Analysis of Cost Outliers after Gastric Bypass Surgery: What can we Learn?

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Background: A clinical pathway for gastric bypass surgery (GBS) implemented at our institution in 1999 resulted in reduced costs and decreased variability in patient care. However, a reanalysis of GBS hospital costs identified a 16% incidence of "cost outliers". We hypothesized that analysis of clinical variables would identify factors associated with increased hospital costs following GBS.

Methods: Medical records and financial data for 91 GBS patients from November 2000 to July 2001 were reviewed. Patients with costs >1 SD above the total hospital cost mean comprised the cost outlier (CO) group, while the remaining patients were considered the normal cost (NC) group. Potential etiologies for COs included patient demographics, the number and severity of medical co-morbidities, surgical factors, and major postoperative complications.

Results: There were 15 patients in the CO group, and 76 patients in the NC group. Patient demographics were similar in both groups. Diabetes mellitus and severe medical co-morbidities, especially sleep apnea and degenerative joint disease were more common in the CO group (60% vs 9.2%, *P*<0.05 vs NC). The incidence of major complications (33% vs 8%) was significantly increased in the CO group (*P*<0.05 vs NC).

Conclusions: Despite utilization of a clinical pathway for GBS, 16% of patients were "cost outliers". Factors associated with increased hospital costs after GBS included severe medical co-morbidities (especially diabetes mellitus and sleep apnea) and the occurrence of major postoperative complications. Prospective identification of "high risk" GBS patients may allow hospitals with bariatric surgery programs to modify perioperative care and eliminate potential cost outliers.

Key words: Clinical pathway, morbid obesity, cost outliers, bariatric surgery, gastric bypass

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Introduction

The cost of health-care in the U.S.A. continues to rise, despite the best efforts of government agencies, third party payors, hospital administration, and physicians. In 2000, the medical costs attributable to obesity were estimated to exceed $100 billion/year.[1,2] Approximately 60% of adults in the U.S.A. are considered to be overweight or obese, while 5% are morbidly obese with serious weight-related medical problems.[3] The body mass index calculates the relationship between height and weight (BMI=kg/m^2) that is used to define the severity of obesity.[4] Individuals with clinically severe or morbid obesity (BMI≥40, weight-related medical problems) may be treated surgically when medical weight loss therapies have failed.[5,6] The decision to perform surgery on an individual patient is typically based on the estimated risk/benefit ratio of an experienced clinician. Although the surgical technique for the gastric bypass procedure is relatively standard, patients with severe obesity are at increased risk for complications following upper abdominal surgery. To eliminate variability in perioperative patient care, we developed a standardized patient care regimen or clinical pathway for gastric bypass surgery at our institution.[7]

The clinical pathway for gastric bypass surgery (GBS) at the Penn State Milton S. Hershey Medical Center (HMC) was instituted in April of 1999. Initially, we analyzed the impact of the clinical pathway on resource utilization after GBS.[7] As described by others, we noticed a reduction in hospital length of stay and total hospital costs in patients having GBS after implementation of the pathway.[7-10] Based on our initial experience with the pathway, several revisions were implemented. To determine whether the revised pathway impacted resource utilization, we reanalyzed total hospital costs in all patients having GBS from November 2000 to July of 2001. We were surprised to note that approximately 16% of patients having GBS had higher than expected hospital costs. Our hypothesis was that analysis of these "cost outliers" would help us to identify clinical factors associated with increased hospital costs following GBS.

