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Sedation and paralytic use in open abdomen patients—results from the EAST SLEEP Survey

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ABSTRACT

Background: Patients with an open abdomen after trauma or emergency surgery may benefit from reduced sedation and chemical paralysis. We studied the effect of attending surgeon experience on sedation depth and paralytic use, as well as enteral nutrition and time between laparotomies.
Methods: We performed an institutional review board-approved survey (Sedation Level after Emergent ExLap without Primary Fascial Closure) of the senior and active Eastern Association for the Surgery of Trauma membership using Qualtrics (Qualtrics, Inc, Provo, UT). We obtained 393/1,655 responses (23.7%). Spearman's rho was used for ordinal data, and multivariate logistic regression was used to adjust for trauma center level and presence of trainees in the relationship between surgeon experience and use of deep sedation.
Results: Surgeon experience was associated with deep sedation (Richmond Agitation and Sedation Score ≤ -3, $P = .001$) and chemical paralysis ($P = .001$). Surgeon experience was associated with less concern about delirium and more concern for evisceration as the reason for sedation depth ($P = .001$) and for paralysis ($P = .001$). Using multivariate logistic regression, surgeon experience was associated with deep sedation (odds ratio 3.6 [95% confidence interval 1.3, 10.4], $P = .017$ for ≥ 20 years; odds ratio 3.5 [95% confidence interval 1.1, 10.4], $P = .025$ for 15–20 years). Trauma center level was also significant (odds ratio 7.2 for Richmond Agitation and Sedation Score ≤ -3 [95% confidence interval 1.7, 31.0], $P = .008$ for level III/IV versus level I/II). Increased surgeon experience was associated with delay of commencement of enteral feeds until return of bowel function ($P = .013$). Few respondents indicated willingness to extubate or mobilize open abdomen patients. Experienced surgeons were likely to wait for a defined time rather than for normalization of resuscitation markers to perform the first takeback laparotomy ($P = .047$) and waited longer between subsequent laparotomies ($P = .004$).
Conclusion: There were significant variations in practice among respondents based on the length of time since their last residency or fellowship, including variations that deviate from current best practice for management of patients with an open abdomen.

Introduction

Damage control laparotomy was first reported by Stone et al in relationship to the coagulopathy that occurs in the face of major trauma.[1] Mattox added to this literature with his publication in 1992, although Rotondo et al further served to advance the concept.[2,3] It has been widely applied to both severely injured and critically ill surgical patients. Its use has often been lifesaving, but also fraught with potential complications, including wound infections, fistula, sepsis, and hernia.[4–6] Many aspects of open abdomen management for both traumatic and non-traumatic indications remain controversial. As recently as 2011, deep sedation utilizing the Richmond Agitation and Sedation Score (RASS) to a level of −5 along with systemic neuromuscular blockade were advocated to help reduce possible domain loss and improve fascial closure rates, with the goal of achieving primary fascial closure

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prior to 8 days.[7] Later work, however, has not found neuromuscular blockade to be associated with time to abdominal closure in trauma patients.[8]

Deep sedation and neuromuscular blockade may also have significant consequences for critically ill and injured patients, including intensive care unit (ICU) acquired weakness[9] and delirium, which in turn has been associated with worsened mortality.[10] Interventions that reduce delirium, in turn, have been associated with improved outcomes; these have included spontaneous awakening and breathing trials, choosing to reduce or minimize sedation, and improving mobility in critically ill and injured patients.[11–13] Early enteral nutrition has been shown to improve wound healing and decrease sepsis and organ failure.[14–17] However, it is not clear to what extent these advances in care are being practiced among the acute care surgical community.

We therefore elected to survey the active and senior membership of the Eastern Association for the Surgery of Trauma (EAST) to determine patterns of management for patients with an open abdomen after trauma or emergency general surgery. As many of these developments in care have occurred over the past 20 years, we elected to study the relationship between attending surgeon experience, defined as number of years in practice after completion of the most recent residency or fellowship training, and aspects of open abdomen management related to sedation, chemical paralysis, feeding, and timing of surgery. We hypothesized that experienced surgeons would utilize deep sedation (RASS −3 to −5) and chemical paralysis more frequently, as well as utilize less aggressive enteral feeding and reoperative surgery practices.

