Stapled versus hand-sewn anastomoses in emergency general surgery: A retrospective review of outcomes in a unique patient population

Jason P. Farrah, MD, Cynthia W. Lauer, MD, Mallory S. Bray, MD, Jason M. McCartt, MD, Michael C. Chang, MD, J.Wayne Meredith, MD, Preston R. Miller, MD, *and* **Nathan T. Mowery, MD,** *Winston-Salem, North Carolina*

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Address for reprints: Nathan T. Mowery, MD, Department of Surgery, Medical Center Boulevard, Winston-Salem, NC 27157; email: nmowery@wfubmc.edu.

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BACKGROUND: Recent studies have identified unique clinical and physiologic characteristics of emergency general surgery (EGS) patients and called for outcomes data in this population. There are no data in the US literature analyzing the impact of technique on anastomotic failure rates in EGS patients. The purpose of the current study was to compare outcomes of hand-sewn (HS) versus stapled (ST) bowel anastomoses in EGS patients.

METHODS: A retrospective chart review of all patients admitted by our EGS service undergoing bowel resection for emergent indications from January 2007 to July 2011 was performed. Time from surgery to diagnosis of anastomotic failure was recorded as were the diagnostic modality and treatment of each anastomotic failure. Specific data on damage-control techniques, if used, were also collected.

RESULTS: There were 100 HS (43%), and 133 ST (57%) anastomoses in 231 patients. Operative times were shorter in ST anastomosis technique (205 minutes for HS vs. 193 minutes for ST, $p = 0.02$). Anastomotic failures were identified in 26 patients (11%) and were significantly higher in the ST group than the HS group (15.0% vs. 6.1%, $p = 0.003$). A multivariate logistic regression analysis, controlling for age and preoperative nutritional status, revealed ST technique to be an independent risk factor for anastomotic failure (odds ratio, 2.65; 95% confidence interval, 1.08–6.50; $p = 0.034$).

CONCLUSION: Anastomotic failures are more than twice as likely with ST than HS anastomoses in the EGS population. This is true even when controlling for markers of preoperative nutrition and demographics. These data suggest that the HS anastomosis should be the preferred method of reconstruction after bowel resection in EGS patients. (*J Trauma Acute Care Surg*. 2013;74: 1187–1194. Copyright © 2013 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level IV.

KEY WORDS: EGS; anastomosis; acute care surgery; outcomes.

Methods for restoring gastrointestinal continuity after resection fall into one of two broad general categories: stapled (ST) or hand sewn (HS). A large body of research has demonstrated that outcomes in the elective general surgery patient do not significantly differ in terms of reconstruction technique.[1–6] A recent meta-analysis demonstrated that ileocolonic anastomoses in Crohn's patients developed fewer leaks when performed with ST technique, raising the possibility that certain surgical populations may indeed benefit from selective technique use.[7] In addition, a recent Cochrane database review indicated that little is known regarding the impact of anastomoses type in patients in high-risk situations such as emergency surgery and called for new clinical trials investigating the differences of technique use on outcomes in these patients.[6]

Several authors have recently identified emergency general surgery (EGS) as a distinct specialty[8,9] caring for patients with unique physiologic and clinical characteristics differing greatly from elective general surgery patients.[10–13] Likewise, there is a paucity of literature critically assessing outcomes and providing the essential data to guide evidence-based practice in the care of this unique patient population.[13] The purpose of the current study was therefore to assess outcomes of operations involving gastrointestinal resection and anastomosis in EGS patients to identify unique patient characteristics and techniques predicting anastomotic failure. We hypothesized that ST technique would predispose EGS patients to anastomotic failure. It was theorized that this would be caused by the edematous nature of the bowel secondary to high levels of inflammation that defines this emerging patient population.

