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EVIDENCE-BASED CURRENT SURGICAL PRACTICE

GI Surgical Emergencies: Scope and Burden of Disease

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Abstract

Nearly 3 million patients are hospitalized every year for emergent gastrointestinal (GI) surgical problems and nearly one third of those will require surgery. This article reviews the scope of GI surgical emergencies within the context of emergency general surgery (EGS), costs of care, overview of several common GI surgical problems, and traditional and emerging treatment modalities. This article also argues for ongoing work in the area of risk assessment for EGS, and describes quality metrics as well as outcomes of care for these patients.

Keywords Acute care surgery · Emergency general surgery · Gastrointestinal surgery

Introduction

Emergency general surgery (EGS) encompasses urgent or emergent management of conditions wherein operative or non-operative management can be utilized to minimize patient morbidity and mortality.[1] Shafi et al. evaluated administrative data to estimate the frequency and type of EGS conditions being managed.[1] The authors defined several common diagnoses comprising the EGS spectrum EGS (a comprehensive list of 260 diagnoses). This work highlights frequently encountered gastrointestinal surgical emergencies that represent a large part of the scope and burden of EGS diseases encountered by general surgeons.

As this field is broad, contextualizing the contributions that defined the scope of EGS, burden of associated diseases, tools for risk assessment, management approaches and patient outcomes is important.[2] This article reviews the current understanding of EGS gastrointestinal diseases with a focus on the most common conditions, costs of care, disease management including newer treatment modalities, and quality/patient outcomes.

Burden of Disease

A confluence of factors has contributed to a substantial public health burden of emergency surgical disease in the USA. The annual volume of EGS patients requiring hospitalizations is estimated at 2.6 million (exceeding the sum of all new cancer diagnoses), and these patients are treated at over 900 hospitals across the nation with an estimated cost exceeding $28 billion.[3] That cost far exceeds that of numerous other common conditions (Figs. 1 and 2).[4,5]

Over the course of a decade (2001–2010), there were an estimated 388,358,479 hospital admissions in the USA. Of these, 27,668,807 patients (7.12%) were admitted for

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Learning Objectives Learners will be able to identify the most common GI surgical emergencies.
Learners will be able to estimate the costs of care for GI surgical emergencies in the USA.

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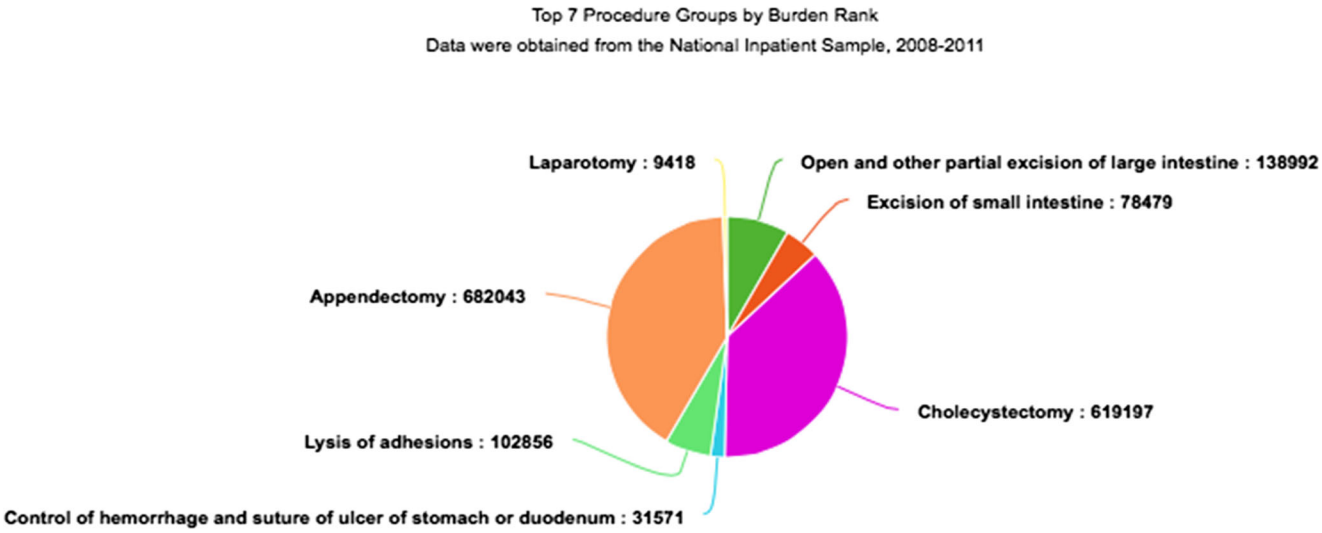

