Interhospital transfer (IHT) in emergency general surgery patients (EGS): A scoping review

Ryan D Emanuelson, MD a,1, Sarah J Brown, MSc b, Paula M Termuhlen, MD, FACS c,*

a University of Minnesota Medical School, Duluth Campus, 1035 University Dr, Duluth, MN 55812
b University of Minnesota Health Science Library, Phillips-Wangensteen Bldg 516 Delaware St SE, Minneapolis, MN 55455
c Western Michigan University Homer Stryker M.D. School of Medicine, 1000 Oakland Dr, Kalamazoo, MI 49008

ABSTRACT

Background/Aims of study: Interhospital transfer of emergency general surgery patients continues to rise, and no system for transfer of emergency general surgery patients exists. This has major implications for cost of care and patient experience. We performed a scoping review to understand outcomes related to transfer and the associated factors and to identify any opportunities for improvement.

Methods: Studies involving emergency general surgery patients with interhospital transfer were identified by searching OVID MEDLINE, EMBASE, Cochrane Library, and Scopus. There were 1,785 records identified. After duplicates were removed, there were 1,303 articles screened in the initial phase. Fifty-eight articles were included in the second phase. Eventually, 21 articles were included in the review. Thirty-seven articles were removed during the full-text screening phase due to the following: wrong publication type (2), wrong population (8), abstract (11), outside the United States (3), and wrong study design (6).

Results: Transferred patients had a higher mortality rate, were older, were more likely to be male and to undergo reoperation, and had higher resource utilization compared to patients who were not transferred. All emergency general surgery patients had a high burden of chronic disease. Unnecessary transfer, typically defined by lack of intervention and discharge within 72 hours, was reported to be 8.8% to 19%.

Conclusion: Emergency general surgery patients have a high rate of comorbidities. Limited physiologic status information prior to patient transfer limits understanding of the necessity for transfer. Areas for improvement include assigning a physiologic status for all patients and utilizing telehealth. More detailed information needs to be captured to determine the appropriateness of transfer.

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INTRODUCTION

Emergency general surgery (EGS) is a common health occurrence that impacts an estimated 2 million patients or about 7% of hospital admissions in the United States annually [1–4]. The most common EGS procedures include partial colectomy, small bowel resection, cholecystectomy, operative management of peptic ulcer disease, lysis of peritoneal adhesions, appendectomy, and exploratory laparoscopy/laparotomy [5]. Despite the increased cost of care and complication in EGS patients, the rate of interhospital transfers has increased in recent years [2,6,7].

The increase in transfers has occurred despite previous research showing similar outcomes in procedures that are typically within the skill set of most general surgeons, especially when comparing rural versus urban settings [8,9]. The increase in EGS patient transfers is likely due to a multitude of factors, one of which may include lack of access to a general surgeon. The number of surgeons willing to cover emergency surgery has decreased, whereas the number of surgeons who have specialized has increased [10,11]. This problem is exacerbated by the unequal distribution of surgeons. Roughly 30% of counties in the United States with a total population of 9.8 million people do not have a surgeon, whereas the national average is about 45 surgeons per 100,000 people [12–14].

The American College of Surgeons (ACS) has a well-developed pathway for transfer when it comes to trauma patients, but it does not have any specific guidelines in place for EGS [6,8,15] in part because of the increased complexity associated with EGS. Patients who present with acute surgical conditions can be urgent or emergent, both of which require significant resource allocation. The decision to transfer is difficult.
and can include many factors including local surgeon skill set and the ability of the hospital to manage acutely ill patients. Other factors including comorbid conditions may increase the need for higher level of care, which again may or may not be available at a local hospital. There are significant risks related to transfer including delay of care, risk of transportation, potential for clinical deterioration, potential for poor handoff communication, and neglected patient preferences [2,16–19,20].

The 7 most common EGS procedures, as reported above, do not have a consistent or cohesive transfer protocol for patients who require these procedures or who have the diagnoses that lead to these operations. Given the increasing number of patients who require emergency surgery that could be done by general surgeons, without clear protocols in place, we sought to understand the key characteristics of these patients and their outcomes depending on transfer status available in the current literature. In addition, we sought to identify factors that may have driven the decision for transfer.

