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General surgeon involvement in the care of patients designated with an American Association for the Surgery of Trauma-endorsed ICD-10-CM emergency general surgery diagnosis code in Wisconsin

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Abstract

Background: The current national burden of emergency general surgery (EGS) illnesses and the extent of surgeon involvement in the care of these patients remain largely unknown. To inform needs assessments, research, and education, we sought to: (1) translate previously developed International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-

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CM) diagnosis codes representing EGS conditions to ICD-10-CM codes and (2) determine the national burden of and assess surgeon involvement across EGS conditions.

Methods: We converted ICD-9-CM codes to candidate ICD-10-CM codes using General Equivalence Mappings then iteratively refined the code list. We used National Inpatient Sample 2016-2017 data to develop a national estimate of the burden of EGS disease. To evaluate surgeon involvement, using Wisconsin Hospital Association (WHA) discharge data (1/1/16-6/30/18), we selected adult urgent/emergent encounters with an EGS condition as the principal diagnosis. Surgeon involvement was defined as a surgeon being either the attending provider or procedural physician.

Results: 485 ICD-9-CM codes mapped to 1,696 ICD-10-CM codes. The final list contained 985 ICD-10-CM codes. Nationally, there were 2,977,843 adult patient encounters with an ICD-10-CM EGS diagnosis. Of 94,903 EGS patients in the WHA dataset, most encounters were inpatient as compared to observation (75,878 [80.0%] vs 19,025 [20.0%]). 57,780 patients (60.9%) underwent any procedure. Among all Wisconsin EGS patients, most had no surgeon involvement (64.9% [n=61,616]). Of the seven most common EGS diagnoses, surgeon involvement was highest for appendicitis (96.0%) and biliary tract disease (77.1%). For the other five most common conditions (skin/soft tissue infections, gastrointestinal hemorrhage, intestinal obstruction/ileus, pancreatitis, diverticular disease), surgeons were involved in roughly 20% of patient care episodes.

Conclusion: Surgeon involvement for EGS conditions ranges from highly likely (appendicitis) to relatively unlikely (skin/soft tissue infections). The wide range in surgeon involvement underscores the importance of multidisciplinary collaboration in the care of EGS patients.

Level of Evidence: Prognostic/epidemiological, Level III

Keywords

emergency general surgery; surgeon involvement

Background

The conditions recognized as “emergency general surgery (EGS)” represent a significant public health burden and are associated with substantial morbidity and mortality. Based on data from 2001 to 2010, more than 3 million hospitalizations were due to EGS diagnoses annually, accounting for 7.2% of all United States admissions.(1) The annual case rate (1,290 per 100,000) for EGS diagnoses was higher than the sum of all new cancer diagnoses (all ages and types) [650 per 100,000 (95% confidence interval, 649.3-651.3)] in the United States.(1) EGS is an independent risk factor for death and postoperative complications. Patients who undergo an EGS operation are up to eight times more likely to die postoperatively than are patients undergoing the same procedures electively.(2) Additionally, up to 15% of EGS patients will be readmitted to the hospital within 30 days of their surgery.(3)

Members of the Patient Assessment Committee (PAC) of the American Association for the Surgery of Trauma (AAST) previously created a list of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes that they proposed

represented EGS diagnoses.(4) The committee's work provided one way to define EGS as a specialty, that could then be applied to education, research, and quality improvement efforts. This list of codes has had substantial impact on EGS-focused research and quality improvement efforts, serving to define patient populations in numerous published articles and in workforce studies.(5-14) However, the implication in these studies, yet untested, is that surgeons are integrally involved in most instances in which patients are hospitalized for an EGS diagnosis.

In October 2015, the United States transitioned to the International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS), replacing the ICD-9-CM coding system for most inpatient and outpatient medical encounters.(15) Thus, to continue the evaluation and advancement of EGS care, there is an urgent need to understand which ICD-10-CM codes reflect EGS. As such, we aimed to: (1) update the ICD-9-CM EGS codes proposed by Shafi et. al. to a set of ICD-10-CM codes, (2) determine national estimates of the incidence of hospitalization for diagnoses that represent EGS based on this definition, and (3) predict involvement of a general surgeon as the primary provider.

Methods

Generation of ICD-10-CM codes involving EGS

Our team used a 3-step process to generate a list of candidate ICD-10-CM codes. The intent of this translation process was to develop a list of ICD-10-CM diagnosis codes putatively representing EGS, faithful to the ICD-9-CM list of codes proposed by Shafi et al., without altering the types or breadth of clinical concepts captured by those ICD-9-CM codes.(4) First, General Equivalence Mappings (GEMS) from the Centers for Medicare & Medicaid Services and the National Center for Health Statistics were used to translate previously published ICD-9-CM codes for EGS conditions to a list of candidate ICD-10-CM codes using the Agency for Healthcare Research and Quality (AHRQ) MAPIT tool.(16, 17) Second, the candidate list of ICD-10-CM codes derived from the automated mapping was divided into six groups, with each separately reviewed by two to six physician members of the AAST PAC. Committee members flagged ICD-10-CM codes that did not represent one of the EGS diagnoses (as previously defined) for removal from the candidate list. As a last step, committee members suggested additional ICD-10-CM codes that matched one of the previously defined EGS diagnoses, identified from the official tabular lists and indexes of ICD-10-CM, that were not initially identified by the mapping process. Discrepancies were reconciled by the senior author.