Fig. 1 Emergency gastrointestinal surgery scope and burden of disease

emergency surgical diagnoses as defined. During this period, both the actual number of admissions and the proportion of admissions attributed to EGS diagnoses incrementally increased.[6] In addition, the proportion of patients requiring surgery increased from 659,340 (27.7%) in 2001 to 872,332 (28.7%) in 2010.[6] In that 10-year nationwide analysis, 586,496 patients (2.12%) expired.

Despite increasing admissions, hospital mortality steadily declined over time, from 2.73% in 2001 to 1.61% in 2010. This decline occurred despite increasing sepsis rates. During the same period, the EGS patients were most commonly and increasingly treated at urban hospitals (84.5%). While non-teaching hospitals cared for the majority of EGS patients (60.33%), those treated at teaching hospitals increased from 37.5 to 41.8% during the study period. The mean duration of hospital stay decreased from 5.34 days in 2001 to 4.90 days in 2010. While seemingly small, a reduction of 0.44 days in duration of hospital stay between 2001 and 2010 may have

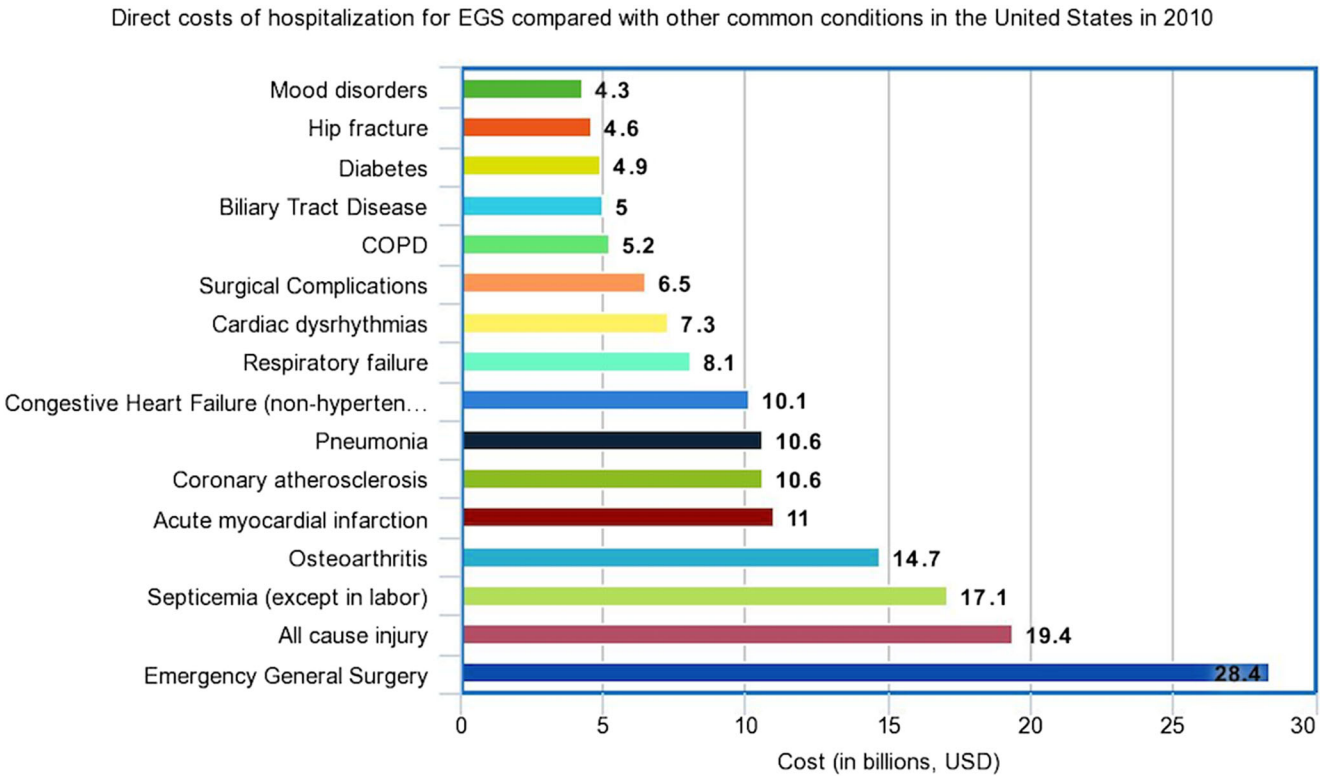

Fig. 2 Emergency gastrointestinal surgery costs of care

reduced hospital charges by $2.5 billion to $5.3 billion based on the published range of daily hospital charges ($1853–3949 per day).