METHODS

Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (Fig 1) guidelines were followed to conduct the review and analysis [21]. A protocol was developed and registered with the Open Science Framework at https://osf.io/7g4uf/.

Search Strategy. A medical librarian (SJB) created the literature search strategy after meeting with the research team to clarify goals and further define selection criteria. The search strategy was built and tested for sensitivity in Ovid MEDLINE using Medical Subject Headings (MeSH) and keywords (see Appendix 3), and the search strategy was translated to 3 other databases: Cochrane, EMBASE, and Scopus. Reference lists of included studies were also reviewed for relevant articles. Searches were run without limits from database inception through June 2, 2021.

Study Selection. Studies were included if they met the following criteria: (1) patients transferred with emergency general surgery; (2) articles with an observational study design; (3) included information about intervention or lack of intervention following transfer; and (4) studies in the United States.

Studies were excluded for the following reasons: (1) patients transferred with traumatic surgical emergencies; (2) patients transferred for surgical procedures that were elective; (3) studies outside the United States; (4) publications that were systematic reviews or other type of review; (5) studies with EGS patients who were not transferred; (6) randomized control study design; (7) vascular surgery and GI bleed; and (8) studies with only pediatric patients.

Duplicate references were removed, and items were uploaded to Rayyan [22] for blinded and independent assessment of eligibility by 2 researchers (RE and PMT). After the initial title and abstract screening, conflicts were resolved by consensus. When researchers could not reach consensus, titles were included in the full-text screening. PDFs of 49 selected studies were uploaded for full-text screening and independently reviewed by RE and PMT. The consensus model was again used to resolve conflicts in the full-text screening phase. Near the end of the project, research reviewed included references to check for any additional articles that met inclusion criteria. Again, both researchers

![PRISMA 2009 Flow Diagram](image-url)
came to a consensus when determining which articles should be included. This process added another 9 articles (Fig. 1).

Data Extraction and Analysis. Twenty-eight articles were included in the final analysis (Table 1). A data extraction form was created and tested by 2 researchers (RE and PMT). Prior to data extraction, pilot testing of the form with 2 articles was conducted to highlight inconsistencies, and modifications to the form were made by consensus. The data extraction form was built using Qualtrics software version June 2021 (Qualtrics, Provo, UT).

Method for Data Analysis. Data were manually extracted and uploaded into an Excel spreadsheet by 2 researchers (RE and PMT), allowing for us to carry out the extraction phase. The same 2 researchers (RE and PMT) individually reviewed data and highlighted common themes in the extracted data. Specifically, we looked at important data markers like age mortality, comorbidities, and insurance status. The data were gathered in an Excel spreadsheet, which allowed the authors to assess the information to perform a narrative synthesis. Both researchers then came to a consensus on the most common and important findings in the data.

RESULTS

All publications reviewed were cohort studies using either a locally created health care system database (n = 8) or one of the publicly available databases: National Inpatient Sample [NIS] = 6; ACS National Surgical Quality Improvement Program [NSQIP] = 6; and National Emergency Department Sample [NEDS] = 1) that have been created to examine patient quality and characteristics at a national level (Appendix 2). The most common diagnoses of patients included the following: appendicitis, gallbladder pathology, small bowel obstruction, diverticular disease, ischemic colitis, and general abdominal conditions. In reviewing the final 21 publications related to emergency general surgery patients, we were able to assess the following elements of the patient cohorts:

30-Day Mortality. Fourteen articles studied mortality. The results showed varying mortality rates as different conditions have higher rates of mortality regardless of transfer such as necrotizing fasciitis. Studies that reported broad EGS conditions had mortality rates that ranged from 2.3% to 12.6% in patients who were transferred from emergency department (ED) or outside hospitals (nursing home transfers were even higher, up to 24.7%). In the same studies, the mortality rate in local admits/patients who were not transferred ranged from 0.4% to 3.1%. Three studies investigating just 1 condition (2 studies on necrotizing fasciitis and 1 study on emergent colorectal surgery) had mortality rates ranging from 19.4% (ED) to 25.7% (inpatient transfer [IPT]) to 34.3% nonhospital transfer (NHT) in colorectal surgery group and 8.9% to 15.5% in necrotizing fasciitis patients. In the same studies, the mortality rate was 12.9% in nontransfer of the colorectal study and 17.5% in patients with necrotizing fasciitis. Overall, the rate of patient transfer increased from 1.2% to 3% over a 10-year period, whereas mortality decreased by 40%2 (Table 2).