Methods

The clinical pathway for GBS patients instituted at HMC has been previously described in detail.[7] In summary, patients on the GBS pathway receive standard teaching regarding the surgical procedure and anticipated perioperative course. They undergo standard preoperative evaluations including: nutritional counseling, psychological evaluation, surgical consultation, and work-up of associated medical co-morbidities. Obesity-related medical conditions are documented preoperatively using a combination of past medical history, subjective complaints, and objective data (sleep studies, pH probe tests, radiographs of painful weight-bearing joints, and clinical laboratory tests). Preoperative testing, as clinically indicated, is performed and options for postoperative pain control are discussed. Patients are started on enoxaparin (40 mg if BMI<55 or 60 mg if BMI>55) the day before surgery and maintained on twice daily enoxaparin until discharge. Following surgery, patients are routinely extubated and admitted to the surgical intermediate care unit. Standard postoperative orders are utilized for fluid management, pulmonary care, laboratory data, physical activity, oral intake, and pain control. Patients are given water on postoperative day 1 and advanced to sugar free Carnation™ Instant Breakfast *ad libitum* over the next 2 days. Depending on the adequacy of mobility, oral intake, and pain control, discharge plans are made for the afternoon of postoperative day 3. Standard discharge instructions include incentive spirometry, physical activity limitations, wound care, and clinical conditions of which the surgeon should be notified, i.e. wound erythema with purulent drainage, severe abdominal pain, persistent vomiting.

Utilizing the hospital information system, a report was created based on the parameters of date of surgical procedure for obesity between November 1, 2000 and July 1, 2001 and diagnosis related group (DRG) 288. With approval from our institutional review board, the medical records for these patients were reviewed and clinical data abstracted. Demographic information including patient's age, preoperative weight, gender, and BMI were recorded. Medications and preoperative medical conditions were collected for all patients. Medical comorbidities were further defined as *severe* if they met the following criteria: degenerative joint disease (DJD) – inability to walk independently (use of walker, crutches, or electric cart); sleep apnea – sleep study documenting severe obstructive sleep apnea or obesity-hypoventilation syndrome; hypertension (HTN), diabetes mellitus (DM), and asthma were considered *severe* if patients were taking more than three physician-prescribed medications for their condition.

Information regarding the surgical procedure was abstracted on all patients including: operating surgeon, surgical technique (open vs. laparoscopic), previous bariatric surgery, and whether additional surgical procedures (cholecystectomy, hernia repair, etc.) were performed simultaneously with GBS.

Postoperative complications were collected for all patients throughout their hospitalization and follow-up period. Complications were categorized as wound-related (seroma, skin separation, infection), gastrointestinal (anastomotic leak, stricture, partial small bowel obstruction, distal stomach distention, etc.), pulmonary (pneumonia, atelectasis, tracheal plugging, etc.), and other (deep venous thromboembolism, abdominal abscess, etc.). All complications were reviewed and designated as major or minor by one of the authors (RNC). The occurrence and reason for all hospital readmissions were also recorded. Hospital length of stay was obtained from the hospital information system and verified by chart review.

Financial information on all patients was obtained from the hospital financial system and descriptive statistics were performed on the hospital cost data. We defined cost outliers (CO) as patients with total hospital costs >1 standard deviation above the mean and normal costs (NC) as patients with total hospital costs <1 standard deviation above the mean. Information regarding hospital costs (Total$) was subdivided into categories: room and board (Room$), operating-room (OR$), pharmacy, laboratory and radiology (Lab/Rad$), and miscellaneous (Other$) costs. Operating-room utilization was further analyzed using information obtained from the operating-room information system. Operating-room time (ORT) was subdivided into anesthesia time (AT), patient preparation time (PrepT), surgical time (SurgT), and "wake up" time (WakeT) as previously described.[7]

Data are presented as means±standard error (SE). Statistical evaluation of the data was performed using Excel (Redmond, WA), Minitab version 13 (State College, PA), or SAS software (Cary, NC). Chi-square test was used to compare categorical data and Student's t-test was used to compare continuous variables. All analyses were two-tailed. Differences among means were considered significant if $P<0.05$.

Results

Ninety-one patients with a DRG 288, undergoing GBS from November 1, 2000 to July 1, 2001 and entered into the GBS pathway, were included in this study. There were 15 patients in the CO group with mean hospital costs of $14,187±5,869 per case and 76 patients in the NC group with mean hospital costs of $7,634±886 per case.