PATIENTS AND METHODS

Patients admitted to our EGS service were identified via a unique EGS database we have published previously.[14] Patients were selected retrospectively based on several inclusion criteria as follows: patients admitted to our EGS service directly from the emergency department who underwent gastrointestinal resection with intestinal anastomoses or inpatients referred to or admitted to our EGS service via consult who underwent gastrointestinal resection and anastomosis. Aggregate patient data were used to further divide these patients into subgroups based on immediate versus delayed reconstruction. Patients were excluded from the study group if they were a trauma patient, underwent primary enterotomy/perforation repair, or had colostomy creation without creation of anastomosis. The study included EGS patients treated by bowel resection and anastomosis from January 1, 2007, to July 31, 2011. Indications for surgical intervention crossed a broad array of surgical disease (Table 1).

Selected patient charts were reviewed, and data were collected on patient demographics, medical history, preoperative and postoperative diagnoses, and indications for procedure, operative management including procedure performed, anastomosis technique, and location in the gastrointestinal tract. Additional perioperative information collected included preoperative laboratory values, length of operation, use of vasopressors perioperatively, occurrence of intraoperative hypothermia, blood transfusions administered, and history of corticosteroid use either chronic or perioperatively. Finally, data regarding perioperative complications (including anastomotic dehiscence, intra-abdominal abscesses, and fistula formation), inpatient and intensive care unit length of stay, patient disposition, and mortality were also collected.

Several patients had more than one type of gastrointestinal anastomosis, and therefore, data were analyzed at the patient level as well as the anastomosis level. Length of inpatient and intensive care unit stays, mortality, and disposition were analyzed at the patient level. However, postoperative complication occurrence was analyzed at the anastomosis level. Intra-abdominal postoperative complications were defined as (1) anastomotic dehiscence (dehiscence/"leak" identified at reoperation or radiographic imaging), (2) intraabdominal abscess (identified at reoperation or radiographic imaging), and (3) enterocutaneous fistula (documented as clinical finding in the medical record).

Patients were allowed a single complication per anastomosis. This was done, similar to previous studies, to avoid

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TABLE 1. Demographic Data of Patient Undergoing Anastomoses in the Setting of Emergent General Surgery

Age, y		58.9 (18.1)
Sex	Male	104 (45%)
	Female	129 (55%)
Admission lactate		2.7 (3.3)
Anastomosis technique used	HS	100 (43%)
	ST	133 (57%)
Type of anastomosis	Small bowel–small bowel	125 (54%)
	Small bowel–large bowel	89 (38%)
	Large bowel–large bowel	19 (8%)
Hospital length of stay		15.1 (13.7)
Mortality		9 (3.9%)

Data are expressed as mean (SD) unless otherwise noted.

inaccurate complication rates.[15] This would be expected to occur in a patient who developed a postoperative leak and whom would be expected by definition to have an abscess. Counting both the abscess and leak as separate complications for the anastomosis of occurrence would generate an erroneously high complication rate.[13]

Anastomosis types were categorized as either ST or HS. The decision to perform either ST or HS was at the discretion of the attending surgeon. Anastomosis that were created by way of stapler but with closure of the common enterotomy with suture were counted as ST. According to institution policy, staplers used in construction of ST anastomoses were "GIA 75" disposable linear cutting staplers (PROXIMATE 75 mm Reloadable Linear Cutter, Ethicon Endo-Surgery Inc., Blue Ash, OH) and "TL 60" disposable linear staplers (TL 60 mm Reloadable Linear Stapler, Ethicon Endo-Surgery Inc.). Standard manufacturer recommended tissue loads were used with the staplers. HS anastomoses that were constructed by single-layer or double-layer technique were combined into a single uniform category of sutured anastomoses, given that these techniques have demonstrated clinical equipoise in previous studies.[16]

Study Setting

Wake Forest University Baptist Medical Center is an integrated health care system that operates 1,154 acute care, rehabilitation, and long-term care beds, outpatient services, and community health and information centers in Winston-Salem, North Carolina. Since September of 2008, there has been an established emergent general surgery service staffed exclusively by seven acute care surgeons in which cases are performed by the EGS team and admitted to a single service.