Age and Sex. Age: Nineteen articles reported median age in EGS patients. The median age of EGS patients who were transferred ranged from 47 to 78.1 years. The median age of patients in the local admit group ranged from 44 to 59 years (Appendix 2).

Sex: Seventeen articles included sex in the EGS cohort. The percent of patients who were male in the transferred group ranged from 48% to 57%. The percent of local admissions that were male ranged from 42.3% to 50.9% (Appendix 2).

Socioeconomic Status and Insurance Status. Socioeconomic status: Five articles exploring EGS patients reported socioeconomic status. The makeup of the transfer population included 28.8%–34.6% in the lowest quartile, 25.6%–31.5% in the second quartile, 20.2%–22.5% in the third quartile, and 13.6%–21.2% in the highest quartile. The makeup of the local admission population included 27.4%–28.1% in the lowest quartile, 25.6%–25.8% in the second quartile, 23.9%–24.6% in the third quartile, and 19.9%–22.2% in the highest quartile.

Table 1

| Name | Author, year | Journal |
|------|--------------|---------|
| 1 Unnecessary transfers for acute surgical care: who and why? | Kummerow Broman, K; 2016 [29] | The American Surgeon |
| 2 Factors associated with inter-hospital transfer of emergency general surgery patients | Ingraham, A; 2019 [44] | The Journal of Surgical Research |
| 3 Cost and burden and mortality of rural emergency general surgery transfer patients | Keeven, D; 2019 [8] | The Journal of Surgical Research |
| 4 Transfer of acute care surgery patients in a rural state: a concerning trend | Misercolla, B; 2016 [17] | The Journal of Surgical Research |
| 5 Emergency general surgery transfers in the United States: a 10-year analysis | Reinke, C; 2017 [2] | The Journal of Surgical Research |
| 6 Interhospital transfers of acute care surgery patients: should care for nontraumatic surgical emergencies be regionalized? | Santry, H; 2011 [45] | World Journal of Surgery |
| 7 Acuity, outcomes, and trends in the transfer of surgical patients: a national study | Huntington, C; 2015 [7] | Surgical Endoscopy |
| 8 Transferred emergency general surgery patients are at increased risk of death: a NSQIP propensity score matched analysis | Castillo-Angeles, M; 2019 [46] | Journal of the American College of Surgeons |
| 9 High-volume hospitals are associated with lower mortality among high-risk emergency general surgery patients | Ogola, G; 2018 [30] | The Journal of Trauma and Acute Care Surgery |
| 10 Interhospital transfer for acute surgical care: does delay matter? | Kummerow Broman, K; 2016 [28] | American Journal of Surgery |
| 11 Interhospital transfer for emergency general: an independent predictor of mortality | Velerton, S; 2018 [47] | American Journal of Surgery |
| 12 Triaging to a regional acute care surgery center: distance is critical | Diaz, Jose J; 2011 [48] | The Journal of Trauma |
| 13 Factors associated with interhospital transfers of emergency general surgery patients from emergency departments | Fernandes-Taylor, 2021 [49] | American Journal of Emergency Medicine |
| 14 An evaluation of emergency general surgery transfers and a call for standardization of practices | Brueunderman, 2021 [43] | Surgery |
| 15 Elevation of mortality and resource utilization in emergency general surgery transfer patients | Keeven, D; 2019 [50] | Journal of Trauma Acute Care Surgery |
| 16 Characteristics and timing of interhospital transfers of emergency general surgery patients | Philip, J; 2018 [51] | Journal of Surgical Research |
| 17 Interhospital transfer and adverse outcomes after general surgery: implications for pay for performance | Lucas, D; 2014 [6] | Journal of the American College of Surgeons |
| 18 Transfer status: a significant risk factor for mortality in emergency general surgery patients requiring colon resection | DeWane, M; 2018 [52] | Trauma and Acute Care Surgery |
| 19 Transfer status: a risk factor for mortality in patients with necrotizing fasciitis | Holena, D; 2011 [53] | Surgery |
| 20 Effect of transfer status on outcomes for necrotizing soft tissue infections | Ingraham, A; 2017 [54] | Journal of Surgical Research |
| 21 Effect of transfer status on outcomes of emergency general surgery patients | Philipj; 2020 [39] | Surgery |
Insurance status: Fourteen articles reported insurance status. The results varied by study design and population. The percent of patients who were transferred and had private insurance was 5%–47.5%; Medicare, 38.8%–82.3%; Medicaid, 5.3%–29%; uninsured/self-pay, 1.8%–9%; and other, 2%–10.6%. The percent of patients who were not transferred and had private insurance was 29.3%–45%; Medicare, 34%–47.5%; Medicaid, 8%–28%; uninsured/self-pay, 6%–9.6%; and other, 3.2%–13.3% (Table 3).

