ELSEVIER

Surgery for Obesity and Related Diseases 8 (2012) 595–601

SURGERY FOR OBESITY AND RELATED DISEASES

Original article

Nasogastric tube, temperature probe, and bougie stapling during bariatric surgery: a multicenter survey

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Received March 1, 2011; accepted August 17, 2011

Abstract

Background: An adverse event in laparoscopic bariatric surgery that has not received much scrutiny involves tube/probe stapling or suturing during gastrectomy or gastroenterostomy.
Methods: A retrospective analysis was performed using a questionnaire sent to all bariatric surgeons (n = 43) in Israel.
Results: Eight surgeons reported on 17 cases in which intraoperative nasogastric/orogastric tube (n = 8), temperature probe (n = 6), or bougie stapling (n = 3) was identified. Laparoscopic sleeve gastrectomy was performed in 14 patients and laparoscopic gastric bypass in 3 patients. The patient demographics, operative details, and postoperative results are reported.
Conclusion: Tube/probe complications can occur during laparoscopic bariatric surgery but are seldom reported. However, they can be associated with significant morbidity. The treatment options are dependent on the situation. More importantly, prevention strategies must include constant communication with the anesthesiologist and removal or relocation of a tube before stapling or suturing. (Surg Obes Relat Dis 2012;8:595–601.) © 2012 American Society for Metabolic and Bariatric Surgery. All rights reserved.

Keywords: Nasogastric tube; Bougie; Thermometer probe; Bariatric surgery; Endoscopic stapler

The use of bariatric surgery has been increasing at a rapid rate during the past decade. This has been driven in part by the growing epidemic of obesity and increased publicity and in part by the introduction of laparoscopic bariatric procedures [1].

Laparoscopic Roux-en-Y gastric bypass (LRYGB) has become an established treatment modality for morbid obesity [2–7]. The weight loss has been comparable to that seen after open gastric bypass [3].

However, LRYGB is 1 of the most technically demanding operations performed in general surgery, and its dissemination could come with a possible change in the type and frequency of postoperative complications [8].

Laparoscopic sleeve (vertical) gastrectomy (LSG) was first described in 1999 as a part of the biliopancreatic diversion with duodenal switch procedure [9]. Today, many questions remain about the current state of LSG, among them, the complication rate and long-term results.

International efforts have focused on improving patient safety and examining the quality of outcomes and the incidence of adverse events for bariatric procedures. The designation of centers of excellence in bariatric surgery serves the purpose of concentrating the bariatric procedures in specialized centers, with the purpose of reducing the rate of adverse events.

In Israel, the number of laparoscopic bariatric procedures, as well as the number of new centers performing this type of surgery, has increased dramatically in the past 5 years.

As Gould et al. [10] concluded from their experience in establishing a new bariatric program, it is important for surgeons to carefully analyze the adverse events associated with the learning process.

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doi:10.1016/j.soard.2011.08.017

An adverse event in laparoscopic bariatric surgery that has not received much attention involves intraluminal tube complications, such as with the nasogastric/orogastric tube (NGT/OGT), temperature probe or bougie, that can occur during gastric pouch, gastric sleeve, or gastrojejunostomy formation [1,11].

Methods

A retrospective review of cases in which NGT/OGT complications were encountered during laparoscopic bariatric surgery in Israel was performed. A questionnaire was sent to all 43 bariatric surgeons in Israel. The questionnaire concerned laparoscopic bariatric procedures (LSG or LRYGB) performed by each surgeon from January 2006 to February 2010. The questionnaire included demographic data on the patients, including age, gender, and preoperative body mass index (BMI). It also included morbid obesity-related co-morbidities and medical illness and previous abdominal surgery, including bariatric surgery. All patients met the criteria for surgery from the 1991 National Institutes of Health consensus for bariatric surgery of a BMI of >40 kg/m^2 or BMI >35 kg/m^2, with active co-morbidities related to morbid obesity [12].

Also included in the questionnaire were the details of the laparoscopic bariatric surgery (LSG or LRYGB), the tube involved (NGT/OGT, temperature probe, or bougie), and technical aspects, including stapling or suturing of the tube, step of the operation (creation of the sleeve or gastric pouch, gastrojejunal anastomosis), and timing of the complication (immediately, later during the operation, or postoperatively).