Data sources

Two data sources were used in the current study to (1) produce national estimates of the burden of EGS diagnoses in hospital inpatient encounters and (2) understand the extent of surgeon involvement for patients diagnosed with an EGS condition.

National estimates of diagnoses proposed to represent EGS were obtained using 2016-2017 National Inpatient Sample (NIS) data. The NIS is part of the AHRQ Healthcare Cost and

Utilization Project (HCUP) and is the largest inpatient database in the United States.(18) The NIS includes weights that can be used to obtain national estimates of the total number of patients and inpatient admissions for specific diagnoses and procedures. The NIS also provides information on patient demographics (age, sex, race, ethnicity, payor status) and clinical characteristics (admission source) as well as outcomes (discharge disposition, length of stay [among those discharged alive], total charges/cost, and mortality).

The extent of surgeon involvement in EGS-related hospital encounters was assessed with a Wisconsin statewide database representative of hospital discharges from 1/1/2016-6/30/2018. Of note, the NIS and most state-level databases other than that of Wisconsin do not include physician specialty allowing for the assessment of surgeon involvement. Pursuant to state statute, all Wisconsin hospitals (n=187) must submit information quarterly from all inpatient and outpatient encounters, including emergency department (ED) visits, to the Wisconsin Hospital Association (WHA). In addition to admission and discharge encounter information that includes diagnosis and procedure codes, this database also includes patient sociodemographic information.(19) Importantly, the deidentified WHA dataset includes a random identifier that allows for the assessment of multiple encounters for the same patient. These data were merged with Fiscal Year 2017 WHA Hospital Survey Data in order to identify encounters from acute care, non-federal hospitals, including encounters at general medical, surgical, and critical access hospitals.(19)

Identification of encounters involving EGS

For both datasets, encounters were included if the patient was at least 18 years old and had a candidate ICD-10-CM EGS diagnosis code listed as the principal diagnosis. We limited our analysis to the principal diagnosis code for several reasons. Prior related studies of EGS using administrative data have focused on the principal diagnoses code; thus, we included only the principal diagnosis to maintain comparability. Additionally, if we included encounters with an EGS condition as a secondary diagnosis, we would underestimate surgeon involvement as surgeons would likely predominantly serve as consultants in these episodes of care. In the NIS, encounters were required to have an urgent or emergent admission status. Because the objective was to determine national burden of hospital encounters associated with EGS diagnoses, all encounters in the NIS with an eligible diagnosis were included in the analysis.

In the WHA, the same age and diagnosis inclusion criteria were applied. For these records, we included (1) inpatient encounters originating from the ED or with an urgent or emergent admission type as well as (2) observation encounters originating from the ED. We specified that observation encounters must originate from the ED as admission type is not reliably available for observation encounters. Encounters that represented only ED use were not included because the WHA does not include information about surgeon involvement for these encounter types. To ensure that complete information was available for each encounter and because ED visits resulting in transfer would lack information on surgeon involvement, we excluded all transferred patients. Thus, encounters were required to have a non-hospital admission source (i.e., home, non-health care facility, clinic or physician’s office, skilled

nursing facility, court/law enforcement) as well as a discharge destination other than a short-term hospital.

Diagnosis and procedure categories

EGS diagnoses were grouped using the AHRQ HCUP Clinical Classifications Software Refined (CCSR) database.(20) The CCSR database aggregates all of the ICD-10-CM diagnosis codes (currently over 70,000) into clinically meaningful categories organized across 21 body systems, which follow the general structure of the ICD-10-CM diagnosis chapters.(20) For ICD-10-CM EGS diagnoses that were assigned more than one CCSR category by HCUP, we selected as the primary CCSR category the description that most closely represented the underlying condition involved in the diagnosis. (Supplemental Table 1)

For inpatient procedures, ICD-10-PCS procedure codes classified as major diagnostic or therapeutic procedures by HCUP were grouped into clinically meaningful categories based on chapter headings.(21) For outpatient procedures, Current Procedural Terminology (CPT®) codes were evaluated. CPT® codes were grouped into clinically meaningful categories based upon the Centers for Disease Control and Prevention National Healthcare Safety Network procedure code categories.(22) The resulting CPT® procedure categories were applied to the CPT® codes in the WHA data. CPT® procedures that did not have a procedure category were reviewed by the authors (AI, LG, MC, GU) and assigned an appropriate EGS procedure category. (Supplemental Table 2)

Definition of surgeon involvement

We characterized the extent of significant surgeon involvement in patient care to understand the multi-disciplinary team that cares for patients with the developed EGS diagnoses. An encounter was considered to have had significant surgeon involvement if a surgeon was listed either as the attending provider or was listed as the procedural physician in a given encounter. Surgeon consultation is not captured in WHA data and thus could not be considered.

A general surgeon was defined based on the following taxonomy codes as outlined by the National Uniform Claim Committee (NUCC):(23) colon and rectal surgery; surgery (including the following subspecialties: hospice and palliative medicine, pediatric surgery, plastic and reconstructive surgery, surgery of the hand, surgical critical care, surgical oncology, trauma surgery, vascular surgery); thoracic surgery; and transplant surgery. Taxonomy codes for otolaryngology, obstetrics/gynecology, urology, and plastic surgery that did not also involve general surgery training were not categorized as general surgery. During the study time period, two surgeon specialty classifications were used. Prior to 2017, specialty codes were categorized based on Wisconsin Department of Professional Services (DSPS) classifications. After 2017, WHA assigned provider specialty using the American Medical Association (AMA) and NUCC classification systems. These systems were integrated to discern specialty. (Supplemental Figure 1) Encounters in which the provider specialty for the attending or procedural physician was a general surgeon were defined as having significant surgeon involvement. All other specialties were deemed to

include other types of providers. There were only two providers that did not have an NPPES specialty available that were assumed not to be surgeons (<0.001%).