Unnecessary transfer. Three studies on EGS patients reported unnecessary transfer, which is typically defined as discharge without any procedure within 72 hours. In the 3 studies that included this outcome, unnecessary transfers were reported at 8.8%, 15.6%, and 18%.

Comorbidities. Thirteen articles reported comorbidities. Comorbidity scores were difficult to calculate or assess based on lack of information and different scoring systems which prevented comparison. Additionally, different studies focused on different comorbidities, making it difficult to report/compare comorbidities between studies. In the 13 studies with available information, the percent of patients who were transferred and had diabetes was 13%–47.7%; hypertension, 42.3%–82%; congestive heart failure, 2.5%–24.3%; renal failure, 3.8%–11%; chronic obstructive pulmonary disease, 9.2%–25.2%; and history of tobacco use, 20%–52%. The percent of patients who were not transferred and had diabetes was 7.7%–50%; hypertension, 26.3%–70%; congestive heart failure, 0.6%–18%; renal failure 0.9%–16%; chronic obstructive pulmonary disease, 3.1%–12%; and history of tobacco use, 10%–36%. We could not report specific comorbidity score because of limited data.

Outcomes: Length of Stay (LOS), Intervention, Reoperation, and Cost. LOS: Fifteen articles reported LOS. Patients who were transferred had a median LOS that ranged from 4 to 14.4 days. Patients who were admitted locally had a median LOS that ranged from 2 to 5.8 days (Appendix 2).

Intervention: Eleven articles reported an intervention. Some studies reported operations only, and others included other procedural interventions such as endoscopic procedures. Patients who required intervention after transfer ranged from 15% to 64% in the EGS population. Some of the most common interventions that were reported included the following standard operations such as laparoscopic appendectomy, cholecystectomy, hernia repair, colectomy, sigmoidectomy, small bowel resection, lysis of adhesions, wound debridement, ruptured abdominal aortic aneurysm repair, and endoscopic interventions.

Reoperation: Six EGS articles reported reoperation. EGS patients who were transferred that required reoperation ranged from 9.1% to 55%. EGS Patients who were not transferred that required reoperation ranged from 3.4% to 5% (Appendix 2).
In all 3 of these articles, the cohort that was transferred had a higher cost of patients transferred to the cost of patients who were not transferred. In all 3 of these articles, the cohort that was transferred had a higher cost than the cohort that was not transferred (Appendix 2).

**DISCUSSION**

Several key themes emerged from this review. These studies validated the observation that more patients with EGS diagnoses are being transferred to larger centers with the availability of specialized care. The studies noted that patients who are transferred have higher mortality and an increased number of complications. Patients who transferred were also found to have higher resource utilization as noted by LOS and cost. All studies that reported and compared cost (5) and LOS (13) between transferred and direct admit patients showed higher overall cost and longer LOS in the transferred patient cohort. Patients who are transferred with EGS diagnoses were older and transferred for a variety of reasons such as escalating the level of care for the acute problem, associated comorbidities, or a lack of available expertise at the local level. Given the lack of formal regionalization for these types of patients, many of the articles concluded that a standardized approach to transfer is necessary. In addition to trauma, protocol-based transfer in vascular surgery has been studied and demonstrated a safe and efficient transfer system [23]. EGS transfer system can use both the skeleton of the trauma and vascular system to help develop a protocol that appropriately handles the uniqueness of EGS patients. In addition, 30-day mortality, insurance status, comorbidities, and a determination of the need for transfer were able to be evaluated across the studies.