Interestingly, the analysis demonstrated that the collective burden of EGS conditions affected more than 1290 of 100,000 persons per year which dwarfs that of several common, highly publicized, and extensively researched public health problems such as new-onset diabetes mellitus (899 of 1,000,000 persons per year) and newly diagnosed malignancies (650 of 1,000,000 persons per year). Since EGS conditions represent a spectrum of disease that impacts a large patient population annually, it is important to understand the costs that make management of EGS immense.[7] The current economic climate does not incentivize EGS care and evidence for this healthcare perspective demonstrated that while emergent admissions and operations increased, reimbursement for care continued to decline, highlighting that the EGS patient population may be increasingly uninsured or underinsured.[8–11]

Assuming the costs related to EGS is a tremendous challenge.[12,13] Acute care surgery programs have been developed to meet this need, with the goal of freeing general surgeons or subspecialty surgeons with elective practices from unplanned surgical emergencies that may disrupt or delay elective cases.[14] Plus, this model posits resources similar to a trauma system model, such that the most critically ill EGS patients would have immediate availability to an OR. However, financial implications of this model are still being studied. Several programs that successfully adopted acute care surgery models have reported changes in departmental revenue as well as reduction in hospital costs, but that has not been universally demonstrated.[15–18] More work will need to be done to determine optimal systems of care delivery for patients with GI surgical emergencies.

Common Diseases

Since efforts to study, measure, and benchmark EGS outcomes are needed, it is important to understand which diseases constitute (1) the highest frequency within the realm of EGS and subsequently (2) the impact that these diseases have on patient care. To define the extent of EGS burden further, Scott et al. utilized the National Inpatient Sample to estimate the EGS burden in the USA.[19] Scott et al. described seven procedures (partial colectomy, small bowel resection, cholecystectomy, perforated peptic ulcer disease repair, lysis of peritoneal adhesions, appendectomy, and laparotomy) that accounted for majority of the admissions, morbidity, mortality, and cost in the USA annually. As these were associated with poorer outcomes and the authors concluded that national efforts could be better focused to these commonly performed procedures.

Emergency general surgeries by definition present acutely and are frequently associated with distorted anatomy due to inflammation, gross contamination, and altered patient physiology. Currently, we are beginning to understand and characterize the myriad ways EGS conditions are associated with specific risk factors and their impact on patient outcomes. Despite the focus on quality improvement in surgery, studies continue to show that emergent operations are associated with higher postoperative morbidity and mortality in comparison to non-emergent cases.[20–23] Complications resulting from emergency operations lead to worsened physical status, emotional and financial burden to patients and families, and additional hospital costs.[24] Since the abdomen is a frequent anatomic region for EGS diseases, emergent abdominal surgery can pose unique operative challenges for common diseases often considered trivial. Some of these EGS conditions include appendicitis, cholecystitis, and small bowel obstruction. The management of these conditions, clinical risk estimation models, and outcomes are subsequently reviewed.