Methods

Institutional review board approval

Approval was obtained from the institutional review board at Loma Linda University Adventist Health Science Center prior to initiating the study. The approval date was April 26, 2017, and the approval number was #5170092.

Survey instrument

The survey instrument was initially created in a hard-copy format with 3 sections (Appendix 1). Section 1 focused on the attending surgeon completing the survey and evaluating the number of years of experience since the completion of the highest level of training. This was then divided into 5-year increments (<5, 5–10, 11–15, 16–20, and >20 years after completion of fellowship). The attending surgeons were also asked if they had completed a fellowship in surgical critical care, acute care surgery, or another specialty. Other demographic questions focused on the amount of time on the trauma or acute care surgery service, amount of night calls taken, and amount of time spent as an attending in the ICU. The type of practitioners managing patients in the ICU was also broken down as either self (the practitioner completing the survey manages his or her own ICU patients) or management by other critical-care trained surgeons, non-surgeons, or a mix thereof. Surgeons were then queried about the resident training status of their institution and in which part of the United States they practiced.

Section 2 of the survey assessed if the practitioner completing the survey managed patients with an open abdomen monthly, weekly, multiple times per week, or daily on average. The disease process resulting in the open abdomen was then broken down as traumatic, non-traumatic, or a mix thereof. Finally, the breakdown of blunt versus penetrating trauma among the open abdomen patients was queried.

In Section 3 of the survey, practitioners were asked about the frequency with which they used chemical paralysis in the management of patients with an open abdomen and the primary reason underlying the use of paralytics (to prevent evisceration of abdominal contents, to prevent loss of domain, or for another reason). Practitioners were then queried about the RASS level at which patients who were not paralyzed were maintained for sedation, with the options being light sedation with RASS −2 to 0 or heavy sedation with RASS −5 to −3. The primary reason for choosing the sedation level was then queried (delirium/agitation prevention, minimizing duration of mechanical ventilation, preventing evisceration, or preventing loss of abdominal domain). Practitioners were asked how frequently they extubate patients with an open abdomen and how frequently such patients are ambulated. In addition, practitioners were asked if they used hypertonic saline infusions to minimize edema in their patients with an open abdomen, with what frequency patients with an open abdomen were fed enterally and when enteral feedings were commenced (after the abdomen was closed, upon restoration of gastrointestinal continuity, or upon return of bowel function). Practitioners were also asked about their preferred method of temporary abdominal closure, the timing to the first takeback, the frequency of reoperation if multiple reoperations were needed, when adjuncts such as Wittman patches or vicryl or biological meshes were used to achieve an augmented fascial closure, and what types of adjuncts were used.

Survey distribution

The survey was then transitioned to an electronic, web-based format using the Qualtrics application. A hyperlink to the survey was then transmitted via electronic mail to the active and senior membership of EAST using their existing membership distribution list, after being approved for distribution by the EAST Research-Scholarship Committee (https://www.east.org/forms/92/research-related-survey-request-form). The survey link was sent out 3 times in total to maximize participation to a total of 1,655 electronic mail addresses.

Data analysis

Survey responses were automatically collected by the Qualtrics application in an Excel spreadsheet file (Microsoft Corp, Redmond, WA). The spreadsheet file was then imported into SPSS 22.0 (IBM, Inc, Armonk, NY) to complete data analysis. Standard univariate parametric statistical methods were used. Spearman's rho was used to determine correlation coefficients among ordinal data. Multivariate logistic regression was used to independently analyze the effects of attending surgeon experience, trauma center level, fellowship training by the attending surgeon, and presence of trainees at the attending surgeon's institution on the use of deep sedation.

Results

Demographics

Raw data from the survey can be seen in Appendix 2. A total of 393 survey responses were received out of 1,655 email addresses comprising the active and senior membership of EAST, yielding a 23.7% response rate. In terms of number of years post-training, 24.1%($n = 94$) of surgeons were <5 years finished, 25.6% (100) were 5 to 10 years, 18.7% (73) were 11 to 15 years, 12.3% (48) were 16 to 20 years, and 19.2% (75) were >20 years (Fig 1, *A*). Of the surgeons surveyed, 54.2% had completed a 1-year fellowship in surgical