Demographic and clinical data

In order to describe encounters with an EGS diagnosis, we examined patient demographic and clinical factors including age, gender, race/ethnicity, and payor as well as length of stay and mortality. Additional information was available in the WHA that allowed for an assessment of hospital bed size (logged). National estimates of EGS encounter charges and costs were available from the NIS and are presented in 2017 dollars.

Analysis

To estimate the rate of surgeon involvement among patients with the most common diagnoses in Wisconsin, a distributed exposure method was followed that assumed a uniform distribution of EGS diagnoses over a one-year period.(24) Given that only six months of data in 2018 were available, this assumption allowed for the calculation of an annual rate based on data from that partial year. Population counts for calendar years 2016 and 2017 were included in full. The population count for 2018, with only two quarters of data, was included as half the count for 2018.

For the analysis that focused on the extent of surgeon involvement for EGS-related encounters using WHA data, the level of analysis was the patient and included a patients' first or only eligible encounter, basing inclusion on the principal diagnosis. This likely represents a lower limit of plausible surgeon involvement given that, as patients re-present for the same diagnosis, surgeon involvement is likely to increase (e.g., rehospitalization due to a previous surgery or encounters where patients may repeatedly present for the same condition [e.g., biliary colic]). Analyses were repeated at an encounter-level as a sensitivity analysis to ensure consistent findings.

Descriptive statistics were used to summarize patient sociodemographic (age, race, ethnicity, payor status) and clinical characteristics (admission source, discharge disposition, duration of stay, mortality, and cost/charges) as well as surgeon involvement. The proportion of encounters that included one or more of the proposed EGS diagnosis codes is also provided. Median differences in continuous measures by surgeon involvement were assessed with Wilcoxon rank-sum tests. Differences in dichotomous measures were assessed with Chi-Square tests.

This study was approved by the University of Wisconsin Institutional Review Board. All analyses were conducted with SPSS (Armonk, NY) or SAS (Cary, NC).

Results

Generation of candidate ICD-10-CM codes

The 485 ICD-9-CM codes previously developed by the committee mapped to 1,696 ICD-10-CM codes. Of the 485 ICD-9-CM codes, 205 mapped to an equivalent code in ICD-10-CM, 107 mapped to a single ICD-10-CM code in an approximate fashion, and 173 mapped to more than one ICD-10-CM code. Upon removing duplicates, 1,386 unique ICD-10-CM

codes remained. After review by the committee, 946 of the 1,386 unique ICD-10-CM codes were retained. Reviewers suggested adding 596 unique ICD-10-CM codes not initially included in the automated mapping. After reviewing the corresponding ICD-9-CM codes, only three ICD-10-CM codes were added by the senior author to the final list of ICD-10-CM EGS codes (J34.0, K91.3, and N49.3) when the codes were compared to the original list of ICD-9-CM EGS diagnosis codes. Finally, a net 36 codes were added to reflect annual updates to the coding classification (i.e., addition and deletion of codes since the GEMS were created) associated with the 949 putative EGS-related codes. This led to a total of 985 ICD-10-CM codes for evaluation of national EGS burden and surgeon involvement. (Supplemental Table 3)

Demographic information and clinical characteristics of EGS patients

In the NIS data, there were 5,876,001 patient encounters with one or more of the candidate ICD-10-CM diagnosis codes in 2016-2017. Table 1 details the demographic, clinical, and outcomes characteristics for such encounters in the NIS.

In the WHA data, 94,903 patients with one or more of the candidate ICD-10-CM diagnosis codes were treated at 123 acute care hospitals in Wisconsin. Of these patients, 19,025 (20.0%) were treated during an observation stay originating through the ED, and 75,878 (80.0%) were treated during an urgent/emergent inpatient encounter. Demographic and clinical characteristics of patients in the WHA dataset are detailed in Table 2. Patients treated through observation stays were slightly younger than those treated via inpatient encounters. For both observation and inpatient stays, the percentage of female patients exceeded the percentage of male patients. Private insurance was the primary payor for observation stays while Medicare was the primary payor for the majority of inpatient stays. Abdominal pain, appendicitis, biliary tract disease, and gastrointestinal hemorrhage were the most common diagnoses encountered in the observation setting. (Table 3) Among inpatient encounters, principal diagnosis codes were primarily for skin and subcutaneous tissue infections, gastrointestinal hemorrhage, and intestinal obstruction and ileus.

Of the 94,903 patients, 37,123 (39.1%) did not undergo any procedure, 13,752 (14.5%) underwent a procedure captured by a CPT code, and 44,028 (46.4%) underwent a procedure captured by an ICD-10-PCS code. A detailed list of the procedures performed can be found in Supplemental Table 4.