Data Collection

Patients were identified using an in house EGS registry. Demographic and outcome data were obtained from that registry. Clinical data pertaining to the patient's hospital course were obtained from the patient's electronic medical record.

Outcome Measures

The primary outcome of interest was anastomotic failure rate. Secondary outcome measures were all-cause in-hospital mortality and hospital length of stay.

Anastomotic failure was defined as anastomotic dehiscence or leak as defined at time of reoperation or by radiologic imaging. For the purposes of this study, intra-abdominal abscess occurring at or in immediate proximity to anastomosis on radiologic imaging was counted as anastomotic failure, as was enterocutaneous fistula occurrence documented in the medical record.

Statistical Analysis

Normally distributed continuous variables were summarized by reporting the mean and SD and compared using two sample *t* tests for independent samples. Continuous variables that were not normally distributed were presented by reporting the median and interquartile ranges (IQRs) and compared using the Mann-Whitney U-test. Differences in proportions were compared using a χ^2 or Fisher's exact test. Multivariate logistic regression was used to estimate the independent relationship between anastomotic leak and technique used to create the anastomoses. A two-sided *p* value less than 0.05 was considered to indicate statistical significance. SPSS version 19.0 (SPSS Corp., Chicago, IL) was used for the analysis.

The study was approved by our institutional review board of Wake Forest University Baptist Medical Center. All data are maintained in a secure, password-protected database that is HIPAA compliant. All patient information is deidentified before analysis and reporting.

RESULTS

Study Population

Two hundred thirty-one EGS patients were identified as having undergone bowel resection with restoration of intestinal continuity during the study period (Table 1). Table 2 demonstrates the typical preoperative diagnoses encountered in this study population. We find these diagnoses to be of typical distribution for EGS populations. A total of 233 anastomoses were created in these 231 patients. These were divided into two comparisons groups. HS technique was used in creation of 100 (43%) of the anastomoses, whereas a surgical stapling technique was used in creation of 133 (57%) of the anastomoses. While the decision of which type of anastomosis was at the discretion of the attending based on clinical picture, there was no significantly different demographic parameters between

TABLE 2. Indication for Surgical Intervention

Small bowel obstruction	90
Gastrointestinal mass/cancer	26
Mesenteric ischemia	21
Incarcerated hernia	18
Perforated viscus/free air	14
Peritonitis	14
Appendicitis	10
Inflammatory bowel disease	8
Perforated diverticulitis	6
Volvulus	5
Other	21

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TABLE 3. Demographic Comparison of Patient HS Versus ST Anastomoses

	HS (n = 100)	ST (n = 133)	*p*
Sex (male)	44	60	0.9
Age	59 (19)	59 (17)	0.9
Admission lactic acid, mmol/L	2.9 (4.3)	2.6 (2.3)	0.6
Admission albumin, g/dL	3.4 (0.6)	3.5 (0.8)	0.4
Admission white blood cell count	11.2 (5.3)	11.5 (5.3)	0.6
Admission hemoglobin, g/dL	12.5 (2.7)	12.5 (3.0)	0.9

Data are expressed as mean (SD).

groups (Table 3). This included markers of admission shock and inflammation.

Median operative times were significantly shorter if the ST technique was used (205 minutes for HS vs. 193 minutes for ST, $p = 0.02$). Anastomotic failures were identified in 26 patients (11.1%). The median time to diagnosis of anastomotic failure was 7 days postoperatively (IQR, 3.5–11). Anastomotic failure was diagnosed by computed tomographic scan in 12 patients, reexploration in 13 patients owing to clinical picture, and discovery of an enterocutaneous fistula in 1 patient. When comparing the technique, failure was significantly higher in the ST group than the HS group (15.0% vs. 6.1%, $p = 0.003$) (Table 4).

In an attempt to determine if the gastrointestinal location of the anastomosis altered the failure rate, we divided the 233 anastomoses into three groups as follows: small bowel–small bowel, small bowel–large bowel, and large bowel–large bowel. There were no significant differences in leak rates among these groups regardless of the technique used (Table 3).