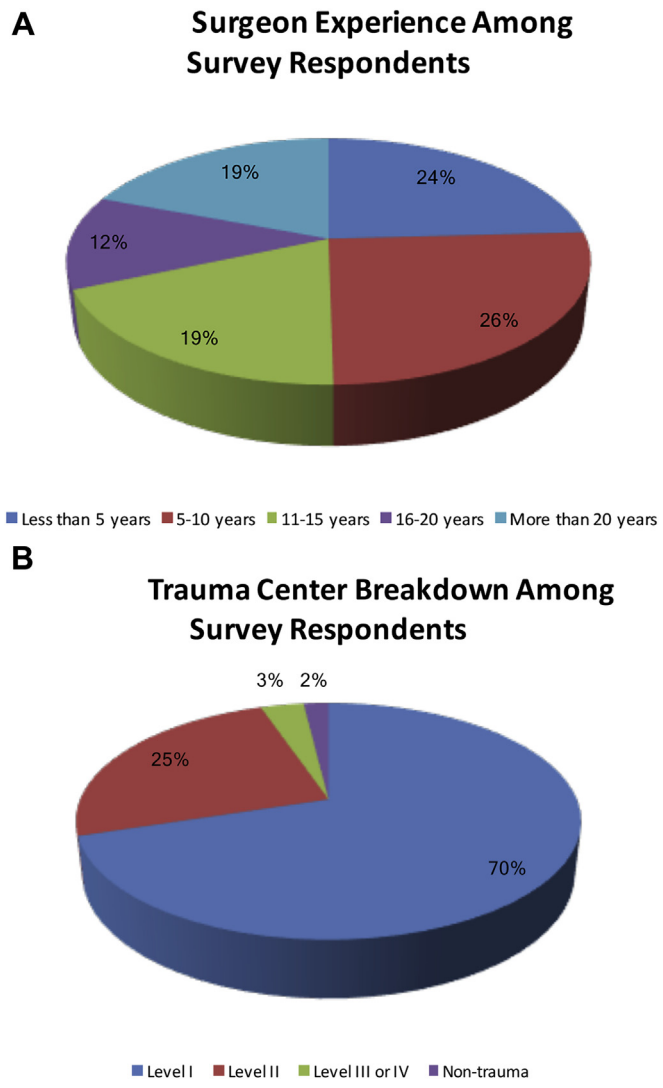

Fig 1. *(A)* This figure illustrates the breakdown of survey respondents in terms of experience, defined as number of years since completion of training. *(B)* This figure illustrates the breakdown of the type of trauma center at which survey respondents practice.

critical care and/or trauma, while 34.2% had completed a 2-year fellowship in the field. Of those surveyed, 96.1% were on the trauma or acute care surgical service at least 4 days a month and 97.4% took night call at least twice a month. At least 4 days a month, 85.4% of those surveyed attended in the intensive care unit. Of the respondents, 70.1% worked at an American College of Surgeons (ACS)-verified or Emergency Medical Services (EMS)-designated level 1 trauma center, and 24.7% of respondents worked at an ACS-verified or EMS-designated level 2 trauma center. Of respondents, 3.3% worked at an ACS-verified or EMS-designated level 3 or 4 trauma center (Fig 1, *B*), and 82% worked at a facility that trained surgical residents. All areas of the United States were represented. Respondents all managed a patient with an open abdomen at least monthly, with 40.6% of respondents managing such a patient at least weekly.

Sedation and paralysis

Of the respondents, 27.8% reported never using chemical paralysis to manage patients with an open abdomen; 53.8% used chemical paralysis when indicated for another reason such as adult respiratory distress syndrome. Chemical paralysis on patients with an open abdomen was used selectively by 17.6%, while 0.8% used chemical paralysis on open abdomen patients in all cases.

Surgeon experience was associated with deep sedation (RASS $\leq$3, Spearman's rho 0.190, $P = .001$, Fig 2, *A*). Increasing surgeon experience was associated with less concern about delirium and more concern for evisceration as the reason for choice of sedation level (Spearman's rho 0.166, $P = .001$, Fig 2, *B*). Increased surgeon experience may be associated with use of chemical paralysis, although this is not statistically significant (Spearman's rho 0.088, $P = .093$). Surgeon experience was correlated with concern for evisceration as the reason for the use of chemical paralysis (Spearman's rho 0.153, $P = .001$, Fig 2, *C*). Using multivariate logistic regression, surgeon experience was associated with deep sedation ($P = .049$ overall, odds ratio [OR] 3.6 [95% confidence interval (CI) 1.3, 10.4], $P = .017$ for $\geq$20 years; OR 3.5 [95% CI 1.1, 10.4], $P = .025$ for 15–20 years). Trauma center level was also significant ($P = .026$ overall, OR 7.2 for RASS ≤ -3 [95% CI 1.7, 31.0], $P = .008$ for level III/IV versus level I/II). Fellowship training and presence of trainees were not significant factors.