We also asked about intraoperative complications because of such accidents (staple line disruption, anastomotic or staple line leak), the methods used for the repair (primary suturing, restapling or reanastomosis, or conversion to a different bariatric procedure), conversion to open or hand-assisted surgery, and the length of the operation. The postoperative data collected included the length of stay and postoperative complications, including leakage and the need for reoperation. We also asked the surgeon how such accidents could have been possibly prevented and methods to reduce the frequency of such complications. Finally, we asked the surgeons to report data on the total number of LSG and LRYGB performed during the study period. The surgeons were asked to return the questionnaire; those who did not return them were contacted by telephone to ensure that no cases were missed.

Operative techniques used

The gastric pouch and sleeve creation during LRYGB and LSG, respectively, were completed using 45- or 60-mm linear endoscopic staplers with or without reinforcement of the staple line with hand sewing or tissue reinforcement material. For the gastrojejunostomy, 3 different operative techniques were used: combined inner layer linear stapled and outer layer hand sewn, 2-layer hand sewn, and transabdominal 25-mm EEA. The staplers used were the Endopath ETS-Flex 45 linear, Echelon, and Endopath Stealth 25-mm EEA (Ethicon Endo-Surgery, Cincinnati, OH) and Endo-GIA Universal 12 mm (Covidien Autosuture, Mansfield, MA).

Table 1
Number of LSG and LRYGB cases performed and incidence of reported events for each surgeon during study period

Incidence of reported events	LSG/LRYGB/total performed by surgeon (n)	Surgeon number
4	200/160/360	1
1	450/10/460	2
2	200/0/200	3
1	220/80/300	4
1	127/87/214	5
2	250/200/450	6
3	250/20/270	7
3	150/40/190	8
17	1847/597/2444	Total

Results

Eight surgeons, from 8 different medical centers, reported on 17 cases in which intraoperative NGT/OGT (n = 8), temperature probe (n = 6), or bougie (n = 3) complications were identified. LSG was performed in 14 patients and LRYGB in 3. These surgeons performed a total of 2444 LSG and LRYGB operations during the study period. The incidence of tube stapling was .75% and .5% for LSG and LRYGB, respectively. The relative experience and incidence of the complications for each of the 8 surgeons are listed in Table 1.

The rest of the surgeons (n = 35) were contacted and had had no experience with these types of adverse events. They reported a total of 1712 (1245 LSG and 467 LRYGB) procedures performed during the same period.

The demographics of these patients are listed in Table 2. The mean age was 42 years, and 9 (53%) were women. The average preoperative BMI was 47.2 kg/m^2.

Two patients had undergone previous abdominal surgery, 1 of which was laparoscopic adjustable gastric banding.

In all cases, the complications occurred during the same part of the procedure. The NGT/OGT, temperature probe, or bougie tube were stapled and transected during formation of the gastric pouch or gastric sleeve. No complications involving suturing of the NGT/OGT during the gastrojejunostomy were reported.

Figure 1 demonstrates a case in which a thermometer was stapled during formation of the gastric sleeve during LSG.

Table 2
Patient demographics

Pt. No.	Age (yr)	Gender	BMI (kg/m^2)	Co-morbidities	Previous surgery
1	47	Female	44	None	None
2	58	Male	40	DM, HTN, LIP, IHD	None
3	39	Female	44	None	None
4	37	Male	39	LIP	LAGB
5	30	Female	45	None	None
6	40	Male	46	None	None
7	42	Female	47	None	None
8	50	Male	68	None	None
9	35	Female	45	None	None
10	37	Male	51	None	None
11	60	Female	40	None	LC
12	50	Female	43	HTN, DM, LIP, FL	None
13	30	Male	50	HTN, DM, LIP, FL	None
14	28	Female	42	None	None
15	53	Male	52	DM, HTN, FL, LIP, IHD, OSA	None
16	33	Female	60	DM, HTN, FL, LIP	None
17	26	Male	46	None	None

Pt. No. = patient number; BMI = body mass index; DM = diabetes mellitus; HTN = hypertension; LIP = hyperlipidemia; IHD = ischemic heart disease; LAGB = laparoscopic adjustable gastric banding; FL = fatty liver; LC = laparoscopic cholecystectomy; OSA = obstructive sleep apnea.