**30-Day Mortality.** Unsurprisingly, we found that EGS patients who were transferred had a higher rate of mortality when compared to EGS patients who did not transfer. All studies that compared mortality between patients who transferred versus those who did not showed an increase in mortality in transferred patients. Most studies showed a higher mortality rate in EGS transfer patients (ranging from 2.3% to 7.5%) than the general rate of mortality of all EGS surgery including urgent 2.3%, emergent 3.7%, and elective 0.4%, respectively [24].

EGS patients are facing a serious illness regardless of their baseline status, and those who are transferred are among the most acutely ill as demonstrated by the high percentage of patients with serious chronic illnesses. In general, greater than 10% of EGS transfer patients require care in the ICU [25,26] during their hospitalization, something small/ rural hospitals may not have. Small and critical access hospitals can provide quality surgical care, but if they do not have the requisite resources in place to adequately manage complicated postoperative patients, such as patients who require invasive monitoring after surgery [27], they will struggle to adequately provide care. Patients who are transferred and end up in the ICU at the referring hospital likely contribute to the observed increased mortality. Patients with a higher chronic disease burden have higher mortality, and high-risk patients are more likely to die regardless of whether they are transferred.

There are many reasons that necessitate transfer including the presence of comorbidities, escalation of care, patient preference, and previous relationship between patient and accepting surgeon. The most common reported reasons for patient transfer included requirement of a higher level of care and continuity of care with a surgeon who had been previously involved in the care, whereas patient/family requests contribute to a small percentage of patients who are transferred [28,29]. Transfer because of a need for a higher level of care is a broad category and does not give us significant information on the patient status. Additionally, it depends on providers giving a reason for transfer. This is important to understand as communication between hospitals plays an important role in patient transfer. There are times in which the initial accepting surgeon is not the same surgeon on service when the patient finally gets transferred to the new facility [7]. In our review, a comprehensive understanding of the specific reasons for transfer was not able to be captured.

Whereas mortality rates remain elevated in patients requiring transfer, overall mortality has decreased over time. Huntington et al compared outcomes following transfers during 2 different time periods (2005–2008 and 2009–2012), and the later time period showed a decrease in mortality and major complications, indicating that outcomes following transfer have improved. The study also reported that transfer patients in the second period of time had a lower Charlson Comorbidity Index score, suggesting a possible lower threshold to transfer [7].

Surgeons working at community or rural hospitals may refer patients because they feel they are not able to adequately care for the patient, either because the issue is outside their scope of practice or because they do not have adequate resources to properly manage the patient (ICU beds, nursing staff, etc). Conversely, accepting surgeons at tertiary facilities typically accept all patient transfers upon request [18]. The current pathway to transfer is not well defined, and as discussed below, some patients are transferred and never undergo an intervention.

When transfers happen, they typically occur for a reason and patients may have better outcomes upon transfer. One study included in the review noted that high-risk patients/procedures, defined as a risk above 4%, had better outcomes when the procedure was done at a high-volume center [30]. This would support high-risk patients transferring to tertiary centers. There is a fine line when trying to determine who should transfer versus who can stay at their presenting hospital. A standardized approach to EGS patients can help decide who would likely benefit to transfer and who can receive care at their original facility.

**Unnecessary Transfer.** With the increase in EGS patients who are transferred, there has also been an increase in patients who undergo unnecessary transfer, defined as discharge within 3 days without an intervention [29]. This ranged from about 10% to 20% in the articles included in the study. Even at the low end, there is significant room for improvement. The most common outcome for a transferred patient was no intervention. That is not to say patients who were transferred and did not undergo an operation were inappropriately transferred. Escalation of care may be due to higher level of care outside the operating room or for management of comorbid conditions that are exacerbated by having an EGS diagnoses.

In patients who did require an intervention, most procedures were within the scope of a general surgeon, such as cholecystectomy, wound debridement, lysis of adhesions, small bowel resection, colectomy, and appendectomy. This finding may suggest lack of access to basic surgical care [17]. Current general surgery residency graduation requirements include competence in each of the mentioned procedures, implying that general surgeons should be able to operate on the majority of EGS diagnoses [31]. Previous studies have reported that residents of rural areas, individuals who are historically underrepresented by race, and the socioeconomically disadvantaged are at high risk of living in an EGS desert with little or no access to EGS care [1]. More recently, research has shown that up to 25% of patient transfers were potentially avoidable and that hospital-related factors were more likely to account for potentially avoidable transferred compared to patient-related factors [32,33]. Using this information is a starting point when trying to adapt a better transfer system. Importantly, patients undergoing an unnecessary transfer can negatively impact the availability of beds, leading to a delay in patient care, and may also unnecessarily increase the number of resources necessary to treat the problem.