Damage-Control Laparotomy

There were 41 (18%) of the 233 patients who required damage-control laparotomy (DCL) technique. DCL patients, as expected, had higher markers of shock at presentation as measured by admission lactic acid (4.3 mmol/L vs. 2.2 mmol/L, $p = 0.001$). Of the 41 DCL patients, 33 (81%) were left in discontinuity after the first operation. The anastomotic failure rate was significantly higher in the in the DCL group when compared with those closed at the first operation (24% vs. 8%, $p = 0.01$). The anastomotic failure was not different between DCL patients who had their anastomosis performed at the primary surgery and those constructed in a delayed fashion (25% vs. 24%, $p = 0.6$).

TABLE 5. Outcome Comparison of Patient Anastomotic Failure Versus No Complication

	Anastomotic Failure (n = 26)	No Complication (n = 207)	*p*
Stapled anastomosis	20 (76.9%)	113 (54.9%)	0.03*
Perioperative vasopressors	8 (31%)	66 (32%)	1.0
Intraoperative hypothermia	11 (42%)	46 (22%)	0.006*
Anastomosis performed at the first operation	18 (69%)	181 (88%)	0.02*
Perioperative corticosteroids	10 (38.5%)	33 (16%)	0.01*
Admission albumin, g/dL	3.1 (0.9)	3.5 (0.7)	0.004*
Admission lactic acid, mmol/L	3.7 (2.9)	2.5 (3.3)	0.18

Data is expressed as mean (SD).

Univariate Analysis of Anastomotic Failure

We divided the cohort into anastomoses that failed and those that did not and examined the known risk factors for anastomotic failure in univariate analysis (Table 5). The typical factors such as admission albumin, intraoperative hypothermia, and perioperative corticosteroid use were shown to be associated with anastomotic failure.

Multivariate Regression for Anastomotic Failure

A regression model was built with known risk factors for anastomotic failure (Table 6). A multivariate logistic regression analysis, controlling for age and preoperative nutritional status, revealed ST technique to be an independent risk factor for anastomotic failure (odds ratio, 2.65; 95% confidence interval, 1.08–6.50; $p = 0.034$). The Hosmer-Lemeshow goodness-of-fit test was nonsignificant ($p = 0.275$), indicating the model does appropriately fit the data.

DISCUSSION

The principal finding in this study is that ST gastrointestinal anastomoses for EGS patients are associated with significantly increased rates of anastomotic failure compared with anastomoses that are HS. In fact, ST anastomoses in this setting are more than twice as likely to fail as those that were HS, and this association holds true even when controlling for

TABLE 4. Outcome Comparison of Patient HS Versus ST Anastomosis

	HS (n = 100)	ST (n = 133)	*p*
Operative time, min	205 (IQR, 173–301)	193 (IQR, 151–240)	0.02*
Anastomotic failures	6/100 (6.1%)	20/133 (15.0%)	0.03*
Mortality	2 (2.0%)	7 (5.3%)	0.3
Hospital days	13 (IQR, 8–24)	9 (IQR, 8–23)	<0.01*
Type of bowel being anastomosed			
Small bowel–small bowel anastomosis	2/48 (4.2%)	10/77 (13.0%)	0.1
Small bowel–large bowel anastomosis	4/40 (10%)	9/48 (18.8%)	0.4
Large bowel–large bowel anastomosis	0/12 (0.0%)	1/8 (12.5%)	0.4

Data are expressed as median and IQR.
*indicates statistical significance.

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TABLE 6. Multivariate Logistic Regression to Estimate the Independent Relationship Between Anastomotic Technique and Anastomotic Failure

	Odds Ratio	95% Confidence Interval	*p*
Stapled anastomosis	2.65	1.08–6.50	0.034*
Age	1.051	1.043–1.059	<0.001*
Admission albumin	0.437	0.244–0.784	0.005*

*Indicates statistical significance.

markers of preoperative nutrition and demographics. Location of the anastomoses in the gastrointestinal tract did not seem to be responsible for this association as there was a trend toward higher leak rates in all types of connections in ST anastamoses independent of the type of bowel being operated on.