The preoperative demographics of the CO and NC groups were generally well-matched as shown in Table 1. The mean age of 42 years and BMI range from 56 to 58 were similar in both groups. There was a preponderance of female patients in both groups, but the percentage of females was higher in the NC group. The number of weight-related medical conditions was also similar in the NC and CO groups (4.2 diagnoses/pt vs. 4.7 diagnoses/pt.).

The distribution of obesity-related medical diagnoses in the NC and CO groups is shown in Table 2. Sleep apnea and degenerative joint disease were the most common obesity-related medical diagnoses in our patients. However, hypercholesterolemia, gastroesophageal reflux, and hypertension were commonly seen (>40% of patients) in both groups as

Table 1. Demographics of Gastric Bypass Patients

Group (n=)	Age (yr)	Gender (F:M)	BMI (kg/m^2)	Medical Diagnoses (number/pt)
NC (n=76)	42±1	8:1	56.2±1.3	4.2±0.2
CO (n=15)	42±3	3:2	58.3±3.6	4.7±0.4

NC: Normal Costs, CO: Cost Outliers, F: Female, M: Male.

Table 2. Weight Related Medical Diagnoses in Gastric Bypass Patients

Medical Diagnosis	Normal Costs n (%)	Cost Outliers n (%)
APNEA	61 (80%)	12 (80%)
ASTHMA	14 (18%)	3 (20%)
CAD	1 (1.3%)	0 (0%)
CHO	38 (50%)	11 (73%)
DJD	55 (72%)	10 (67%)
DM	25 (33%)	9 (60%)*
GERD	39 (51%)	6 (40%)
HTN	39 (51%)	6 (40%)
MENS	12 (16%)	1 (7%)
SUI	13 (17%)	4 (27%)
VS	21 (28%)	8 (53%)

* = p<0.05 Cost Outlier vs. Normal Cost by Chi square test

APNEA = Obstructive Sleep Apnea; ASTHMA = Asthma; CAD = Coronary Artery Disease; CHO = Hypercholesterolemia/Hypertriglyceidemia; DJD = Degenerative Joint Disease; DM = Diabetes mellitus GERD = Gastro-esophageal Reflux Disease; HTN = Hypertension; MENS = Menstrual Irregularities; SUI = Stress Urinary Incontinence; VS = Venous Stasis.

well. Diabetes mellitus was identified in 60% of the CO patients and was significantly increased relative to the NC group ($P<0.05$ vs. NC). Other weight-related medical diagnoses such as venous stasis, urinary stress incontinence, dysfunctional uterine bleeding, asthma, and less frequently coronary artery disease were identified to a similar extent in both the NC and CO groups.

The incidence of severe medical co-morbidities was examined in the CO and NC groups. Seven of 76 patients in the NC group (9.2%) had "severe co-morbidities", with sleep apnea/obesity hypoventilation syndrome being the most prevalent in 5/7 patients. Severe co-morbidities were identified in nine of the 15 patients (60%) in the CO group ($P<0.05$ vs. NC). As seen with the NC group, severe sleep apnea with obesity hypoventilation syndrome was most commonly observed (7/9 patients), followed by severe DJD in 3/9 patients. Patients with severe co-morbidities were more likely to require intensive care unit admission and mechanical ventilation following their GBS. Seven of the 8 patients maintained on mechanical ventilation after surgery and admitted to the surgical intensive care unit had severe co-morbidities, with sleep apnea being the most common (5 patients). To further analyze the impact of severe medical co-morbidities overall on cost of care, total hospital costs in all patients with or without severe co-morbidities was compared. The mean hospital costs of patients with severe medical co-morbidities (n=16) was $10,804±1,137 verses $8,302±358 ($P$=0.052) in patients without severe medical co-morbidities (n=75).

Table 3 illustrates hospital costs subdivided by category. As defined, patients in the CO group demonstrated increased room and board, operating-room, laboratory, radiology, and other costs when compared to the NC group. However, operating-room costs account for the largest percentage of total costs. Therefore, the utilization of operating-room resources was examined to see if surgical technique or prolonged surgical times were an important determinant of cost outliers after GBS (Table 4).

