<th>PROCEDURES</th>
<th>NUMBER OF PATIENTS</th>
<th>BMI</th>
<th>ICU ADMISSION</th>
<th>EMERGENT ADMISSION</th>
<th>PLANNED ADMISSION</th>
<th>ICU MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helling, 2004</td>
<td>Vertical gastric banding Gastric bypass</td>
<td>250</td>
<td>56 ± 10.6</td>
<td>24% after 1 night PACU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ezri, 2004</td>
<td>Bariatric restrictive procedures (excluding gastric bypass)</td>
<td>234</td>
<td>42.3 ± 5.3 (laparoscopic) 42.2 ± 5.7 (open)</td>
<td>0.5% after PACU stay</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Cendan, 2005</td>
<td>?</td>
<td>1279</td>
<td>59 ± 13</td>
<td>19%</td>
<td>52.7%</td>
<td>47.3%</td>
</tr>
<tr>
<td>Sosa, 2005 (abstract)</td>
<td>Gastric bypass</td>
<td>740</td>
<td>?</td>
<td>6%</td>
<td>47.7%</td>
<td>52.3%</td>
</tr>
<tr>
<td>V d Broek, 2009</td>
<td>Gastoplasty</td>
<td>265</td>
<td>40 ± 7</td>
<td>8%</td>
<td>36%</td>
<td>64%</td>
</tr>
</tbody>
</table>
Prophylactic CPAP in the first 24 hours after gastric bypass surgery showed an improvement in lung volumes and oxygenation but there was no decreased length of stay or a lower complication rate [18].

**Obstructive sleep apnoea**
The LABS Consortium recently showed that diagnosed OSA is independently associated with an increased risk of major adverse outcomes (for example, death, reintervention or failure to be discharged from the hospital within 30 days after surgery) [15]. For diagnosed OSA, guidelines advise ICU monitoring for the first postoperative night for fast intervention should respiratory complications occur [19]. Nowadays, anaesthesiologists obtain polysomnographic examination in super obese patients as part of the preoperative screening. By using polysomnography, the severity of OSA can be given by counting the episodes of apnoea or hypopnoea for every hour of sleep. OSA is divided into 4 categories: mild OSA has an apnoea-hypopnoea index (AHI) between 1 and 5, moderate OSA with AHI 6-24, severe OSA with AHI>24. Valencia and colleagues evaluated OSA prevalence in 52 morbidly obese patients with a mean BMI of 51±9 and reported that 98% had a moderate OSA and 33% had severe OSA with significant oxygen desaturation (SaO2< 65%). Electrocardiographic abnormalities occurred in 31 % of the patients [20].

Anaesthesiologists agree that in the absence of a polysomnographic recording, a presumptive diagnosis may be made based on criteria such as BMI, increased neck circumference, snoring, daytime hypersomnia, inability to visualize the soft palate and tonsillar hypertrophy [21]. Benumof advises an assessment of the severity of BMI and AHI, cardiopulmonary disease and narcotic/ sedative requirements [19]. When any of these factors is severe, postoperative ICU admission is required.

In obese patients, benzodiazepines should be avoided because of their effects on the central nervous system and upper airway musculature. The use of opioids should also be limited. Obese patients with suspected OSA requiring opioids or benzodiazepines should be kept in a monitored setting. By nightfall the effect of intraoperative (local) anaesthetics is dissipated and the need for analgesics increases. This is also the time that redistribution of lipophilic sedative agents from the fatty tissue in the blood stream occurs [12]. Epidural analgesia does not eliminate this risk, as respiratory arrest has been reported in OSA patients up to 2-3 days postoperatively [22].

**Cardiovascular indications for ICU admission**
Obesity is an independent risk factor for cardiovascular disease [23]. Obesity may affect the heart through its influence on known risk factors such as dyslipidemia, hypertension, glucose intolerance, inflammatory markers, OSA and the prothrombotic state [24]. In a meta-analysis, Buchwald et al. observed that 35% of the studied population had systemic hypertension. In this study, that included 2,094 patients, coronary artery disease occurred in 7% and congestive heart failure in 2.3% [11].