Fourteen complications were recognized immediately on stapling of the tube. Three complications were identified later during the operation, usually when the anesthesiologist failed to pull the tube out.

We describe 3 case scenarios representative of the most common mechanisms for these events encountered in our series (Fig. 2).

Case 1

Case 1 involved accidental reintroduction of a NGT because of incomplete withdrawal A 49-year-old female patient was undergoing LSG. After greater curvature dissection, the anesthesiologist was asked to remove the NGT. After affirmative answer from the anesthesiologist that the NGT had been removed, the bougie was placed into the stomach. The stomach stapling was begun, during which the NGT was staple-transected.

The underlying mechanism was that the anesthesiologist pulled the NGT from the stomach and the esophagus; however, to facilitate the future reinsertion of the NGT, it was left in place in the oropharynx. During insertion of the bougie, the NGT was accidentally pulled all the way into the stomach, and its movement went unnoticed, leading to the complication.

Case 2

Case 2 involved failure to remove all gastric probes/tubes. A 45-year-old female patient was undergoing LSG. The stomach was released completely, and the anesthesiologist was asked to remove the NGT, which he did. After completing stapling transection of the stomach, the bougie was removed, and the procedure completed. During the attempt to remove the temperature probe, excessive resis-

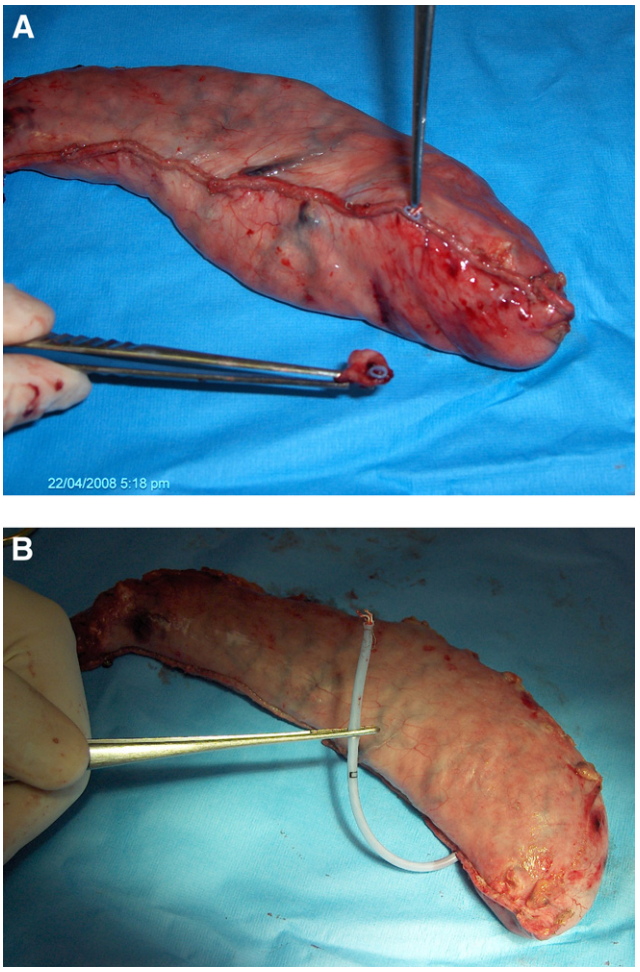

Fig. 1. (A) Thermometer cut during sleeve formation in LSG. Tip of thermometer, incorporated into staple line, shown. (B) Thermometer pulled out of SG specimen.

Fig. 2. NGT stapled into staple line and cut, together with rim of tissue.

tance was encountered. The abdomen was insufflated again and, on inspection, an area of "dimpling" of the staple line was found that included the stapled probe. This area of the staple line was excised and repaired manually (Fig. 1).

Case 3

Case 3 involved failure to correctly position the bougie. A 35-year-old male patient for whom laparoscopic adjustable gastric banding had failed was undergoing band removal and conversion to LSG. The band was removed, and a 42F bougie was inserted down to the pylorus. After the first firing, the bougie moved up inadvertently and was repositioned deeper again. The thin tip of the bougie made a U-shaped turn, instead of pointing down to the pylorus. This went unrecognized, and the tip of the bougie was stapled during subsequent stomach division. It was cut out with scissors and the stomach restapled medial to the defect.