Surgeon involvement

Among the 94,903 patients with one or more of the candidate EGS diagnosis codes, 61,616 (64.9%) did not have a surgeon documented as either the attending provider or listed as the procedural physician in the WHA dataset. (Table 4) Thus, only 33,287 (35.1%) patients with a diagnosis representing EGS had significant surgeon involvement in their care. When a surgeon was documented as an attending or procedural provider, the surgeon's role was operative in 28,235 (84.8%) patient encounters and nonoperative in 5,052 (15.2%) patient encounters. Of the seven most common EGS diagnoses, surgeon involvement was highest for appendicitis (96.0%) and biliary tract disease (77.1%). (Figure 1) For the five other most common diagnoses (skin & soft tissue infections, gastrointestinal hemorrhage, intestinal

obstruction and ileus, pancreatitis, diverticular disease), surgeons were involved in roughly 20.0% of encounters. While we expected certain diagnoses to have substantial surgeon involvement given the nature of treatment for these conditions (e.g., appendicitis: 91.2% operative; 4.8% non-operative; 4.0% no surgeon involvement), surgeon involvement was documented to a lesser extent than other clinical specialties for traditionally “surgical” diagnoses, including peritonitis and intra-abdominal abscesses: 20.1% operative; 25.2% non-operative; 54.7% no surgeon involvement.

Patients were more likely to have surgeons significantly involved in their care versus not involved if they were treated at hospitals that have a larger bed size (mean of logged hospital bed size, 4.95 vs. 4.86, $p<0.0001$; in untransformed counts, the range was 1-723 beds) and were located in urban as compared to rural settings (35.6% vs. 32.6%, $p<0.0001$).

Sensitivity analyses

Results from the encounter-level analyses were consistent with those described above at the patient level. In the encounter-level analysis, 94,903 patients had 114,192 individual encounters in the dataset. There were no substantial differences in the demographics or clinical attributes presented in Table 1 between the patient- and encounter-level analyses. The frequencies of specific diagnoses and procedures were also similar between the two groups including the percentage of patients that did not have a procedure (39.1% in the patient-level analysis; 41.1% in the encounter-level analysis). Significant surgeon involvement in the encounter-level analysis (27.4% operative; 5.8% non-operative; 66.9% no surgeon involvement) was also similar to that in the patient-level analysis. Additionally, when considering all encounters a patient had during the study years (not just including first encounters), the percent surgeon involvement for the top 10 CCSR diagnosis categories did not substantively differ (i.e., no diagnosis code category shifted in range by more than one position). Only three diagnosis categories had a change in surgeon involvement of more than one percent [DIG017: Biliary tract disease (77.1% percent for 1st encounters vs. 75.3% for any encounters); DIG020: Pancreatic disorders (excluding diabetes) (14.2% vs. 11.8%); DIG010: Abdominal hernia (81.1% vs. 79.3%)]. The largest increase was by 0.7% [DIG013: Diverticulosis and diverticulitis (25.7% vs. 26.4%)].

Discussion

This study utilized a rigorous approach to develop a set of ICD-10-CM codes that can be used to define and assess the national burden of EGS diagnoses and predict involvement of a general surgeon as the primary provider. The identification of these codes is important for research and workforce studies, and is particularly critical given the increasing burden of these conditions. The 485 ICD-9-CM codes previously developed mapped to 1,696 ICD-10-CM codes which were then narrowed to 985 ICD-10-CM codes by the committee. The number of EGS-related codes increased in ICD-10-CM primarily because one ICD-9-CM code often translated into several ICD-10-CM codes due to the ICD-10-CM coding scheme including specifics on disease characteristics and laterality which were not present in ICD-9-CM.

The committee translated the previously identified ICD-9-CM codes to ICD-10-CM codes as closely as possible. Although the ICD-9-CM diagnosis codes can be converted to a comparable list in ICD-10-CM, there are several limitations of the Shafi et al.(4) study that were considered and influenced the design of the current study. First, the previously developed list of ICD-9-CM diagnoses were derived from the self-reported experience of seven surgeons who had active EGS practices and were members of the AAST Patient Assessment Committee at that time. Though, unlikely, it is possible that this experience may not be widely generalizable. Second, the ICD-9-CM diagnoses did not address how frequently EGS surgeons are involved when one of these conditions is diagnosed.

Thus, our team also characterized the extent of surgeon involvement in EGS patient encounters and found significant variation in surgeon involvement by EGS diagnosis. Specifically, although some conditions have high rates of surgeon involvement (e.g., appendicitis: 91.2% operative; 4.8% non-operative; 4.0% no surgeon involvement), surgeons were involved to a lesser extent for other conditions (e.g., peritonitis and intra-abdominal abscesses: 20.0% operative; 25.2% non-operative; 54.7% no surgeon involvement). This may be due in part to institutional norms, with patients being admitted to a medical service with the involvement of other procedural specialties, such as interventional radiology and advanced gastroenterology, for diagnoses that could also involve a surgeon later in the course of the disease progression (e.g., choledocholithiasis or perforated appendicitis). Not surprisingly, gastrointestinal, biliary tract, and skin and soft tissue pathology conditions constitute a substantial proportion of EGS disease. However, we have documented that surgeons were often not involved in the care of patients being treated for these diagnoses as either an attending or procedural physician. We suspect this is because mild disease for these conditions (e.g., cellulitis and simple abscesses, partial small bowel obstruction, self-limited gastrointestinal hemorrhage, and uncomplicated pancreatitis and diverticulitis) is both common and does not necessarily require the expertise of a surgeon. (Table 4)

Regarding the national burden of EGS diagnoses, we have demonstrated that the prevalence of EGS conditions has increased from 2009 to 2016. In their analysis of NIS data from 2009, Shafi et al.(4) documented 2,344,576 patients admitted emergently for EGS diagnoses in the United States. In our analysis, including both urgent and emergent admissions, we estimated that 2,938,000 patients are admitted with an ICD-10-CM EGS diagnosis annually.