Other critical care interventions

Surgeon experience was not associated with the frequency of extubation for patients with an open abdomen nor was it associated with the frequency of ambulation or mobilization for patients with an open abdomen. Of respondents, 43.2% extubated a patient with an open abdomen less than 10% of the time, while 75% of respondents ambulated or mobilized a patient with an open abdomen less than 10% of the time. Of the respondents, 31.2% either never fed patients with an open abdomen or predominantly used trophic feedings; 33.2% advanced to full feedings in less than half of patients; and 35.6% advanced to full feedings in more than half of patients. Surgeon experience was associated with waiting for return of bowel function before starting enteral feedings rather than beginning feedings after the restoration of gastrointestinal continuity (Spearman's rho 0.130, $P = .013$, Fig 2, *D*).

Surgical parameters

There was no association between surgeon experience and the method of abdominal wall closure, with 81.6% of surgeons using a commercially available abdominal negative pressure wound therapy device. Surgeon experience was associated with takeback for second look laparotomy after a defined time interval rather than based on normalization of resuscitation markers such as lactate, base deficit, and coagulation parameters (Spearman's rho 0.104, $P = .047$, Fig 2, *E*). Surgeon experience was also associated with successive takebacks to the operating room after 48 to 72 hours rather than 12 to 24 hours (Spearman's rho 0.149, $P = .004$ by Pearson's χ^2, Fig 2, *F*).

Discussion

This study's key findings indicate that, in a population of surgeons that are members of EAST and actively involved in the care of trauma and emergency surgery patients, there is significant variation in management of patients with an open abdomen based on the number of years in practice after the most recent training (residency or fellowship). In particular, surgeons who had more time away from training were more likely to employ deep sedation and be more concerned about evisceration than delirium as a reason to use deep sedation. The relationship between surgeon experience and tendency to employ deep sedation also was