All the complications, except for 2, required repair of the staple line with or without proof of leakage using intraoperative techniques, such as inflation with methylene blue. In 12 patients, suturing of the staple line in the damaged part was applied, and in 2, stapling along the stomach was used to resect the damaged part. In 1 case, a large defect in the staple line was identified when the stapled NGT was excised during LSG. In that case, the defect was used for creation of a gastrojejunal anastomosis, converting the operation to RYGB instead of the planned SG. In 2 cases, in which a thermometer was incorporated into the staple line during SG, no damage was identified after somewhat forceful removal of the thermometer. Subsequent intraoperative inflation of methylene blue ruled out leakage from the staple line. No repair was performed, and no leak was identified in these cases postoperatively.

One patient (5.9%) underwent conversion to an open procedure (RYGB) and 1 (LSG) required laparoscopic reoperation for a clinical leak discovered on postoperative day 10.

Overall, 3 patients (17.6%) developed a clinical staple line leak and had prolonged hospital stay (mean 21 d). The average operating room time for the original operation was 105.4 minutes and 180 minutes in the LSG and LRYGB groups, respectively. The average length of stay was 6.2 days and 9 days in the LSG and LRYGB groups, respectively. No mortality was reported.

Discussion

The use of LSG and LRYGB is increasing owing to the expansion of the morbidly obese population and the lack of efficient alternatives [13]. A proportional increase in the prevalence of adverse events is expected, especially when the growing number of new centers starts performing bariatric surgery.

Tube/probe complications can occur during laparoscopic bariatric surgery [1,10] but are seldom reported. Sanchez et al. [13], in a series of 727 LRYGBs performed by 5 surgeons during 5 years at 2 institutions, reported a rate of 1.2% of intraoperative OGT complications. In our review, the rate of NGT/OGT, thermometer probe, or bougie complications during stapled bariatric operations in the study period was .75% and .5% for LSG and LRYGB, respectively. The 8 surgeons, who reported these events, performed 58.8% of all LSG and LRYGB procedures performed during the study period. They account for $<$20% of all bariatric surgeons in Israel.

All complications in our review involved incorporation of the probe/tube into the staple line during gastric sleeve or gastric pouch formation. None included tube complications during gastrojejunostomy formation.

Although uncommon, these complications can lead to severe postoperative morbidity. For example, the leak rate for this group of patients is quite high (17.6%) and the overall complication rate for the present study was nearly 29%, with a total of 3 leaks and 2 additional operative repairs (1 open conversion to RYGB and 1 late repair of a leak). This is a significant morbidity rate that is totally preventable.

Unlike a regular gastrointestinal leak occurring after a routine operative course, most of these types of leaks can be regarded as preventable adverse events. Therefore, the attitude toward these cases should be similar to that of the retention of the foreign body or wrong site surgery.

Moreover, such cases could draw lawsuits. A systematic approach to these adverse phenomena should be implemented.

The estimates of retained foreign bodies in surgical procedures are much lower, ranging from 1 in 8000 to 13,000 surgeries and ≤1 in every 5000 abdominal cavity cases [14].

In contrast, the airline industry, held up as the safest mode of travel, has accident rates of 1 per 243,309 takeoffs and rates of near misses of 1 per 166,583 [15].

The gap between the error rates in the airline industry and our current surgical theater performance must be closed. Current approaches to the prevention of operating room accidents, OGT/NGT devices among them, are incomplete. Compliance with strict protocols could reduce the wrong site surgery rate by 62% [14]. Similarly, a reduction in the above-mentioned complications could be potentially achieved by compliance to protocols.

Prevention strategies must be applied. When asked, all surgeons participating in the survey agreed that the most important prevention strategy is communication among the operating room team and, especially, active communication with the anesthesiologist.

A designated team approach might be a good solution for the reduction of the incidence of this complication. In our institution, we have no anesthesiologists designated to the bariatric team; therefore, we decided to critically rethink the whole routine of the operating room procedure. We have developed a special poster that addresses the procedures step by step and in each step describes methods to prevent tube complications.