We additionally discovered that in EGS patients, as in other general surgery patient populations, more profound malnutrition confers increased risk of anastomotic failure. Furthermore, the current data demonstrate that EGS patients with anastomotic failure do not have evidence of greater degrees of shock compared with those without anastomotic failure. Mean lactate levels and base deficit levels were elevated across both groups of patients in this study, further highlighting that this unique patient population is essentially homogenous in its presentation of advanced physiologic derangement.

We find this interesting because it further underscores the impact of technique use as an independent predictor of anastomotic failure in EGS patients. That is to say the current data suggest that, in general, EGS patients present in some degree of shock and this alone does not predict anastomotic failure; however, technique use may.

The literature overwhelmingly supports the use of surgical staplers for restoration of intestinal continuity in the setting of elective general surgery.[1–6,15,17] Some authors have pointed out that surgical practices used in elective general surgical settings are extrapolated for application in emergency settings. However, some surgical patient populations may benefit from selective use of staplers in gastrointestinal anastamoses[6,15] and recent publications have called for investigation of outcomes in settings known to be associated with increased systemic inflammation and severe physiologic derangements such as trauma and emergency surgery.[6,7,13,15,18]

Surgical practices used in the care of the injured patient are also likewise extrapolated for application in the care of EGS patients; however, the question of which technique produces optimal results in injured patients still remains. Studies of gastrointestinal anastomoses in injured patients yield mixed results and conflicting conclusions.[15,19–21] A large well-designed, recent Western Trauma Association multicenter trial demonstrated that in the setting of injury, ST anastomoses were more prone to failure and complication than those constructed with HS technique.[15] This study was preceded by a smaller single-institution retrospective review of small bowel anastomoses in injured patients finding no significant difference in ST versus sutured technique.[19] Confusing the issue further, following the Western Trauma Association trial, a prospective multicenter study examining suture technique in penetrating colon trauma determined that in the setting of penetrating colon injury, technique of anastomotic construction did not significantly contribute to intra-abdominal complications and declared either ST or sutured technique equally safe in this setting.[21] Certainly, anastomosis creation in the injured patient continues to be a perplexing problem itself.

Brundage et al.[15] suggest that ST anastomoses in the trauma patients may be prone to failure due to the edematous nature of injured bowel, the unavoidable by-product of fluid resuscitation and reperfusion injury. It is noted that staplers were designed for bowel of normal thickness and that standard dimensions of available surgical staples may lead to incomplete closure and anastomosis disruption. In our experience, we have found similar issues in the construction of anastomoses in injured patients. Moreover, our experience further leads us to conclude that edematous friable bowel is nearly exclusively encountered in EGS patients as well, likely a by-product of similar inflammatory states encountered in the injured. Edematous bowel wall in these patients may likewise lead to incomplete closure in these patients when staplers are used, placing these anastomoses at risk. We further theorize that the typically high levels of premorbid health conditions in these patients including diabetes, malnutrition, atherosclerosis, and preexisting enteropathy place these patients at risk for poor wound healing, placing further increasing risk of anastomotic failure. These are attractive theories in explaining our findings of higher rates of anastomotic failure overall in these patients but may not fully explain why it would occur in ST anastomoses more often than HS.

Proponents of stapling devices tout their efficiency as a major advantage and advocate their use in damage-control technique specifically. Interestingly, previous studies documenting total operative times did not find a statistical difference in operation duration between types of reconstruction, and in fact, some studies found sutured technique to be faster.[3,5] Our data demonstrate a significantly longer operative duration when sutured technique was used; this would seem to fall in line with practical thoughts that hand-sewing is a longer process than firing a stapler; however, it is interesting in that it contradicts data previously reported in similar studies.