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**Figure 1.** Gastric Banding. Restriction of the stomach is created using a silicone band, which can be adjusted by the addition or removal of saline through a port placed just under the skin. (used with permission of Covidien, Zaltbommel, the Netherlands)

**Figure 2.** Gastric Sleeve. The stomach is “tubulized”. This volume reduction provides the food intake restriction component of this operation. In this picture the newly created gastric sleeve is placed before the old, complete, stomach (used with permission of Covidien, Zaltbommel, the Netherlands).
Cardiac physiology is different in obese patients, adipose tissue comprises a substantial proportion of total body weight. Therefore, a large quantity of fluid is present in the interstitial space of adipose tissue (± 10% of the tissue wet weight) [25]. Obese persons have a higher blood volume, higher cardiac output and a lower peripheral resistance than lean patients. The cardiac output is increased due to increased stroke volume and not because of an increase in heart rate [26]. Increased left ventricular filling pressure finally causes ventricular dilatation. This dilatation leads to increased wall stress, producing an increase in myocardial mass and ultimately results in eccentric left ventricular hypertrophy (LVH) [27,28]. Prolonged duration of eccentric LVH is associated with greater impairment of left ventricular diastolic dysfunction and, later on, with poorer left ventricular systolic function [29]. Left ventricular systolic dysfunction and expanded blood volume may lead to left atrial enlargement and thus increase the risk of atrial fibrillation.

The effect of obesity on cardiac function is increased by the prolonged duration of the obesity itself – thus by age [30].

**Surgical indications for ICU admission**

Solitary wound complications, incidental splenectomy, incisional and internal hernias and early small bowel obstruction, are rarely a reason for ICU admission. Anastomotic leakage is a major complication that in many cases requires reoperation and intensive care [31]. Anastomotic leak occurs equally in open (1.68%) and laparoscopic gastric bypass (2.05%), but the leak rate after laparoscopic gastric bypass is related to the learning curve of the surgeon [32,33]. Anastomotic leaks occur at a median of 4 days after surgery and 67% of the patients with an anastomotic leakage showed signs of a systemic inflammatory response (SIRS). This group needs to be treated urgently and death cannot always be prevented. The overall mortality rate of patients who needed reoperation for leakage was 10%. In this important study by Al Sabah et al., it seems that a higher BMI protects against the severity of the SIRS response [34]. However, a high body weight could also blur the clinical symptoms and therefore delay the diagnosis. The clinical presentation of anastomotic leak includes tachycardia (72%), fever (63%), abdominal pain (54%), purulent drain output (24%), oliguria (21%), nausea and vomiting (17%), hypotension (17%) and, shoulder pain (14%). Unfortunately there is a lack of specificity in clinical presentation and in imaging studies [35]. Once anastomotic leakage was diagnosed, 67% needed intensive care for a median of 6 days (range 1-75). The remaining one-third of the patients was managed without being transferred to the ICU [36]. Recently Kermarrec et al. showed a mortality rate of 33% for patients requiring surgical revision within 45 days following different types of bariatric surgery. Mortality increased with the number of organ failures at reoperation, the number of reoperations and BMI >50 [31].

**Table 3. Risk factors for post perioperative morbidity and mortality**

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>AUTHOR</th>
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<tbody>
<tr>
<td>Male sex</td>
<td>Pieracci (16), Livingston (58)</td>
</tr>
<tr>
<td>Age</td>
<td>O’Rourke (33), Mason (40), Fernandez (41), Flancbaum (42), Livingston (58)</td>
</tr>
<tr>
<td>Body Mass index of &gt; 60 kg/m²</td>
<td>LABS (15), Davidson (18), Mason (40), Fernandez (41), Flancbaum (42)</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>Lagandre (51), Ettinger (52)</td>
</tr>
<tr>
<td>Cardiovascular Disease</td>
<td>Flancbaum (42), Lagandre (51), Ettinger (52)</td>
</tr>
<tr>
<td>Obstructive Sleep apnoea syndrome</td>
<td>LABS (15), vd Broek (17), Fernandez (41), Flancbaum (42)</td>
</tr>
<tr>
<td>History of venous thrombosis or pulmonary embolus</td>
<td>LABS (15)</td>
</tr>
<tr>
<td>Venous stasis</td>
<td>Prystowsky (50)</td>
</tr>
<tr>
<td>Impaired functional status</td>
<td>LABS (15)</td>
</tr>
<tr>
<td>Intraoperative complication</td>
<td>vd Broek (17), Almahmeed (‘), Fernandez (41)</td>
</tr>
<tr>
<td>Revisional surgery</td>
<td>Céndan (15)</td>
</tr>
</tbody>
</table>
BMI
In most American studies, BMI is shown to be higher than in European studies [7,9,11,12]. Increased BMI is mentioned in several studies as a risk factor for bariatric surgery [8,15,40-42]. Moreover, obesity is an independent risk factor for morbidity during ICU stay for other reasons than bariatric surgery alone [36,37]. Several studies observed a higher morbidity and mortality with a BMI > 50 or BMI>60 but this observation is not confirmed in all studies [38-40]. The recent work of Suter et al. showed that operative morbidity was similar between super obese and morbidly obese subjects. Although many super obese patients remain in the severely obese or morbid obese category, equivalent improvements in quality of life and obesity-related co morbidities indicate the reason for surgery in this specific category [41].