These findings have significant implications for the delivery of health care as well as quality improvement efforts for patients with EGS diagnoses. Even in the hospital setting, a substantial proportion of patients with EGS diagnoses were cared for by providers who were not general surgeons and were cared for in a nonoperative fashion. This highlights the importance of multi-specialty care of EGS patients and the necessity of including healthcare professionals who are not surgeons in quality improvement efforts. The care of EGS patients by non-surgeons is becoming increasingly important as the general surgeon workforce declines. For example, between 2006 and 2011, the state of Wisconsin lost 6.5% of its general surgeon workforce; three counties lost all general surgeons; and 12 counties had no general surgeons in either 2006 or 2011.(25) In a national survey of 1634 acute care hospitals that responded to a survey regarding their ability to provide round-the-clock (RTC) EGS care, 279 (17.1%) hospitals lacked RTC EGS care on average 35.7% (SD=33.6) of the

time. Among 279 hospitals, 162 (58.1%) responded that the inability to provide RTC EGS care was due to a lack of general surgeon coverage.(26)

Limitations

These findings are not without limitations. First, based on the available data, we were unable to identify surgeon consultation in encounters separate from involvement as the attending or procedural physician. The goal of the investigation, however, was to characterize significant surgeon involvement above and beyond consultation. Including consultation would likely increase the proportion of encounters with surgeons involved in patient care. Additionally, the low rate of involvement by surgeons in the diagnoses we studied is likely a result of less severe cases being managed without surgery, but is nevertheless noteworthy. Although all patients with the diagnoses included are candidates for surgery, a majority of patients do not undergo surgery. This suggests potential utility for a streamlined subset of codes or severity markers that indicate a high likelihood of surgeon involvement. Second, owed to limitations in the WHA data, we were unable to include patient encounters that were limited to the ED or were observation encounters that did not also originate from the ED. As we cannot identify surgeons as consultants, we could not identify surgeon involvement in ED only encounters. Additionally, admission type was missing in over 30% of observation only encounters, and thus could not be reliably identified as urgent or emergent encounters. Third, while EGS care has been influenced significantly in the past decade by the development of acute care surgery fellowship programs and models of care, it was not feasible to distinguish general surgeons from acute care surgeons with the available data. Fourth, the patterns we observed for Wisconsin may not be generalizable to other states. Last, to facilitate comparison with prior research, we elected to translate the previously identified ICD-9-CM diagnoses to ICD-10-CM. Future research may want to consider if the list of codes defining EGS diagnoses should be expanded; for example, analysis of the many codes not identified as EGS-related might reveal additional conditions with non-trivial rates of surgeon involvement. Finally, although ICD-10-CM codes have improved in granularity, they are currently insufficient to determine the severity of surgical disease for all conditions. Some of these EGS diagnoses may be appropriately managed without surgical involvement. Future work should continue to investigate whether diagnosis codes can distinguish between less and more severe cases, the latter of which would likely have more surgeon involvement and could provide a more detailed characterization of EGS conditions. Partnerships with coding organizations for future ICD-10-CM iterations may improve precision.

In conclusion, this work will significantly advance the needs assessments, research, and education efforts dedicated to EGS care. Our results underscore a gap in the literature regarding the burden of consultation in an EGS practice that does not result in intervention. Future work should focus on characterizing the nonoperative burden of disease seen by surgeons in consultation. Establishing an AAST-endorsed list of ICD-10-CM diagnosis codes that define EGS will facilitate comparisons between similar groups of patients to direct quality and performance improvement efforts. However, users of this definition of EGS should be aware that general surgeons are involved as the attending or procedural physician in only about one-third of encounters. Furthermore, our novel understanding of the specialties of providers caring for EGS patients supports expanding quality improvement

metrics and processes beyond general surgeons to include the multi-disciplinary groups of providers that direct EGS patients' care. This will be critical as the delivery of EGS adapts to surgeon workforce shortages and the increasing regionalization of EGS care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Conflicts of Interest and Sources of Funding

Dr. Ingraham serves as a clinical consultant to the American College of Surgeons for work unrelated to that presented in this manuscript.

Dr. Utter receives salary support through contracts #HHSA290201800003G from the Agency for Healthcare Research and Quality (AHRQ) and #75FCM18D0027 from the Centers for Medicare & Medicaid Services; he also has served as a consultant to AHRQ.

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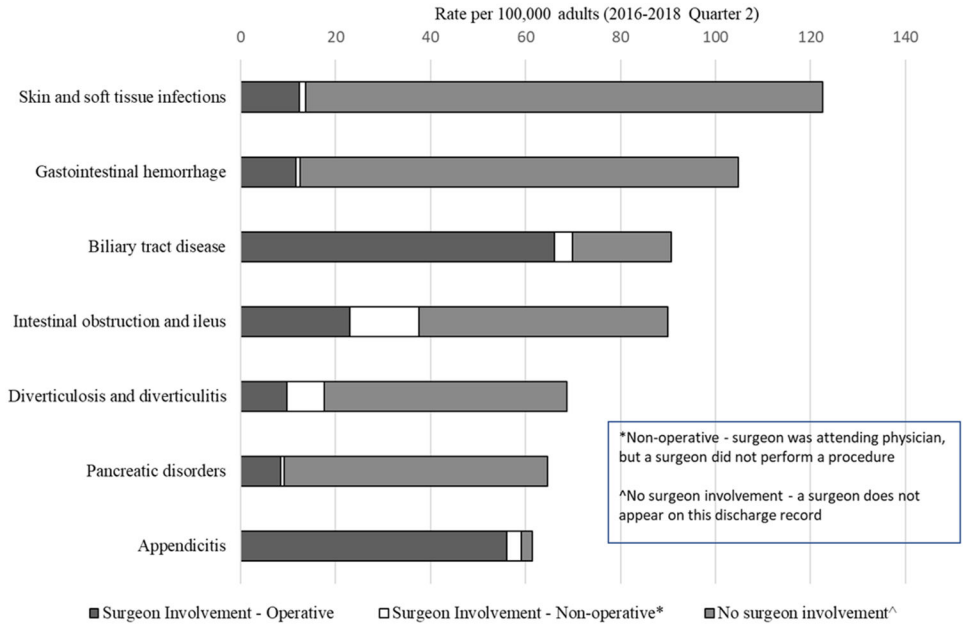