The EGS population represents a unique cohort. Owing to the selection bias, that tertiary referral centers are subjected to the patient populations will have indeterminate outcomes and may require novel operative approaches. Application of previous outcome measures is likely to underestimate the potential for poor outcomes in these particular patient populations. Multiple studies have documented outcomes in this population, but this is the first to suggest that operative technique may need to be adapted to better serve this population. Translation of data performed in elective setting or even in previous emergent populations is likely not applicable to the emerging EGS population.

LIMITATIONS

This study has limitations. First, our conclusions are drawn from analysis of retrospectively collected data and are therefore subject to limitations inherent to all retrospective studies. For example, we acknowledge that bias figures into retrospective studies, and this can be seen in the current study in that anastomosis technique was not randomized but rather

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subject to attending surgeon preference. Second, the data used were only those available in the data set and could not be prospectively controlled for. As such, we had to use potentially inferior variables to determine for instance nutritional status. In the case of nutritional status, albumin was used because it was the only marker of preoperative nutrition consistently available. Fourth, our sample size, while comparable to others used in published studies on the subject, does not allow us to add more variables to our multivariate logistic regression analyses because we would risk overfitting the model. A larger sample size would allow a larger multivariate logistic regression analyses and thus a deeper understanding of the variables independently influencing anastomotic healing.

CONCLUSION

This is the first article to suggest that applying elective surgical techniques in EGS patients may result in unnecessary morbidity and mortality. Anastomotic failures are more than twice as likely with ST than HS anastomoses in the EGS population. This is true even when controlling for markers of preoperative nutrition and demographics. These data suggest that the HS anastomosis should be the preferred method of reconstruction after bowel resection in EGS patients.

AUTHORSHIP

J.P.F. and N.T.M. conceived of and designed this study. All authors contributed to the data acquisition, analysis, and interpretation. J.P.F. and N.T.M. drafted the manuscript, which all authors critically revised.

DISCLOSURE

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DISCUSSION

Dr. Susan I. Brundage (London, England): I'd like to start by applauding the Wake Forest group, not only for this study, but for the body of work that they have created regarding emergency general surgery patients as a distinct population.

The Wake Forest group is generating excellent data regarding this significant clinical problem. The findings of this paper are very similar to the findings of our multi-center trial. Although we looked at relative risk rather than odds ratios, we looked at trauma patients, our relative risk for leaks was undefined because there were so many intraabdominal abscesses. It was 2.7 and overall was 2. So very similar findings to the emergency general surgery service.

It is nice to have data, especially when your colleagues declare, "I staple everything, except when it shouldn't be stapled." So what does that mean? And that takes me to my questions for the Wake Forest group and Dr. Farrah.

How should we respond to naysayers and those committed staplers when they declare, "I staple everything?"

Also, regarding nutritional status, these are very intriguing findings. Stapling fell out despite nutritional status in these potentially very malnourished patients of emergency general surgery as an independent risk factor. You state albumin as your criteria for nutritional status. As Dr. Moore and Dr. Kozar—experts in surgical nutrition—have taught us, albumin is not the end all and be all. Did you look at prealbumin? Tri-fold thickness? Psoas muscle thickness? And if so, why not?

Your findings regarding damage control laparotomy are completely fascinating and really bring up another area of

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interest and a paradigm shift. One might say that in damage control laparotomy for trauma patients that it would be ill-advised to ever perform an anastomosis in the first operation since our criteria for DCL in trauma is often coagulopathy, hypothermia, the lethal triad. So we want to get out, we're not going to perform anastomosis in that first operation. What are your criteria in the EGS surgery population for performing an anastomosis in that initial laparotomy versus subsequent laparotomies?

How do you explain the longer length of stay in the hand-sewn group? Also, Covidien has come up with a tri-stapler with multiple types and levels of staple size. Do you think that this will solve the problem? Would you trust it? How should this be studied?