Initially, we examined the potential impact of surgical technique on cost of care. In our study population, 26.4% of the patients had laparoscopic GBS (n=24) and 5.0% of the patients had their original bariatric operation revised (n=5). Although operating-room costs were increased in the laparoscopic GBS patients ($6,111±113 vs. $4,974±85, $P<0.05$), the total hospital costs were not significantly increased (Laparoscopic $9,950±1,019 vs. Open $8,271±321). Previous bariatric surgery patients were more common in the CO group (13.3%) vs. the NC group (3.3%), but these differences were not significant. We also examined whether performing additional procedures at the time of GBS was associated with increased costs. This did not appear to be the case, as 22% of patients in the NC group had additional procedures performed vs. 27% in the CO group.

Prolonged use of OR time for epidural catheter placement, induction of anesthesia, or a technically difficult surgical procedure could influence both total and OR costs for GBS patients. Table 4 shows the utilization of operating-room resources in the CO and NC groups. There was no statistical signif-

Table 3. Hospital Costs in the Gastric Bypass Groups

Group	Normal Costs	Cost Outlier	% Increase	P-value
Room$	$1,567±38	$4,287±510	174%	<0.001
OR$	$5,143±84	$5,933±259	15%	0.01
Lab/Rad$	$633±28	$2,737±751	332%	0.014
Other$	$290±22	$1,230±201	327%	<0.001
Total$	$7,634±102	$14,187±1,515	86%	0.001

Room$ = Hospital Room cost; OR$ = Operating Room costs; Lab/Rad$ = Pharmacy, laboratory, and radiology related costs Other$ = Miscellaneous cost which are those costs not contained in the above; Total$ = Total hospital costs.

Table 4. Operating Room Utilization by Gastric Bypass Patients

Group	Normal Costs	Cost Outliers	P-value
AT (min)	27±2	33±6	0.345
PrepT (min)	18±1	20±2	0.227
SurgT (min)	160±5	193±16	0.074
WakeT (min)	13±1	13±1	0.778
ORT (min)	218±5	259±23	0.098

AT = Anesthesia Time (time in the door till beginning of Prep time); PrepT = Prep time including positioning and skin preparation; SurgT = Total Surgery time (from incision to dressing); WakeT = Time from dressing to Post-Anesthesia recovery; ORT = Operating room time total.

icance noted in any parameters recorded. Thus, utilization of OR resources does not appear to represent the major source of additional hospital costs in the CO group.

Since OR resources do not appear to be the major source of the increase in total hospital costs, postoperative complications were reviewed, because they might influence requirements for bed acuity, hospital length of stay, and laboratory/radiology costs. There were no complications in 55% of all GBS patients. The most common complications were wound-related, with 14% having skin separation or seroma and 11% wound infections. Major complications were significantly increased in the CO group (8/15 patients, 53.3%) when compared with the NC group (6/76 patients, 7.9%) ($P<0.05$). Seven of the major complications were related to the GI tract: two early gastrojejunostomy (GJ) leaks (one requiring re-operation, the other sealing spontaneously), one early GJ stricture (in a patient with a BMI of 100), an early partial small bowel obstruction, and 3 late GJ strictures (2 re-operative cases). Major pulmonary complications represent the second most common category: 2 patients with pneumonia required intravenous antibiotics, and one case of tracheal plugging occurred in a patient with severe obstructive sleep apnea. Two patients had major wound-related complications with severe infection requiring intravenous antibiotics and local wound care. One patient had postoperative bleeding that required blood transfusion, while another had an abdominal abscess that presented several weeks after surgery.

The rate of hospital readmission was studied during the study period as another outcome indicator that ultimately influences cost of care. Ten patients were readmitted in the NC group (13%) verses seven patients in the CO group (46.7%) for an overall readmission rate of 18%. The majority of readmissions were for a combination of nausea, vomiting, abdominal pain, and/or dehydration (9/17 patients, 53%). Four patients were admitted for infections (three wound-related and one intra-abdominal abscess). One patient was admitted to a referring hospital with dyspnea that improved with diuresis; another was readmitted with hyponatremia and an embolic occlusion of the right femoral artery. A third patient was admitted to a referring hospital with deep venous thromboembolism.