Figure 1.

Surgeon Involvement Among Patients with the Most Common ICD-10-CM Emergency General Surgery Diagnoses in Wisconsin

Table 1.

Demographic, Clinical, and Outcome Data for 5,876,001 Encounters in the National Inpatient Sample with an ICD-10-CM Emergency General Surgery Principal Diagnosis

	NIS Encounters[#] (n=5,876,001)
Age, years, mean (standard deviation)	59.7 (18.6)
Sex, n (%)	
Female	3,040,028 (51.7%)
Male	2,833,963 (48.2%)
Unknown	2,010 (0.0%)
Race and Ethnicity, n (%) [*]	
Black or African American	768,965 (13.1%)
White	3,924,662 (66.8%)
Hispanic	673,204 (11.5%)
Native Hawaiian or other Pacific islander, Asian, American Indian or Alaskan Native	168,680 (2.9%)
Other	155,215 (2.6%)
Unknown	185,275 (3.2%)
First payor identifier group, n (%)	
Medicare	2,828,858 (48.1%)
Medicaid	961,299 (16.4%)
Private insurance	1,558,069 (26.5%)
Self-pay	340,735 (5.8%)
No charge or other	178,890 (3.0%)
Unknown	8,150 (0.1%)
Duration of Stay,[†] days, mean (standard deviation)	4.7 (5.4)
Mortality during hospitalization, n (%)	
Did not die	5,792,186 (98.6%)
Died	79,575 (1.4%)
Unknown	4,240 (0.1%)
Charges, mean (standard deviation)	$45,746.65 ($68,793.63)
Cost,[Ω] mean (standard deviation)	$46,175.89 ($69,463.80)

Abbreviations: Emergency General Surgery (EGS); Emergency Department (ED); National Inpatient Sample (NIS)

[#]Percentages may not total 100% due to missingness in the NIS data

[*]NIS does not report race and ethnicity separately

[†]Among those discharged alive

[Ω]Costs adjusted to constant 2017 dollars

Table 2.

Demographics and Clinical Attributes of 94,903 Patients[#] at 123 Wisconsin Hospitals with ICD-10-CM Emergency General Surgery Diagnosis as the Principal Diagnosis Code

	Wisconsin Hospital Association Encounters		
	Total (n=94,903)	**ED→bservation[Ω] (n=19,025, 20.0%)**	**Inpatient (n=75,878, 80.0%)**
Age, years, mean (standard deviation)	60.9 (19.1)	53.3 (20.2)	62.8 (18.3)
Gender, n (%)			
Female	49,948 (52.6%)	10,511 (55.3%)	39,437 (52.0%)
Male	44,955 (47.4%)	8,514 (44.8%)	36,441 (48.0%)
Race, n (%) [*]			
Black or African American	7,575 (8.0%)	1,715 (9.0%)	5,860 (7.7%)
White	83,051 (87.5%)	66,812 (88.1%)	16,239 (85.4%)
Native Hawaiian or other Pacific islander, Asian, American Indian or Alaskan Native	2,474 (2.6%)	584 (3.1%)	1,890 (2.5%)
Not Reported	1,803 (1.9%)	487 (2.6%)	1,316 (1.7%)
Ethnicity, n (%) [*]			
Hispanic Origin	3,253 (3.4%)	909 (4.8%)	2,344 (3.1%)
Not Hispanic or Latino Origin	90,685 (95.6%)	17,936 (94.3%)	72,749 (95.9%)
Declined	575 (0.6%)	115 (0.6%)	460 (0.6%)
Unavailable	390 (0.4%)	65 (0.3%)	325 (0.4%)
First payor identifier group, n (%)			
Medicare	48,979 (51.6%)	6,826 (35.9%)	42,153 (55.6%)
Medical assistance/ BadgerCare and Other government	12,362 (13.0%)	3,145 (16.5%)	92,17 (12.2%)
Private insurance	30,832 (32.5%)	8,009 (42.1%)	22,823 (30.1%)
Self-pay	2,595 (2.7%)	1,012 (5.3%)	1,583 (2.1%)
Unknown or other	135 (0.1%)	33 (0.2%)	102 (0.1%)
Admission source/Point of origin, n (%)			
Non-health care facility	85,951 (90.6%)	67,990 (89.6%)	17,961 (94.4%)
Clinic or physician office	7,588 (8.0%)	6,668 (8.8%)	920 (4.8%)
Transfer from a skilled nursing facility, intermediate care facility, or assisted living facility	1,261 (1.3%)	1,136 (1.5%)	125 (0.7%)
Court/law enforcement	103 (0.1%)	84 (0.1%)	19 (0.1%)
Duration of Stay,[†] days, mean (standard deviation)	***	***	4.2 (4.3)
Mortality during hospitalization[>], n (%)	***	***	956 (1.3%)
Charges[^], mean (standard deviation)	$28,659.47 ($37,328.32)	$17,165.82 ($10,459.55)	$31,541.30 ($40,913.58)