And, finally, the next step: can your group or others develop an algorithm for operational decision making, much like our esteemed colleagues from Memphis have done regarding colostomy performance, to guide us for when we intraoperatively should potentially choose a hand-sewn or a stapled anastomosis?

In closing, to quote Dr. Maier, who inspired this line of work when I was a fellow at Harborview Medical Center, for the naysayers I would like to say regarding the stapler and edematous bowel, " You can't fight physics." Thanks so much.

Dr. Patricia M. Byers (Miami, Florida): I was fascinated by the paper. I thought it was an excellent revisit of a very important subject, but I was wondering why did you exclude bowel perforations from your study group in that that would be a typical reason to do a bowel resection, perhaps without so much edema as you would find in the obstructive-type scenarios that you described? And in those cases, was there any mention in the op reports of bowel edema by which you could actually stratify the patients? When the anastomoses failed, was there anything written in the reoperation with regard to the reason for the failure, technical versus just staple failure?

Dr. Demetrios Demetriades (Los Angeles, California): Dr. Farrah, that was a nice, large study with a clear message. However, there are still unresolved issues.

A few years ago we did a prospective AAST study, "Destructive Colon Injuries Requiring Resection and Anastomosis" The incidence of anastomotic leaks was exactly the same, staple versus hand-sewn, about 6.7%.

I, personally, prefer a hand-sewn anastomosis. I believe that things are different in non-trauma situations, because quite often the bowel is edematous, due to prolonged peritonitis. If you staple this edematous bowel, a few days later when the edema subsides, you may have anastomotic leaks. So I repeat that I would prefer to do a hand-sewn anastomosis. Thank you.

Dr. Charles E. Lucas (Detroit, Michigan): Around the turn of the century, Dr. Andrew Kirkpatrick from the Trauma Association of Canada and I looked at this issue from the patients treated at the Vancouver General Hospital, mostly blunt injury, and at the Detroit Receiving Hospital, mostly penetrating injury.

Andy was prejudiced towards staples. I was prejudiced towards hand. The both of us ignored the data which showed no difference. And he is still prejudiced towards staples and I am still prejudiced towards hand.

Regarding the stapled anastomosis, did you invert all of the staple lines? And did you use primarily the functional end-to-end stapled anastomosis or the other type where you have the two ends coming out in the same direction? Nice presentation.

Dr. Ting Hway Wong (Singapore): Thank you to the authors of the paper for revisiting a debate that a lot of our elective colleagues have considered closed.

I'd like to ask, firstly, following up on the previous discussant on sewing up the anastomotic lines, do you still have surgeons who practice that routinely? And if so, would you consider that to be hand-sewn or stapled?

Secondly, was there any consideration of the seniority of the surgeon? The duration of the operation? And how many people were present at the operation? Because could it be a technical issue. Thank you.

Dr. Edward Kelly (Boston, Massachusetts): Regarding technique, I think the paper is very good in terms of examining the idea of what technique should surgeons employ when we have many at our disposal. But I think we're lumping a lot of techniques together.

As Dr. Lucas mentioned, there is more than one way to do a stapled anastomosis. Are some more failure prone than others?

Likewise, there is more than one way to do a hand-sewn anastomosis—one layer, two layers, continuous, inverted, and so on. Is there any more detail in the data to see if there is one or more techniques that are more vulnerable than others? Thank you very much.

Dr. Jason Farrah (Winston-Salem, North Carolina): Thank you all for your insightful questions and comments. I will attempt to answer all the questions. There were a lot of them so I will try to get through these.

First, I want to thank Dr. Brundage for her comments and analysis and would like to respond to her firstly.

To those pundits of stapling everything "except when it needs to be hand-sewn," I would echo your comment Dr. Brundage that it is "nice to have data." Here we have presented you data. And I think in this age of evidence-based medicine you can't ignore that. You certainly have to look at the quality of the data, but data that is collected well and analyzed rigorously and subsequently reported cannot simply be ignored.