However, one of the most important limitations in each study and thus in this review is the lack of information regarding what led to the decision for transfer. In other words, was a general surgeon unavailable or did the hospital lack personnel to provide care? Was a surgeon consulted prior to transfer? Who made the final decision to transfer the patient? What was the physiologic status of the patient? Lastly,
we were unable to ascertain what percent of patients had transfers due to patient or family request.

Comorbidities in the Transfer Population. Both groups of patients appear to have high levels of comorbidities such as diabetes and cardiopulmonary diagnoses. However, there was limited use of acuity scores, and when used, different scoring systems created a challenge in comparing the groups. In addition, the lack of access to pretransfer records in all studies makes it difficult to determine if comorbidities in individual patients contributed directly to the transfer decision. Transfer of a patient adds to the complexity in caring for the patient.

Although we do not understand the actual reasons for transfer, chronic illness burden underlying acute surgical illness often mandates a multidisciplinary approach that transcends the availability of a qualified surgeon. The high levels of chronically ill patients in both groups was an unsurprising find as the majority of all hospitalized patients have at least 1 comorbidity [28,29].

Insurance Status Among the Cohorts. Insurance status, specifically whether a patient has health insurance, is important as patients who are uninsured or Medicaid beneficiaries are more likely to be transferred than admitted to hospital [34]. Insurance does not appear to play a role in the transfer decision, and only small percent of patients, regardless if transferred or not, did not have insurance. Fifteen articles using the NIS, NSQIP, and data from their own health care system demonstrate no difference in the patient cohorts. Decreased uninsured rates are significant because the reduction of the uninsured rate leads to patients presenting earlier in the course of their surgical emergency [35]. Another interesting finding was that, in transferred patients, the most common insurance was Medicare. Older patients tend to have chronic diseases which can make acute conditions worse. This has implications for rural general surgery care as the rural population tends to be older (more likely to be on Medicare) and less healthy. Rural patients are at an increased likelihood of requiring advanced surgical care (increased age and sicker baseline health), which coupled with the scarcity or rather unequal distribution of general surgeons puts patients with decreased access to appropriate care [36]. This is consistent with previous research as it has shown that EGS patients who live in rural communities are more likely to live without appropriate access to EGS care [1]. It should be noted that in most instances, these studies took place across the timeframe for the implementation of the Accountable Care Act, perhaps limiting the impact of insurance status on the transfer decision.

Lack of Physiologic Status Information Prior to Transfer. The most commonly reported study limitation was lack of access to the physiologic status of patients throughout their illness. Many of the articles used nationwide databases like ACS NSQIP or NIS. Although these resources are helpful to grasp a high-level view of patient cohorts and disease categories, they lack the granularity required to help understand the experience at the local level. These databases contain information such as inpatient utilization, access, charges, quality, and outcomes. Patient outcomes have improved since the introduction and widespread use of NSQIP, although using these databases alone will not achieve improvement in surgical quality [37,38]. Access to physiologic data can give researchers more data to help create a standardized EGS transfer pathway.

The lack of sharing of information between various electronic health record platforms inhibits the ability to capture the status of patients prior to transfer in databases. Assessing the acuity of surgical illness in the setting of chronic disease is likely to have led to many transfer decisions. However, this is just conjecture because none of the studies were able to obtain accurate and complete pretransfer information even when desired.

Collaboration between key stakeholders is needed to obtain physiologic and decision-making information across the transfer space with shared electronic health record information. Ultimately, a standardized pathway can improve patient outcomes as it can help us better allocate resources to care for EGS patients while cutting down on the number of unnecessary transfers. Determining which risk factors are associated with worse outcomes can help inform decision-making ability on which patients will benefit from transfer and how to improve resource allocation and appropriate level of care [39].