Abbreviations: Emergency General Surgery (EGS); Emergency Department (ED)

[#]Includes only the first encounter in which a patient had an EGS diagnosis

[Ω]ED to observation admissions only

[*] Information only available for encounters beginning Q2 2016

[†] Duration of stay was not calculated for observation encounters due to substantial missingness (18,862 observations out of 19,025; 99.1%). For inpatient encounters, duration of stay was missing for 1,060 (1.4%) encounters.

[>] For mortality among ED to observation encounters, 5,071 observations out of 19,025 encounters (27%) had missing values. For mortality among inpatient encounters, there was one missing value.

[^] Cost data is not available in the WHA dataset

Note: Percentages presented are column percentages

Table 3.

Diagnoses of 94,903 Patients[#] at 123 Wisconsin Hospitals with ICD-10-CM Emergency General Surgery Diagnosis as the Principal Diagnosis Code

	Wisconsin Hospital Association Encounters		
EGS diagnoses groupings using HCUP CCSR headings, n (%)	**Total (n=94,903)**	**ED→bservation[*] (n=19,025, 20.0%)**	**Inpatient (n=75,878, 80.0%)**
Skin and subcutaneous tissue infections	13,771 (14.5%)	1,767 (9.3%)	12,004 (15.8%)
Gastrointestinal hemorrhage	11,776 (12.4%)	2,336 (12.3%)	9,440 (12.4%)
Biliary tract disease	10,187 (10.7%)	2,593 (13.6%)	7,594 (10%)
Intestinal obstruction and ileus	10,100 (10.6%)	769 (4.0%)	9,331 (12.3%)
Diverticulosis and diverticulitis	7,719 (8.1%)	697 (3.7%)	7,022 (9.3%)
Pancreatic disorders (excluding diabetes)	7,254 (7.6%)	547 (2.9%)	6,707 (8.8%)
Appendicitis and other appendiceal conditions	6,906 (7.3%)	3,624 (19.1%)	3,282 (4.3%)
Abdominal pain and other digestive/abdomen signs and symptoms	6,074 (6.4%)	4,100 (21.6%)	1,974 (2.6%)
Abdominal hernia	3,015 (3.2%)	462 (2.4%)	2,553 (3.4%)
Intestinal infection	2,799 (3.0%)	315 (1.7%)	2,484 (3.3%)
Peripheral and visceral vascular disease	1,684 (1.8%)	103 (0.5%)	1,581 (2.1%)
Gastrointestinal cancers - colorectal	1,300 (1.4%)	63 (0.3%)	1,237 (1.6%)
Regional enteritis and ulcerative colitis	1,216 (1.3%)	104 (0.6%)	1,112 (1.5%)
Muscle disorders	1,170 (1.2%)	185 (1.0%)	985 (1.3%)
Gastroduodenal ulcer	1,002 (1.1%)	161 (0.9%)	841 (1.1%)
Pneumothorax	984 (1.0%)	136 (0.7%)	848 (1.1%)
Anal and rectal conditions	917 (1.0%)	274 (1.4%)	643 (0.9%)
Postprocedural or postoperative digestive system complication	894 (0.9%)	154 (0.8%)	740 (1.0%)
Hemorrhoids	774 (0.8%)	146 (0.8%)	628 (0.8%)
Gastritis and duodenitis	711 (0.8%)	65 (0.3%)	646 (0.9%)
Other specified connective tissue disease	521 (0.6%)	66 (0.4%)	455 (0.6%)
Other specified and unspecified gastrointestinal disorders	449 (0.5%)	64 (0.3%)	385 (0.5%)
Pressure ulcer of skin	441 (0.5%)	34 (0.2%)	407 (0.5%)
Peritonitis and intra-abdominal abscess	424 (0.5%)	20 (0.1%)	404 (0.5%)
Hepatic failure	419 (0.4%)	28 (0.2%)	391 (0.5%)
Non-pressure ulcer of skin	263 (0.3%)	39 (0.2%)	224 (0.3%)
Other specified and unspecified disorders of stomach and duodenum	169 (0.2%)	14 (0.1%)	155 (0.2%)
Other aftercare encounter	95 (0.1%)	28 (0.2%)	67 (0.1%)
Postprocedural or postoperative respiratory system complication	85 (0.1%)	18 (0.1%)	67 (0.1%)
Acute phlebitis; thrombophlebitis and thromboembolism	81 (0.1%)	15 (0.1%)	66 (0.1%)
Nonmalignant breast conditions	59 (0.1%)	13 (0.1%)	46 (0.1%)

Abbreviations: Emergency General Surgery (EGS); Emergency Department (ED); Healthcare Cost and Utilization Project (HCUP) Clinical Classifications Software Refined (CCSR)

[#]Includes only the first encounter in which a patient had an EGS diagnosis

* ED to observation admissions only

Note:

-Percentages presented are column percentages

-Diagnoses with <=11 cell counts have been removed from the table and are listed below: Aortic and peripheral arterial embolism or thrombosis; Gastrointestinal and biliary perforation; Pleurisy, pleural effusion and pulmonary collapse; Gangrene; Aortic, peripheral, and visceral artery aneurysms; Shock; Gastrointestinal cancers- small intestine; Digestive congenital anomalies; Other specified and unspecified diseases of bladder and urethra; Septicemia; Malignant neuroendocrine tumors; Other specified female genital disorders; Other specified inflammatory condition of skin; Respiratory failure, insufficiency, arrest; Neoplasms of unspecified nature or uncertain behavior; Other specified and unspecified upper respiratory disease; Esophageal disorders; Endometriosis; Pericarditis and pericardial disease; Other specified and unspecified liver disease

Table 4.