Acute Appendicitis

Appendicitis is a common EGS disease with an incidence of 9.4–11 per 10,000 person-years.[25–27] Further, a large review of the National Inpatient Sample demonstrated that complicated (perforated) appendicitis was about 25% and that the overall complication rate was 7.5%.[25] In the USA, it is frequently managed operatively.[28] Several clinical prediction rules exist to diagnose appendicitis, and Kularatna et al. used systematic review and meta-analysis to demonstrate that the Appendicitis Inflammatory Response score appeared to be the best diagnostic clinical prediction rule.[29] Despite the ability to predict appendicitis diagnosis, initial management based on patient disease severity (beyond non-perforated or perforated appendicitis) lacks high-level evidence.[30] Several authors have reclassified appendicitis based on disease severity and have demonstrated its correlation with outcomes surgical approach, morbidity, mortality, and duration of hospital stay.[31–34] These grading systems could be utilized to better stratify patient cohorts in order to determine optimal initial surgical or nonsurgical management. For example patients with different disease severity could be selected for specific therapies (low severity—antibiosis with or without drainage, moderate severity—laparoscopy or limited incision, and for high severity—laparotomy). With respect to outcomes, disease severity has been shown to be associated with several outcomes as well (both non-perforated versus perforated and grading systems that incrementally describe disease severity). In a recent retrospective single institutional review by Hernandez et al., organ space infection was associated with disease severity but also irrigation.[35] As surgeons utilized more irrigation for increasingly severe disease (perforation and inflammation), the rates of organ space infection increased. In a larger administrative dataset analysis, Won et al. demonstrated that regional variations existed with respect to outcomes and operations

performed.[36] Taken together, improving risk stratification and possibly utilizing a set of disease severity definitions, like the AAST EGS grading system, might improve variation demonstrated nationally.[37–39]

Acute Cholecystitis

Acute cholecystitis secondary to cholelithiasis is common and was the second most frequent discharge diagnosis with a median duration of hospital stay at 3 days based on a large review of USA inpatient data.[40] Acute cholecystitis is increasingly managed using laparoscopy during the past three decades.[41,42] With respect to EGS, several authors have described poorest outcomes in patients that demonstrate increased gallbladder inflammation.[43–45] Mitigating the operative risk associated with high disease severity is important; however, few data incorporate patient disease severity, management approaches, and outcomes. Recently, two grading systems have been validated and assessed. The Parkland Grading system is an intraoperative grading system that estimates operative difficulty.[46] The authors provided a prospective validation and severity was associated with outcomes. Similarly, the American Association for the Surgery of Trauma (AAST) developed a grading system for EGS diseases that incorporate clinical, imaging, operative, and pathologic criteria. Two groups have evaluated this grading system and demonstrated that retrospectively the grading system appeared to describe disease severity and correlate with outcomes; however, discrimination of patient disease severity at lower levels appeared difficult.[47,48] Furthermore, recent work calls into question one of the first methods to assign patient disease severity, the Tokyo Guidelines.[49] This work highlights that the current 2013 Tokyo Guidelines lack discriminatory capacity and that management may be better stratified using different definitions.[50,51] Future analyses focused on patient outcomes evaluating operative and non-operative management for acute cholecystitis will be important.[52]

Small Bowel Obstruction

Adhesive small bowel obstruction (ASBO) represents a common and burdensome EGS disease with an estimated incidence of 4.6% for all types of operations.[53,54] Another study estimated that in patients operated on for prior ASBO, the incidence was higher at 15.6%.[55] Lysis of adhesions and bowel resection contributed to patient complications, cost, and admission as noted by Scott et al. and these are commonly performed during operations for ASBO.[19] Because ASBO is associated with poorest outcomes when surgery is delayed > 24 h and early recognition of patients that will fail non-operative approaches is crucial, several risk assessment models have been generated.[56] Management approaches include operative and non-operative and an increased focus on which patients will fail non-operative management is important.[57–60] While previous work has focused on comparison evaluating management approach or identification of patient/imaging risk factors associated with poorer outcomes, recent work that assesses patient disease severity using standard definitions has been performed. Using these standardized definitions of disease severity improved stratification of management type and subsequent outcomes.[61,62] Future studies aimed at improving outcomes might include these definitions in order to determine the optimal therapeutic management approach while minimizing patient risk and reducing subsequent ASBO events.[63,64]

Despite these aforementioned diseases, others still account for a considerable proportion of EGS burden including perforated peptic ulcer disease, diverticulitis, and skin and soft tissue infections. While a comprehensive overview of all EGS and GI surgical conditions is beyond the scope of this paper, the three most common diseases described above can help provide a framework for understanding GI surgical emergencies as a progression of inflammation or severity of illness, requiring decisions about operative intervention, antimicrobial use, and modalities of treatment at each stage.