The whole process of NGT/OGT manipulation is reviewed before the induction of the anesthesia at the surgical pause. The 'time out' touches the process of OGT or NGT placement and its timely removal before stapling. Furthermore, similar to the surgical count performed by nurses, the implementation of stapler use is routinely announced.

Technically, the steps include removal or relocation of a probe/tube before stapling or suturing, placing temperature probes in alternative locations (i.e., axilla or rectum), retraction of the NGT/OGT during gastrojejunal construction or the use of large-bore or stiff NGTs/OGTs and bougie for tactile and visual perception.

In our series, all complications were identified intraoperatively, and in all patients, except for 3, identified immediately. Despite this, we report a relatively high rate of postoperative leakage.

Once it has occurred, there are many clues for the incorporation of a tube in the staple line or the anastomosis (Table 3). This clarifies that a distinct routine to remove or relocate every tube before the completion of the operation is crucial.

The intraoperative treatment options for these patients include laparoscopic repair with removal of the affected tube and tissue and oversewing or stapling of the defects. In 1 of our patients, the defect was large and was therefore used for creation of a gastrojejunal anastomosis, and the operation was converted to LRYGB instead of the intended LSG.

Table 3
Clues for incorporation of tube/probe in staple line or anastomosis

1. Need for excessive force to close or fire stapler
2. Stapler misfire
3. Tissue deformity on staple line
4. Excessive bleeding from staple line
5. Increased resistance of suture needle in performing anastomosis
6. Inability to withdraw tube at end of stapling process or anastomosis.

In routine cases, we implement local drainage in all patients and NGT drainage after every SG and selectively after RYGB. For these complications, wide local drainage is advised, along with NGT placement across the gastrojejunal anastomosis.

Gastrostomy tube drainage of the gastric remnant should be considered, and maintenance of nothing by mouth postoperatively until leakage is ruled out should be implemented. Conversion to an open or a hand-assisted procedure is dependent on the laparoscopic surgical skills and the intraoperative findings. Intraoperative tests, including gastric inflation with dye (e.g., methylene blue) or air (bubble test) can test the patency of the stapler line after the repair.

Conclusion

Inadvertent intraluminal tube stapling during LSG and LRYGB is rare and probably underreported. However, it can lead to severe intraoperative complications and postoperative morbidity, despite prompt recognition and repair. Efforts should be made to prevent these complications by following routine strategies and prevention protocols.

Acknowledgment

The following persons contributed clinical data: Ahmad Mahajna, M.D., Department of Surgery A, Rambam Medical Center and Rappaport Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, Israel; Moshe Rubin, M.D., Department of Surgery and Transplantation, Sheba Medical Center, Tel Hashomer, Israel; Nasser Sakran, M.D., Department of Surgery, Hillel Yaffe Medical Center; Nahum Begleibter, M.D., Department of Surgery, Hadassah Hebrew University Hospital, Jerusalem, Israel; Anya Feigin, M.D., Department of Surgery and Transplantation, Sheba Medical Center, Tel Hashomer, Israel; David Goitein, M.D., Department of Surgery C, Chaim Sheba Medical Center, Tel Hashomer, Israel; Ivan Schwartz, M.D., Department of Surgery, Meir Medical Center, Kfar Saba, Israel; Nissim Geron, Department of Surgery, Carmel Medical Center, Haifa, Israel.

References

[1] Safadi BY, Kieran JA, Hall RG, et al. Introducing laparoscopic Roux-en-Y gastric bypass at a Veterans Affairs medical facility. Am J Surg 2004;188:606–10.

[2] Wittgrove AC, Clark GW, Tremblay LJ. Laparoscopic gastric bypass, Roux-en-Y: preliminary report of 5 cases. Obes Surg 1994;4:353–7.

[3] Schauer PR, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. Ann Surg 2000;232:515–9.

[4] Wittgrove AC, Clark GW. Laparoscopic gastric bypass, Roux-en-Y—500 patients: technique and results, with 3–60 month follow-up. Obes Surg 2000;10:233–9.

[5] Nguyen NT, Goldman C, Rosenquist CJ, et al. Laparoscopic vs. open gastric bypass: a randomized study of outcomes, quality of life and costs. Ann Surg 2001;234:279–89.