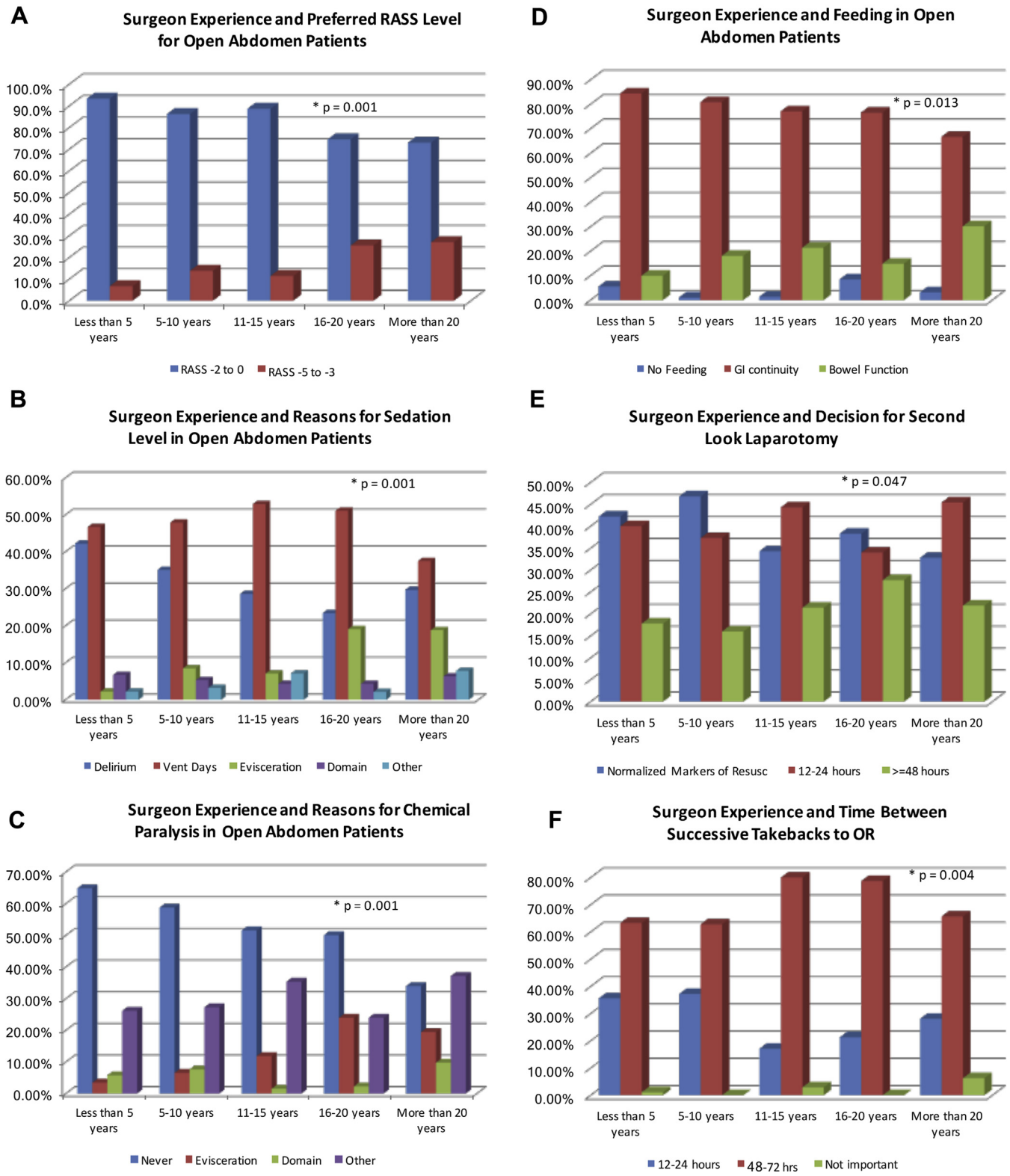

Fig 2. *(A)* Surgeon experience was associated with deep sedation (RASS −5 to −3). *(B)* Surgeon experience was associated with increased concern about evisceration and less concern about delirium as regards the choice of level of sedation. *(C)* Surgeon experience was associated with increased concern about evisceration as regards the use of chemical paralysis. *(D)* Surgeon experience was associated with increased tendency to wait for return of bowel function before starting feeds. *(E)* Surgeon experience was associated with time-based return to the operating room for second look laparotomy, rather than a decision based on normalization of markers of resuscitation. *(F)* Surgeon experience was associated with longer time between successive takebacks (48–72 hours rather than 12–24 hours).

validated by logistic regression analysis and was independent of both fellowship training for the surgeon and the presence of trainees at the surgeon's institution. Although there was not a statistically significant correlation between surgeon experience and the tendency to use paralysis, experienced surgeons were more likely to focus on evisceration as their reasoning for the use of chemical paralysis. In addition, experienced surgeons were more likely to wait until return of bowel of function to initiate enteral feedings. Experienced surgeons were also more likely to wait until a defined time interval for the first takeback laparotomy and were more likely to perform subsequent takebacks at 48- to 72-hour intervals. Interestingly, there was no difference in practice pattern when it came to surgeon experience as far as extubation and mobilization of patients with an open abdomen; rather, extubation and mobilization of a patient with an open abdomen are relatively rare occurrences among the surveyed population.

Open abdomen management is ubiquitous, with all surveyed practitioners indicating that they manage a patient with an open abdomen from trauma or emergency surgery at least monthly. Thus, there has truly been a paradigm shift in the management of these patients since the original manuscripts on the subject.[1–3] There is, however, significant variation among open abdomen management that can be attributed to the length of time that surgeons have practiced since their last residency or fellowship. In particular, this variation encompasses the depth of sedation and, perhaps, the use of chemical paralysis, as well as corresponding attitudes regarding the relative importance of preserving abdominal domain and evisceration versus delirium and mobilization.