New and Emerging Treatment Modalities

Laparotomy is considered the standard of care for patients that display in extremis physiology given the expediency of the maneuvers and ability to rapidly control foci of contamination or associated hemorrhage. While this approach is rapid and provides maximal exposure, the complications from this large incision are myriad. Innovative practices and extension of commonly utilized management approaches are being considered for a variety of EGS diseases. Increasingly, non-operative management is being utilized in the cases several EGS conditions. In appendicitis, a paradigm shift toward antibiosis continues to be evaluated and implemented. For severe forms of acute cholecystitis, the percutaneous cholecystostomy tube has provided surgeons with the opportunity to delay potentially difficult operative management, especially in patients with advanced comorbidity profiles. In perforated diverticulitis, the non-operative management is considered standard of care for low-severity disease states whereas the several randomized controlled trials have shown that laparoscopic lavage for perforated diverticulitis is not beneficial.[65] All of these highlight the shifts in surgical management in patients with EGS diseases and that importance that disease severity has in the successful management for each.

Trends in laparoscopy continue to evolve, with more surgeons utilizing this technique in emergency operations.[66] An analysis of the NSQIP database demonstrated an increasing trend in emergency laparoscopy utilization from 5.5% in 2005 to 11.5% in 2014 for all types of colorectal EGS conditions.[66]

Over a similar time period, Dahlberg et al. demonstrated that the increasing utilization of laparoscopy for appendectomy (nearly 90% of the entire cohort) was associated with considerable reduction in postoperative morbidity and mortality.[67] Further, Di Savierio demonstrated that laparoscopy in the setting of most severe forms of appendicitis is possible and safe but also that intracoporeal anastomoses were achievable.[68,69] Expanding this technique and the indications for laparoscopy as well as defining which patient populations will not benefit from this approach initially is needed.

Non-operative management incorporating stents or the action of stenting for bowel obstructions is of interest. Kohler et al. evaluated the use of self-expanding metaling stents for malignant or benign colorectal obstructions and found demonstrated initial safety as well as a variety of patient/obstruction features that were associated with failure and subsequent complications.[70] Long-term outcomes demonstrate, however, that there were no differences in long-term outcomes in patients that underwent emergency surgery or stent placement for left-sided colonic obstructions.[71]

Novel devices and their practical application continue are of use for the well-selected patient. Since anastomotic leakage represents a serious complication and technique does not appear to influence subsequent outcomes, appropriate management might reduce the consequences of this complication.[72] Endoscopic vacuum-assisted closure (E-VAC) represents one novel method to address these types of complications, irrespective of disease or location.[73–75] This technique borrows the concepts of negative pressure wound therapy and reestablishes the benefits of negative pressure intra-cavitary. Expanding this technique and identifying patients that might benefit further from early application is needed as indications are currently highly selective.

Risk Stratification

Clinical prediction models provide insight as to which patients are at highest risk for complications or death after surgery; however, each requires rote memorization or complex calculations. Recently, the American Association for the Surgery of Trauma (AAST) has developed a grading system for several EGS conditions.[37–39,76] The AAST EGS grading system has the advantage of being simple and reproducible for many disease states, characterizing inflammation severity from stages 1–5 for specific clinical, imaging, operative, and pathologic criteria.[77] These scales have been evaluated retrospectively in single and multi-institutional settings. Multiple studies have demonstrated that AAST disease severity is associated with clinical outcomes of interest as well as intraoperative surgical approaches (small bowel resection and ostomy).[38,61,77,78] Furthermore, in order to accurately delineate the impact that disease severity has on management approaches, it is important to evaluate both operative and non-operative patients.[52] In patients that received non-operative management and successfully resolved the obstruction, the AAST EGS grade was lower compared to patients that received operative management, and this suggests a potential role to identifying patients based on more uniform definitions in order to predict successful non-operative management.[61]

A promising and physiology-based score (Physiological Emergency Surgery Acuity Score-PESAS) derived using by Sangji and Kaafarani et al. determined that patient disease acuity could be incrementally assessed and might be useful for patient preoperative counseling.[79] Similarly, incorporation of patient demographics, comorbidities, and preoperative laboratory values from the NSQIP database could be used to generate the Emergency Surgery Score (ESS).[80] This ESS score correlated with increasing patient mortality and in a subsequent analysis 30-day patient comorbidity.[80] It may be that using the PESAS in combination with AAST EGS grades and a comorbidity index will provide the most precision with respect to risk stratification, but this is still being studied.