So I would say to these folks that have the idea in your head of, "I only staple when I need to staple," we have made some small steps here I believe in this study to demonstrate who those patients are exactly and have begun to qualify the time when you would in fact not staple. For example, if it's an EGS patient, the time when you should not staple, but rather hand sew.

In respect to the albumin question, again this is a good question and really highlights the limitations of this study and its retrospective nature. We only have the datasets that were available to us retrospectively. We were not able to choose those datasets in a prospective fashion due to the nature of the study. We wanted some marker for nutrition and analyzed what was available. We found that the albumin level was the most consistently available. In fact, there was only one patient who did not have an albumin level preoperatively.

Other markers of nutrition, prealbumin, retinol binding protein, etc., while valuable, are data points we could analyze in further studies and that's a very excellent point and we plan to do that in the future. Again, the albumin was the only thing that was consistently available.

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In regards to your damage control laparotomy question, I do believe that there is a need for algorithms. We do not have a consistent algorithm at Wake Forest at this time.

We are looking intensely into this concept of abbreviated laparotomy in EGS patients and when should we do them, when should we not and, furthermore, when should we stop and leave the patient in discontinuity or when should make an anastomosis but still leave the abdomen open.

Right now there seems to be a split with some attending surgeons preferring to make an anastomosis on first laparotomy and then returning to the operating room for a second look laparotomy to assess not only the other bowel but also their anastomosis for viability. Other attending surgeons fear that an anastomosis made on first laparotomy may be damaged during exploration on subsequent laparotomy and would prefer to close the abdomen in some fashion once the anastomosis is created. I think there is value in each of those viewpoints. This will need to be teased out on further analysis and we plan to do that as well.

I do not know how to explain the length of stay being longer in the hand-sewn group. I've looked at the data several times with my coauthor, Dr. Mowery, and others. And it does appear that the people in the hand-sewn group tended to, more often than not, be people who had been in the hospital longer, specifically those who were collected onto our service after a consult from an in-hospital medical service.

Generally you will see that those folks will tend to be in the hospital longer (total number of days) by the virtue of the late consult, if you will. What we may need to go back and do is start the hospital day as the day of operation. That may clear up some of that confusion.

In regard to your question about staplers, I think this is an excellent question. Thick tissue loads are often used in colon anastomosis. Interestingly in our study, those weren't the ones that were breaking down the most. It was the small bowel.

In regards to the advent of this new technology, I don't know how that will play out. I think that ultimately what this study is pointing to is that a uniform technique that will apply across the board for all these patients is not the way to go. So I don't think that these staplers will change the application of this data at all in the future.

For example, in EGS patients you often will encounter small bowel proximally that may be of normal caliber apposed to small bowel distally that's of very thick caliber. And I think that's where the value of the hand-sewn anastomoses comes in, because of the multiple iterations you can make along the way and adjusting stitch-by-stitch for your bowel thickness. You can't do that in a stapler no matter the load type.

In regard to why did we exclude bowel perforations: that question needs to be cleared up. I apologize for the way that looked on the screen. I'm specifically talking about duodenal ulcer perforations and the like, not perforations that would typically need a resection and anastomoses. So what I am referring to specifically are operations like graham patch procedures. These were not included because there was not an anastomosis created.

And then the unresolved issue brought up by Dr. Demetriades: I have read your paper it was excellent. I would only say that these are different patient populations we are talking about here—your study on trauma patients with penetrating injuries to the colon versus ours with the EGS patients. Basically, the whole point of this paradigm shift is that these EGS patients are unique patients with different presentations than anywhere else in all of surgery. And while we do extrapolate from elective general surgery and trauma surgery to help begin to understand them, ultimately what we need is unique data specific to these patients. Comparing them as similar cohorts will not get us the answer in the end.

And then in regard to the question do we invert staple lines. This was not looked at in the study. And I simply do not know if it is, in general, our practice to invert staple lines.

Thank you very much. Again I appreciate the opportunity to discuss the study and to entertain these questions.

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