Discussion

Patients with clinically severe obesity are generally considered to be high-risk surgical candidates primarily because of their pre-existing medical co-morbidities.[11] Given the elective nature of bariatric surgical procedures, patients expect good clinical outcomes. We developed a clinical pathway for GBS at our institution to minimize variability in patient care and improve resource utilization.[7] An integral aspect of any performance improvement program involves analysis of patient care, implementing change, and re-analysis. When re-analysis of GBS outcomes was performed, we identified a 16% incidence of cost outliers.

COs represent a subgroup of GBS patients that utilize a disproportionate amount of resources. Analysis of cost outliers and efforts to eliminate or manage cost outliers represents an important approach to improving the overall quality and efficiency of healthcare.[12-14] To better understand the factors contributing to increased resource utilization after GBS, we examined patient demographics, medical co-morbidities, the impact of surgical technique, and perioperative complications in the NC and CO groups.

Although patient age and pre-existing medical co-morbidities have been documented to influence outcome and resource utilization following traumatic injury,[15,16] the mean age and number of medical co-morbidities/patient were similar in the NC and CO groups. The risk/benefit ratio of bariatric surgery in patients >50 years old was controversial in the 1980s.[17] However, a more recent study in patients >55 years of age demonstrated acceptable outcomes in this population.[18] We were also concerned that "super-obese" patients with BMI>55 would be "high risk", but found no difference in resource utilization or costs in this subgroup. Perhaps this is because they represent such a clinically heterogeneous group in terms of age and associated medical co-morbidities.

The pattern of medical co-morbidities was similar in the NC and CO groups, with the exception of diabetes mellitus that was more prevalent in the CO group. Diabetes and perioperative glucose control have been shown to increase the risk of wound-related complications, especially infection.[19,20] A 10 to 15% incidence of wound-related complications is commonly seen following bariatric surgical procedures.[11] Although surgical site infections represented two of the major complications in the CO group, neither diabetes-related wound complications nor management of elevated glucose levels appears to explain the increased costs or resource utilization in the CO patients. Another possibility is that the diabetic patients are more likely to have severe medical co-morbidities and that increased costs are not directly related to diabetes or its complications. Additional studies will be required to determine whether perioperative glucose control influences the rate of wound infection after GBS, as has been shown for sternotomy incisions after open heart surgery.[21]

It was not surprising that severe medical co-morbidities were associated with increased costs of care. In particular, severe sleep apnea and degenerative joint disease were more commonly seen in patients with increased resource utilization after GBS. Patients with severe obesity are at increased risks for pulmonary complications after upper abdominal surgery due to postoperative reductions in lung capacity and hypoxemia.[22] In addition, the anesthetic management of patients with obstructive sleep apnea may influence their ability to be extubated after surgery.[23,24] The requirement for postoperative ventilatory support and intensive care unit admission represented a major source of increased hospital costs in 40% of patients in the CO group.

The use of perioperative continuous positive airway pressure (CPAP) may reduce respiratory complications in patients with severe sleep apnea.[25] However, compliance with CPAP represents a major problem in patients with sleep apnea, and many surgeons are unwilling to allow patients with recent upper gastrointestinal surgery to utilize CPAP postoperatively. Patients with severe sleep apnea are at increased risk for airway and ventilatory problems after the administration of general anesthesia.[23-26] Epidural catheters may be utilized for perioperative pain control in these patients. However, epidural catheters are technically difficult to place in this population and may be dislodged during patient transfer. Consequently, there is a high incidence of epidural catheter malfunction requiring catheter removal after GBS in our experience. Although limiting narcotic administration and utilization of inhalational agents with rapid pharmacokinetic properties (e.g. Sevoflurane) may facilitate recovery from anesthesia, there is no consensus on the optimal anesthetic management of this high-risk bariatric surgery population.[23-25,27] We believe this represents an important aspect of perioperative care that could be standardized with additional input from our anesthesia colleagues.