Finally, surgical decision making for common EGS diseases often considers operative therapy. The lack of consideration for non-operative management is obfuscated by the lack of defining appropriate cohorts for comparison.[52] Several risk assessment methods including the AAST EGS grade or the Parkland grading scale for cholecystitis represent a significant advance in patient EGS disease benchmarking.[46–48]

Quality Improvement

This underscores the need for a systems approach to improving quality.[3,81] The best known example of such methodology is the National Surgical Quality Improvement Program (NSQIP). Risk-adjusted benchmarking used in NSQIP has shown significant variations in outcomes across the hospitals, and has led to significant improvements in patient outcomes.[52] This study identified a potential gap in surgical benchmarking for EGS diseases when non-operative cases were excluded from analyses. Further, it demonstrated that by including this management approach, an opportunity for surgical quality improvement programs is possible.[52] Using the same approach, Trauma Quality Improvement Program (TQIP) has also shown wide variations in risk-adjusted outcomes at participating trauma centers, and developed processes to improve the quality of care for these patients. EGS is practiced at hundreds of hospitals without such benchmarking.[19]

In assessing and quantifying postoperative morbidity and mortality for emergency versus nonemergency general surgery operations, Becher et al. identified all general surgery inpatients in the American College of Surgeons National Surgical Quality Improvement Program 2008 database.[82] Preoperative, intraoperative, and postoperative clinical

metrics and occurrences were analyzed. A total of 25,770 emergent and 98,867 non-emergent cases were identified. Postoperative morbidity was significantly worse in the emergent group, including ventilation more than 48 h, bleeding requiring transfusion, deep vein thrombosis, renal failure, and need for reoperation. Overall, emergent cases had significantly more postoperative complications (22.8 vs. 14.2%) and higher mortality rates (6.5 vs. 1.4%).

The AAST has also proposed an EGS quality improvement program (EQIP) to measure risk-adjusted outcomes of centers caring for EGS patients based on a retrospective multi-institutional cohort study undertaken by the AAST Patient Assessment and Outcome Committee.[39] The study showed that anatomic severity of EGS diseases is an important determinant of patient outcome and resource use, independent of physiologic status and preexisting comorbidities. The AAST grading system fills an important void in EGS severity measurement. Anticipated uses of this grading system include risk adjustment in studies of comparative effectiveness research, evaluation of the clinical experience of trainees in acute care surgery, formulation of treatment guidelines, and ultimately, measurement of quality of care at centers. The proposed EQIP methodology is similar to that of NSQIP and TQIP, which have been successfully used to measure and improve quality of surgical and trauma care, respectively.

This analysis highlighted the need for a robust EGS registry with well-defined data elements which do not need to be very exhaustive. Data elements would include AAST grade, presence or absence of any comorbidity, and SOFA score. The AAST Patient Assessment Committee is currently in the process of developing detailed data dictionaries for grading multiple EGS diseases.

These risk assessment tools will aid surgeons in future analyses to provide equitable comparisons to further standardize EGS management and provide risk adjustment between centers. Thus, the optimal care of the emergency general surgery patient represents the most compelling impetus to respond with concerted efforts to address the burden disease as it has for the trauma patient. Just as the injured patient drove the trauma surgeons to develop innovative approaches to surgical care for the injured, the care of the EGS patient had led to an increased need for well-studied diagnosis, risk stratification, and subsequent correlation of risk with the correct operative or non-operative approach.

Outcomes

There is an unfortunate paucity of outcomes data specific to emergent general surgery procedures and no uniformly accepted system to measure quality of EGS care provided exists.[83] Moreover, national standards for optimal resources or clinical processes for EGS patients have been neither established, nor any national benchmarks for hospital performance.[84] Indeed, the absence of collective EGS outcomes investigation prevents separating the impact of suboptimal care from the complex physiology as contributors to poor outcomes and therefore prohibits making improvements in care difficult.

EGS operations are considered to carry higher morbidity and mortality than non-emergent cases. Patients who undergo an EGS operation are up to eight times more likely to die postoperatively than are patients undergoing the same procedures electively.[18] In addition, approximately half of all patients undergoing EGS will develop a postoperative complication[85,86] and up to 15% will be readmitted to the hospital within 30 days of their surgery.