Venothromboembolic events
Obesity is a risk factor for venothromboembolic events (VTE). This is augmented by a pneumoperitoneum during surgery and the postoperative hypercoagulability due to increased levels of clotting factors [45,46]. Also, a history of deep vein thrombosis or pulmonary embolus are independently associated with an increased risk of major adverse outcomes after bariatric surgery (such as death, venous thromboembolism or reintervention) [15]. The incidence of VTE in patients following bariatric surgery, receiving routine perioperative prophylaxis is 0.2 – 3.5% [42,43]. Clear dosing regimens for thrombosis prophylaxis are lacking since the relationship between dosing and body weight is unclear. The role of routine duplex ultrasonography in detecting deep venous thrombosis is not clear and prophylactic inferior vena cava filter placement seems to be beneficial only for patients at high risk for postoperative thrombosis, such as patients with venous stasis disease, BMI >60, truncal obesity, prior thrombosis and known hypercoagulable state [44,45]. Despite the low incidence of VTE, there is a lack of evidence on a reasonable regimen for sufficient DVT prophylaxis; most centres are using a combination of mechanical devices, prophylactic low-dose anticoagulation and early, frequent mobilization [46,47].

Rhabdomyolysis
Rhabdomyolysis is caused by destruction of skeletal muscle. Risk factors are, besides obesity, surgery >4 hours, presence of diabetes or hypertension, open surgical technique and patient ASA status III or IV. In the studies by Ettinger and Lagandré, the incidence varies between 7% and 26.5% [48,49]. Both authors used creatinin phosphokinase (CPK) of five times the normal value as the cut-off point. However, this is a subject of discussion. Some authors propose higher cut-off values for laboratory diagnostic, at least in obese patients, because many cases of rhabdomyolysis in obese patients do not present a real risk of renal damage. However, the relation between irreversible renal damage and mortality, between biochemical data and prognosis was not confirmed in a clear but small study (only 324 patients of which 16 had elevated CPK and 2 developed renal failure) [50]. The prevention of rhabdomyolysis in bariatric surgery can be achieved by padding pressure areas, using pneumatic beds during surgery, using two combined surgical tables, limiting surgery time and administering aggressive fluid therapy [51].

Centres of excellence
In 2007 the Leapfrog Group Hospital Quality and Safety Survey added bariatric surgery to its growing list of high-risk procedures [52]. This has led to the development of Bariatric Surgery Centers of Excellence. Criteria for these centres are the immediate availability of critical care, adjusted equipment and infrastructure, and clinical pathways as well as minimum volume requirements for individual surgeons and hospitals. Several studies reported a decrease in mortality when bariatric surgery was performed by surgeons and in hospitals that perform more than 100 procedures per year [53,54]. Incidentally, one recent study did not support this benefit of high volume and designated centres [55]. However, without adequate equipment to support the challenges of caring for obese patients, simple functions such as patient mobilization, transfers, ambulation and even positioning in bed can be considered as problems for nursing and other staff. Nursing units should have access to hydraulic lifts and extended width-rated and weight-rated beds and chairs. Respiratory support with CPAP or non-invasive bi-level positive airway pressure should be available [12].

We are introducing a clinical pathway for bariatric surgery in our own institute. As well as well known risk factors (cardiovascular, pulmonary morbidity, OSA) patients are planned for elective postoperative ICU admission if they have a BMI > 45 (male) or a BMI> 50 (female). Patients admitted for re-intervention are discussed by surgeon and anaesthesiologist and ICU admittance is considered according to individual conditions.

Conclusion
The rise in prevalence of obesity is associated with an increase in bariatric surgery. Bariatric surgery is a name for a collection of diverse surgical treatments with their own risk factors. There are also national and local differences between the organization and logistics of advanced care following bariatric surgery. Therefore, it is difficult to compare the literature on this subject.

Several risk factors for intensive care admission were identified, but with poor levels of evidence. The risk factors can be divided into patient characteristics and perioperative complications. Almost all risk factors are related to extreme weight and most of them also to age. Additionally, males, heavier patients, pulmonary co morbidity and the need for reoperation may warrant the necessity for extended mechanical ventilation en thus advanced care. Surgeons, anaesthesiologists and intensivists need to develop clinical pathways. This would create an opportunity to study different risk factors and risk interventions. Through the use of these pathways - which includes advanced care – may decrease the incidence of mortality and morbidity in high volume centres and may improve the quality of care of this challenging patient population.
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