Patients with severe DJD who utilize walkers or motorized carts for ambulation also demonstrate increased hospital costs, primarily related to prolonged hospital length of stay. Despite early consultation of physical therapy, independent patient mobility was the rate-limiting step in hospital discharge of these patients. A more liberal use of preoperative physical therapy and anticipating the need for short-term rehabilitation may facilitate recovery in this patient population.

Although minimally invasive surgical techniques may reduce costs by reducing hospital length of stay, we treated the laparoscopic and open GBS patients on the same clinical pathway. Consequently, the hospital length of stay in the open and laparoscopic GBS patients was similar. OR costs were increased in the laparoscopic GBS group (primarily due to increased equipment-related costs), while total hospital costs were similar to the open GBS patients. Although laparoscopic GBS was not associated with cost outliers, the clinical pathway for laparoscopic GBS patients could potentially be revised to facilitate early discharge in patients with good pain control, oral intake, and mobility.

Although one could argue that patients with previous bariatric surgery should not be included in this analysis, these patients were treated on the same GBS clinical pathway during the study period. Therefore, we chose to include them in the study. Patients with previous GBS were slightly more common in the CO group, but this difference was not statistically significant. Several studies have shown that patients having previous bariatric surgical procedures are at increased risk for complications following revisional surgery.[28,29] Consequently, revisional GBS is likely to be associated with increased costs. However, the current study is probably not adequately powered to detect a difference in this subpopulation of patients.

Not surprisingly, major perioperative complications were associated with increased resource utilization and hospital costs. Technical complications related to gastric stapling and the gastrojejunal anastomosis represent the most common major complications after GBS. This observation highlights the importance of meticulous attention to surgical technique (intestinal blood supply, avoiding tension, anastomotic technique, etc.) when performing bariatric surgery. In addition, many high volume bariatric surgery centers routinely verify anastomotic integrity by insufflating the gastric pouch and gastrojejunal anastomosis with methylene blue containing saline or by routinely performing postoperative upper gastrointestinal series. Routine drainage of the gastrojejunal anastomosis with a closed suction drain represents another strategy to facilitate early identification of anastomotic leaks. In GBS patients with postoperative fever and incisional pain only, we are less likely to perform contrast studies to verify gastrojejunal anastomotic integrity if the drainage is serosanguinous with normal amylase content.

In summary, patients with severe, multiple medical co-morbidities (diabetes, severe sleep apnea, and degenerative joint disease) and major perioperative complications are more likely to be cost outliers after GBS. Although utilization of a clinical pathway may help to reduce resource utilization and minimize variability in patient care, identification of "high risk" patients may also help to improve outcomes and eliminate "cost outliers" after GBS. Meticulous attention to surgical technique is important to minimize the incidence of major GI complications. Patients with severe sleep apnea and obesity hypoventilation syndrome may benefit from perioperative CPAP, epidural analgesia, and careful attention to anesthetic management. Patients with severe mobility problems before GBS may recover more quickly with preoperative physical therapy and planned postoperative rehabilitation.