Other recent studies clearly demonstrated large variations in risk-adjusted mortality rates of EGS patients across several hundred hospitals nationwide. Additionally, a wide gap in mortality between high- and low-mortality hospitals is clear, with several thousand more deaths than expected, reiterating a significant room for improvement in quality of care. Multivariate analyses found male sex, increased blood glucose levels, longer surgical times, increased creatinine levels, lower serum albumin levels, and current smoking to be independent predictors of morbidity.[87] It is difficult to elucidate specifically the reasons for this discordance. Resource limitation which may include distinct teams of surgeons and other clinical providers, 24/7 availability of operating rooms and personnel, data registry, performance improvement process, and clinical practice guidelines possibly all play a role. Therefore, a data registry that captures patient demographics, clinical information, and outcomes is essential for quality improvement.

Another important consideration is availability of trained surgical manpower and adequate response to staffing needs. Notwithstanding the encompassed diverse and complex pathology, these cases are typically treated by the surgeon on duty with call assigned, obligatory, and independent of whether that surgeon is immediately available or has the time, resources, incentive, or expertise to deliver appropriate care.[88,89] The current system results in delays in care,[90] significant practice variation,[91] and, at times, suboptimal outcomes.[82,87] Further, persistent shortages in the general surgery workforce, increased emphasis on sub-specialization, lifestyle demands, reimbursement pressures, and unsatisfying monetary compensation have discouraged surgeons to elect to provide emergency coverage.

Using trauma care as a model, one potential way to optimize care of the EGS patient would be regionalized care for the most ill patients. Protocols for patient stabilization and transfer to centers with a higher level of care that contain providers like in-house intensivists and 24/7 access to operating rooms might be reasonable to pursue. This would also decrease the burden of care on local hospitals that might be

underresourced for these higher utilizers. However, because several of these diseases provide the operative backbone of community surgical practice, it will be vitally important to develop collaborative strategies to optimize patient outcomes without compromising case volume and experience for surgeons from referring centers.

Summary

EGS encompasses the care of the most acutely ill, highest risk, and most costly general surgery patients. Those patients particularly seem to manifest unique clinical, pathophysiologic, and inflammatory responses to their surgical disease. Studies suggest that there is a need for improvement in both methods and systems of care for the emergent population. Axiomatically, the emphasis should be on the need for cost-effective, evidence-based EGS surgical practice, and we should continue to support efforts to assess and monitor quality of care.

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CME/MOC Questions

1. Emergency general surgery is defined as:

a. Non elective operation that is done to prevent mortality
b. An operation performed in the first 36 hours of hospital presentation
c. An operation declared as urgent by the anesthesiologist
d. Any operation performed during non standard operating time (ie nights and weekends)

2. Patients requiring emergency surgical intervention have been found to have all the following complications when compared to patients undergoing non emergent surgery EXCEPT:

a. Worse clinical status and overall outcome
b. Increased emotional and financial burden
c. Additional hospital costs
d. Shorter hospital length of stay

3. Seven operations have been identified as making up 80% of EGS cases. These include:

a. Total abdominal colectomy, small bowel resection and cholecystectomy
b. Appendectomy, Lysis of adhesions, small bowel resection
c. Laparotomy, total abdominal colectomy, appendectomy
d. Appendectomy, lysis of adhesions, hepatorrhaphy

4. Between 2001 to 2010, the number of hospital admissions for emergency surgery patients has increased. Which of the following has decreased?

a. The proportion of these patients requiring surgery
b. The associated number of patient deaths
c. The rates of patients with sepsis
d. The number of patients treated in non-teaching hospitals

5. When compared to nonemergent cases, postoperative morbidity was found to be significantly worse in the emergent group which included higher rates of all of the following EXCEPT :

a. Renal failure
b. Deep vein thrombosis
c. Ventilator requirement of more than 48 hours
d. Urinary tract infections

6. Which of the following has been found to be an independent predictor of morbidity in EGS patients:

a. Female sex
b. Lower transferrin levels
c. History of smoking
d. Increased blood glucose levels

7. Which of the following is true?

a. NSQIP has not successfully been used to measure and improve surgical care
b. Patients undergoing emergency operations have equivalent mortality to patients undergoing the same procedure electively
c. TQIP has shown minimal variation in risk adjusted outcomes for trauma patients
d. There is currently no EGS quality improvement program evaluating outcomes

8. Which of the following have been identified as factors discouraging surgeons to provide emergency coverage?

a. Abundance of surgeons providing emergency coverage
b. Reimbursement pressures
c. Appropriate monetary compensation for additional hours worked
d. Lack of operating time for additional cases