To develop a standard pathway, a better understanding of patient status/reason for transfer is needed. Commonly used comorbidity scores such as Charlson Comorbidity Index and Elixhauser scores take disease burden into account. An issue with these scoring systems is they focus on conditions patients have at baseline rather than physiologic status during their acute event [40]. Acute Physiology and Chronic Health Evaluation II is another acuity scoring system but is typically used in ICU care, making it less useful in EGS care [41]. Adding physiologic status to the database, such as vitals, pertinent laboratory test results, imaging findings, and physical examination findings could help develop a scoring system that would give surgeons another tool in determining who should transfer. In clinical practice, more consistent use of the Emergency Surgery Score, a scoring system that has been shown to accurately predict mortality in patients undergoing emergency surgery in multiple surgical specialties, could help predict which patients may need to transfer [42]. Regardless, it would be helpful to have physiologic information in large databases to help further understand trends.

Solutions. A more coordinated regionalized response could better allocate resources and efficiently manage patients as close to home as possible. Another obvious solution is the increased use of telehealth to support care closer to home or assess need for transfer. This has significantly increased in the time of COVID-19 pandemic, and its use will likely stay at a higher rate than prior to the pandemic. Although not the same, a study looking at vascular patients reported that a third of cases in which a transfer request was made did not end up in transfer. This most common reason patients stayed occurred because of reassurance from consulted vascular surgeon. A similar collaboration model could be used with EGS patients. If the goal is to get the right treatment to the right patient at the right time, communication and support between surgeons at referring and accepting centers are vital. Often, many hospital systems do not communicate well with each other. At least 1 group of investigators has recently published an article that was able to capture information such as availability of an on-call surgeon, hospital capacity, patient request, patient status, availability of appropriate diagnostic and treatment testing, and specialist availability as dimensions of the transfer decision.

Limitations Across Studies. We recognize the key limitation of our study, and those that we evaluated question how much of a true difference exists between patients who are transferred and patients who are not transferred. Patients in the different groups were similar based on demographics. Physiologic status was unable to be assessed in any of the studies in our review. We recognize that chronic illness burden underlying acute surgical illness is not just about the surgeon and the operation but also other providers, health care workers, and institutions that provide the highest level of care. What drives the decision to transfer? It remains unclear (Appendix 2).

In conclusion, patients who are transferred for EGS are older and have a high burden of chronic illness. A major limitation to understanding the decision for transfer is the limited ability to obtain pretransfer information about physiologic status and care prior to transfer. With the lack of data sets and no national registry for EGS patients, management is variable, and there is a need for a national EGS data registry that include patients who were operatively or nonoperatively managed and transferred or nontransferred, through which research and national QA initiatives could be developed consistently. This type of information deserves further investigation and understanding of pretransfer environment as well as patient status and hospital access to specialty care. Having accurate patient information that is shared across electronic
health platforms and across patient care settings will facilitate better understanding of what leads to the transfer decision. We hope that this will improve patient outcomes and facilitate the development of transfer protocols for the EGS patient [43].

Author Contribution

Ryan D. Emanuelson: conceptualization, data curation, formal analysis, writing of the original draft, and review and editing.
Sarah Jane Brown: methodology (search strategy and protocol), writing of the methods section, and review and editing.
Paula M. Termuhlen: conceptualization, data curation, formal analysis, review and editing, supervision.

Appendix 1. Shows limitations and conclusions that were reported by the authors of each article