Involvement of General Surgeons in the Care of 94,903 Patients[†] with ICD-10-CM Emergency General Surgery Diagnoses at 123 Wisconsin Hospitals

EGS Diagnosis Grouped by HCUP CCSR Category, n (%)	Patients with EGS Diagnosis, 94,903	Surgeon Involvement - Operative, 28,235 (29.8%)	Surgeon Involvement - Nonoperative, 5,052 (5.3%)	No Surgeon Involvement, 61,616 (64.9%)
Skin and subcutaneous tissue infection	13,771 (14.5%)	1,386 (10.1%)	145 (1.1%)	12,240 (88.9%)
Gastrointestinal hemorrhage	11,776 (12.4%)	1,311 (11.1%)	96 (0.8%)	10,369 (88.1%)
Biliary tract disease	10,187 (10.7%)	7,431 (73.0%)	419 (4.1%)	2,337 (22.9%)
Intestinal obstruction and ileus	10,100 (10.6%)	2,584 (25.6%)	1,632 (16.2%)	5,884 (58.3%)
Diverticulosis and diverticulitis	7,719 (8.1%)	1,094 (14.2%)	890 (11.5%)	5,735 (74.3%)
Pancreatic disorders (excluding diabetes)	7,254 (7.6%)	950 (13.1%)	81 (1.1%)	6,223 (85.8%)
Appendicitis and other appendiceal conditions	6,906 (7.3%)	6,297 (91.2%)	334 (4.8%)	275 (4.0%)
Abdominal pain and other digestive/abdomen signs and symptoms	6,074 (6.4%)	321 (5.3%)	364 (6.0%)	5,389 (88.7%)
Abdominal hernia	3,015 (3.2%)	2,243 (74.4%)	202 (6.7%)	570 (18.9%)
Intestinal infection	2,799 (2.9%)	58 (2.1%)	48 (1.7%)	2,693 (96.2%)
Peripheral and visceral vascular disease	1,684 (1.8%)	249 (14.8%)	40 (2.4%)	1,395 (82.8%)
Gastrointestinal cancers - colorectal	1,300 (1.4%)	746 (57.4%)	23 (1.8%)	531 (40.9%)
Regional enteritis and ulcerative colitis	1,216 (1.3%)	167 (13.7%)	89 (7.3%)	960 (79.0%)
Gastroduodenal ulcer	1,002 (1.1%)	443 (44.2%)	54 (5.4%)	505 (50.4%)
Pneumothorax	984 (1.0%)	335 (34%)	116 (11.8%)	533 (54.2%)
Anal and rectal conditions	917 (1.0%)	640 (69.8%)	26 (2.8%)	251 (27.4%)
Postprocedural or postoperative digestive system complication	894 (0.9%)	228 (25.5%)	174 (19.5%)	492 (55.0%)
Other specified connective tissue disease	521 (0.5%)	115 (22.1%)	23 (4.4%)	383 (73.5%)
Other specified and unspecified gastrointestinal disorders	449 (0.5%)	106 (23.6%)	47 (10.5%)	296 (65.9%)
Peritonitis and intra-abdominal abscess	424 (0.4%)	85 (20.1%)	107 (25.2%)	232 (54.7%)
Aortic and peripheral arterial embolism or thrombosis	395 (0.4%)	247 (62.5%)	31 (7.9%)	117 (29.6%)
Gastrointestinal and biliary perforation	257 (0.3%)	173 (67.3%)	21 (8.2%)	63 (24.5%)

Abbreviations: Emergency General Surgery (EGS); Healthcare Cost and Utilization Project (HCUP) Clinical Classifications Software Refined (CCSR)

[†]Includes only the first encounter in which a patient had an EGS diagnosis

Note:

-Percentages presented are row percentages

-Diagnoses with <=11 cell counts have been removed from the table and are listed below: Muscle disorders; Hemorrhoids; Gastritis and duodenitis; Hepatic failure; Pressure ulcer of skin; Non-pressure ulcer of skin; Pleurisy, pleural effusion and pulmonary collapse; Gangrene; Aortic, peripheral, and visceral artery aneurysms; Other aftercare encounter; Shock; Postprocedural or postoperative respiratory system complication; Acute phlebitis; thrombophlebitis and thromboembolism; Gastrointestinal cancers – small intestine; Digestive congenital anomalies; Nonmalignant breast conditions; Other specified and unspecified diseases of bladder and urethra; Septicemia; Malignant neuroendocrine tumors; Other specified female genital disorders; Other specified inflammatory condition of skin; Respiratory failure, insufficiency, arrest; Neoplasms of unspecified nature or uncertain behavior; Other specified and unspecified upper respiratory disease; Esophageal disorders; Endometriosis; Pericarditis and pericardial disease; Other specified and unspecified liver disease