This practice variation, in many cases, is at odds with the current evidence in the field. For example, there is evidence that neuromuscular blockade does not accelerate the rate of achieving primary fascial closure.[8] There is also evidence across a broad set of critically ill patients that, at the very least, interrupting sedation daily reduces ventilator dependence, length of ICU stay, and length of hospital stay.[18] Coupling this with daily ventilator weans has likewise achieved the same gains.[19] There is also plentiful evidence that delirium should be a significant consideration in the management of critically ill patients.[10,20–22] Compliance with these elements, even partially, improves mortality in a wide variety of critically ill patients.[11] The evidence for early enteral nutrition, even in patients with an open abdomen, is also quite significant, indicating that early enteral nutrition in patients with an open abdomen may reduce the incidence of sepsis and improve outcomes without a corresponding trade-off in the time to achieving fascial closure.[14–16,23]

Finally, experienced surgeons appear more likely to wait for a defined time period rather than for normalization of resuscitation markers for initiating the first takeback to the operating room for patients with an open abdomen; likewise, experienced surgeons also appear to wait longer between successive takebacks. This observed trend is in contravention to the data now emerging from the multicenter prospective American Association for the Surgery of Trauma Open Abdomen registry, indicating that an early first takeback and frequent subsequent takebacks are key to improving the odds of achieving primary fascial closure.[24,25] Patients requiring more abdominal re-explorations or those with intra-abdominal abscesses, bloodstream infections, acute renal failure, enteric fistula, and high Injury Severity Score have been found less likely to achieve primary fascial closure.[24,26] Furthermore, delaying the first takeback after temporary abdominal closure beyond 24 hours has been associated with reductions in primary fascial closure.[25]

Therefore, the question remains—when this data is available–why is it not being implemented, particularly among more experienced surgeons? One factor is making such data accessible through the creation of best practice guidelines, bundles, and checklists.[27] However, this implementation needs to leave some room for individualized care; strict protocols without exceptions may not accommodate all patients while at the same time they may make it difficult to achieve compliance.[28]

While bundles of care have been well-implemented in other areas such as the ABCDEF bundle, there is no equivalent bundle for the management of the open abdomen. Indeed, there is still a need for specific research on sedation, paralysis, time to primary fascial closure, and delirium in patients with an open abdomen after trauma and emergency surgery. This is currently the subject of the EAST-sponsored SLEEP-TIME (Sedation Level after Emergent Exlap with Packing—TIME to closure) multicenter trial (https://www.east.org/content/documents/mukherjee_proposal.pdf). With more research and careful implementation of bundles of care, it is possible that the experience-based effect noted in this study will dissipate and the care for patients with an open abdomen will become more standardized, while continuing to allow for variation when necessary.

This is the first survey to examine practice regarding open abdomen management in the current era. Of note, the survey yielded a response rate well in line with electronically distributed surveys of large surgical organizations. For example, a survey on palliative care practices sent to the EAST membership in a similar manner to this survey had a 29% response rate.[29] A similar survey of the EAST members on management of pericardial effusion had a 27% response rate.[30] In contrast, a web-based survey of the World Society of Emergency Surgery concerning antibiotic practices had a response rate of only 12.5%.[31] One notable survey with a 93% response rate covered opinions on the highly incendiary issue of gun control from the American College of Surgeons Committee on Trauma.[32]

In keeping with the surveyed population, there was a preponderance of surgeons with advanced fellowship training in surgical critical care and acute care surgery. The sample likely over-represented trauma centers; there are currently 506 ACS-verified trauma centers in the United States (https://www.facs.org/search/trauma-centers?country=united%20states) and approximately 1,000 EMS-designated but non-ACS-verified trauma centers[33] out of 5,534 hospitals (https://www.aha.org/statistics/fast-facts-us-hospitals). The sample also likely over-represented surgical training programs, of which there are currently 267 as of the 2017 data (https://medicalschoolhq.net/ss-21-looking-at-the-match-data-for-general-surgery/). Albeit with these caveats, the available data still provides a variable sample, representing all experience levels, all areas of the United States, and different practice environments. Some additional limitations associated with this work include its survey-based paradigm, which may be prone to sampling error as well as errors of generalizability. There may be room for interpretation in attempting to distill complex patient management concepts into multiple-choice responses. There was no a priori power analysis to indicate that the survey size was sufficient. Despite these weaknesses, it is still apparent that there is dissonance between what has been published as best practice, particularly in recent literature, and its adoption among practicing trauma surgeons.

In conclusion, multiple aspects of management in patients with an open abdomen after trauma or emergency surgery exhibit significant variation based on the length of time that attending surgeons have been in practice. Thus, there may be opportunity for increased standardization of care and improvement in outcomes with widespread adoption of published best practices in this area.

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Conflicts of interest/Disclosure

All of the authors indicate they have no potential conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.surg.2019.07.017.

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