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References

1. Wolf AM, Colditz GA. Current estimates of the economic cost of obesity in the United States. Obes Res 1998; 6: 97-106.
2. U.S. Dept. of Health and Human Services. The Surgeon General's call to action to prevent and decrease overweight and obesity. Office of the Surgeon General, 2001.
3. Must A, Spadano J, Coakley EH et al. The disease burden associated with overweight and obesity. JAMA 1999; 282: 1523-29.
4. NIH, NHLBI. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. HHS, Public Health Service, 1998.
5. Gastrointestinal surgery for severe obesity. NIH Consensus Development Conference Draft Statement. Obes Surg 1991; 1: 257-66.
6. Balsiger BM, Leon EL, Sarr MG. Surgical treatment of obesity: Who is an appropriate candidate? Mayo Clin Proc 1997; 72: 551-8.
7. Cooney RN, Bryant P, Haluck R et al. The impact of a clinical pathway for gastric bypass surgery on resource utilization. J Surg Res 2001; 98: 97-101.
8. Pritts TA, Nussbaum MS, Flesch LV et al. Implementation of a clinical pathway decreases length of stay and cost for bowel resection. Ann Surg 1999; 230: 728-33.
9. Pitt HA, Murray KP, Bowman HM et al. Clinical pathway implementation improves outcomes for complex biliary surgery. Surgery 1999; 126: 751-8.
10. Rouse AD, Tripp BL, Shipley S et al. Meeting the challenge of managed care through clinical pathways for bariatric surgery. Obes Surg 1998; 8: 530-4.
11. Byrne TK. Complications of surgery for obesity. Surg Clin North Am 2001; 81: 1181-93.
12. Burnett DM, Cifu DX, Kolakowsky-Hayner S et al. Predicting "charge outliers" after spinal cord injury: A multicenter analysis of demographics, injury characteristics, outcomes, and rehabilitation charges. Arch Phys Med Rehab 2001; 82: 114-9.
13. Ahrens T. Outlier management. Influencing the highest resource-consuming areas in acute and critical care. Crit Care Nurs Clin North Am 1999; 11: 107-16.
14. Burnett DM, Kolakowsky-Hayner S, Gourley EV et al. Spinal cord injury "outliers": An analysis of etiology, outcomes, and length of stay. J Neurotrauma 2000; 17: 765-72.
15. Champion HR, Copes WS, Buyer D et al. Major trauma in geriatric patients. Am J Public Health 1989; 79: 1278-82.
16. Morris JA, MacKenzie EJ, Edelstein SL. The effect of

pre-existing conditions on mortality in trauma patients. JAMA 1990; 263: 1942-6.
17. Printen KJ, Mason EE. Gastric bypass for morbid obesity in patients more than 50 years of age. Surg Gynecol Obstet 1977; 144: 192-4.
18. Macgregor AM, Rand CS. Gastric surgery in morbid obesity. Outcome in patients aged 55 years and older. Arch Surg 1993; 128: 1153-7.
19. Hoogwerf BJ. Postoperative management of the diabetic patient. Med Clinics North Am 2001; 85: 1213-28.
20. Malone DL, Genuit T; Tracy JK et al. Surgical site infections: Reanalysis of factors. J Surg Res 2002; 103: 89-95.
21. Zerr KJ, Furnary AP, Grunkemeir GL et al. Glucose control lowers the risk of wound infection in diabetics after open heart operations. Ann Thorac Surg 1997; 63: 356-61.
22. Trayner E, Celli BR. Postoperative pulmonary complications. Med Clin North Am 2001; 85: 1129-39.
23. Connolly LA. Anesthetic management of obstructive sleep apnea patients. J Clin Anesth 1991; 3: 461-9.
24. Salihoglu Z, Karaca S, Kose Y et al. Total intravenous anesthesia versus single breath technique and anesthesia maintenance with sevoflurane for bariatric operations. Obes Surg 2001; 11: 496-501.
25. Renotte MT, Baele P, Aubert G et al. Nasal continuous positive airway pressure in the perioperative management of patients with obstructive sleep apnea submitted to surgery. Chest 1995; 107: 367-74.
26. Gupta RM, Parvizi J, Hanssen AD et al. Postoperative complications in patients with obstructive sleep apnea syndrome undergoing hip or knee replacement: A case control study. Mayo Clin Proc 2001; 76: 897-905.
27. Sollazzi L, Perilli V, Modesti C et al. Volatile anesthesia in bariatric surgery. Obes Surg 2001; 11: 623-6.
28. Sweeney JF, Goode SE, Rosemurgy AS. Redo gastric restriction: A higher risk procedure. Obes Surg 1994; 4: 244-7.
29. Owens BM, Owens ML, Hill CW. Effect of revisional bariatric surgery on weight loss and frequency of complications. Obes Surg 1996; 6: 479-584.

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