[6] Higa KD, Tienchin H, Boone KB. Laparoscopic Roux-en-Y gastric bypass: technique and 3-year follow-up. J Laparoendosc Adv Surg Tech A 2001;11:377–82.

[7] DeMaria EJ, Sugerman HJ, Kellum JM, Meador JG, Wolfe LG. Results of 281 consecutive total laparoscopic Roux-en-Y gastric bypasses to treat morbid obesity. Ann Surg 2002;235:640–7.

[8] Podnos YD, Jimenez JC, Wilson SE, Stevens CM, Nguyen NT. Complications after laparoscopic gastric bypass: a review of 3464 cases. Arch Surg 2003;138:957–61.

[9] Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve gastrectomy for morbid obesity. Obes Surg 2007;17:962–9.

[10] Gould JC, Garren MJ, Starling JR. Lessons learned from the first 100 cases in a new minimally invasive bariatric surgery program. Obes Surg 2004;14:618–25.

[11] Dresel A, Kuhn JA, Westmoreland MV, Talaasen LJ, McCarty TM. Establishing a laparoscopic gastric bypass program. Am J Surg 2002; 184:617–20.

[12] Hubbard VS, Hall WH. Gastrointestinal surgery for severe obesity: National Institutues of Health Consensus Development Conference 255 Draft Statement. Obes Surg 1991;1:257–66.

[13] Sanchez BS, Safadi BY, Morton JA, et al. Orogastric tube complications in laparoscopic Roux-en-Y gastric bypass. Obes Surg 2006; 16:443–7.

[14] Gallagher TH, Levinson W. Disclosing harmful medical errors to patients: a time for professional action. Arch Intern Med 2005;165: 1819–24.

[15] Available from: http://www.airline-safety-records.com/airline_safety_five_year_table.htm. Accessed November 2010.

Editorial comment

Comment on: Nasogastric tube, temperature probe, and bougie stapling during bariatric surgery: a multi-center survey

The authors of this report are to be commended on bringing light to the issue of inadvertent stapling of tubes, probes, and bougies during laparoscopic bariatric surgery. I frequently commented on my experience with this complication during the years I served as the director of Professional Education for the American Society for Metabolic and Bariatric Surgery. After seminars, I would be approached by multiple surgeons in the audience who had had a similar iatrogenic misadventure. This occurred so frequently that I began asking for a show of hands from the surgeon attendees if they had a similar complication, and I was impressed by the number of raised hands in the audience. I believe it is safe to state that the true number of surgeons who were willing to acknowledge the event in public was low; however, I estimated anywhere from 25–50% of members acknowledged having stapled a "tube" during laparoscopic bariatric surgery, although published reports never listed this intraoperative complication.

This important study from Israel was possible owing to the small number of bariatric surgeons (43 total) who cooperated by sharing data on the occurrence and outcomes from this complication. It is important to state *this is a totally preventable complication*, in the same category as retained foreign bodies or wrong site surgery, and must be addressed with written standards and protocols. Although in this study, all 17 cases of inadvertent stapling were recognized in the operating room, there was still a 29% overall complication rate and a 17.6% leak rate after repair in these cases. This is not a benign complication, and the focus must be on mechanisms of prevention, not prompt recognition after the event.

I was fortunate to only experience 2 instances of stapling of a nasogastric tube during laparoscopic bariatric surgery (1 during gastric bypass and 1 during vertical banded gastroplasty). In both instances, the anesthesia team verbally confirmed that the tube was removed, yet it was still present in the stomach. There was not even an attempt to withdraw or reposition the tube, and I assume the anesthesia team misunderstood my question and were not paying attention to the procedure. Because of these events, I was able to institute several changes in policy that prevented any additional recurrences in the past 10 years, and I would like to share my personal experience and recommendations. The principle underlying mechanism of occurrence of this event is the lack of cooperation and communication between the anesthesiologist and the surgeon.

The mechanisms I used for prevention are as follows:

1. I insisted on a dedicated bariatric operating room team and anesthesia team with a *written* protocol that everyone must review before participating in bariatric surgery. I understand this is a major road block at some institutions, just as it was at mine, until I refused to accept any future responsibility for similar intraoperative complications unless this policy was adopted. It is past time for healthcare to adopt aviation standards for safety protocols in our operating rooms,