| Limitations | Conclusions |
|-------------|-------------|
| Regional study. The definition of clinically unnecessary was based on consensus among authors who were intentionally conservative in the definition. Unable to capture data on patients who were transferred but not admitted. | About 20% of EGS are unnecessary. All stakeholders can benefit from transfer guidelines. |
| Time spent at the referring hospital or emergency department (ED) was not documented for all patients. | Hospital-level characteristics better predict need for transfer than patient-related factors. |
| Absence of physiologic status and physiologic data. | NIS does not include physiologic data. Hospital-level characteristics better predict need for transfer than patient-related factors. |
| Time spent at the referring hospital or emergency department (ED) was not documented for all patients. | NIS does not include physiologic data. Hospital-level characteristics better predict need for transfer than patient-related factors. |
| Inability to analyze all patients cared for in the referral centers without a transfer, by time spent at the referring hospital or emergency department (ED) was not documented for all patients. | NIS does not include physiologic data. Hospital-level characteristics better predict need for transfer than patient-related factors. |
| Inability to analyze all patients cared for in the referral centers without a transfer, by time spent at the referring hospital or emergency department (ED) was not documented for all patients. | NIS does not include physiologic data. Hospital-level characteristics better predict need for transfer than patient-related factors. |
| NEDS is a population-level data set and is not validated to address specific conclusions or recommendations. | NEDS is a population-level data set and is not validated to address specific conclusions or recommendations. |
| Interhospital transfer in the EGS patient population increases the odds of mortality and is more costly than direct admissions, even after controlling for multiple other contributing factors. | NEDS is a population-level data set and is not validated to address specific conclusions or recommendations. |
| Age, severity of illness, and distance from a regional referral center explain much of the variation in mortality and can be used for triage to regional EGS centers. | NEDS is a population-level data set and is not validated to address specific conclusions or recommendations. |
| Medical complexity and older patients who present at small, rural hospitals are more likely to be transferred. Future research on the unique needs of rural hospitals and timely transfer of EGS patients who require specialty surgical care have the potential to significantly improve outcomes and reduce costs. | NEDS is a population-level data set and is not validated to address specific conclusions or recommendations. |

Conflict of Interest

None of the authors have any conflict of interest.

Funding Source

This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Approval

Study exempt from required IRB review due to type of study.

(continued on next page)
Appendix 1. (continued)

| Limitations | Conclusions |
|-------------|-------------|
| 15. Time spent in the referring hospitals is not measured, so it is not possible to know if definitive care was truly delayed. | Emergency general surgery patients who are transferred have significantly higher mortality, morbidity, and resource utilization. The type of transferring setting (EDT, IPT, and NHT) also makes a difference. With the progression to a more regionalized health care system, value will be achieved by improving outcomes while lowering costs. Referral centers must be prepared to assume outcome and financial risk as they receive EGS patients. |
| 16. Single academic medical center, potentially limiting the generalizability of our results. Study did not include patients who were initially transferred to medical services who subsequently consulted or ultimately transferred the patient to the EGS service. | Study documented the provision of care to patients with a range of EGS diagnoses transferred to a tertiary medical center, including specifics regarding the characteristics of and the care provided at the referring facility as well as details regarding the timing of transfers. A need for general surgery or specialty services and a need for a higher level of care were found to be major contributors to interhospital transfers for EGS conditions. At the same time, approximately one third of the patients transferred to the center did not undergo a procedure following transfer. The incidence of interhospital transfer in surgery is high. Transferred patients have worse outcomes than nonelective direct admissions. However, this difference is largely due to confounding by patient factors, as sophisticated adjustment techniques nearly equalized the risk for adverse outcomes. The type of transferring institution has a significant impact on postoperative risk adjusted morbidity and mortality after emergent colon surgery, with patients originating at outside hospital wards and/or nursing home/chronic care facilities demonstrating the worst postoperative outcomes. In patients undergoing surgical intervention for necrotizing fasciitis, interhospital transfer is associated with increased mortality compared to patients undergoing definitive management at the presenting hospital. |

Appendix 2. Large table with key data extracted from each article

| Author, date | Setting | Participants (#) | Length (y) | Ave age (y) T/NT | % Male T/NT | Database | Cost ($) | LOS (d) T/NT | Intervention (%) | Reoperation (%) |
|--------------|---------|------------------|------------|------------------|-------------|----------|----------|-------------|-----------------|----------------|
| 1 Kummerow-Broman 2016 | U | 21,77 | 5 | 57 | 53 | HCS | 1 | | | |
| 2 Ingraham, 2018 | U | 17,236,701 | 6 | 61.6/58.8 LA: 52; EDT: 58; IPT: 62 | 50.1/46 LA: 49; EDT: 50; IPT: 48 | HCS | 1 | | | |
| 3 Keener, 2018 | U | 663 | 2 | 61.2/54.7 | 49 | HCS | 1 | | | |
| 4 Miscewola, 2016 | U | 772 | 1 | 60 | 49 | HCS | 1 | | | |
| 5 Reiner, 2017 | U | 525,913 | 10 | 60 | 49 | HCS | 1 | | | |
| 6 Santrey, 2011 | CH | 319 | 3.08 | 59.2/55 | 53.4/50.9 | HCS | 1 | | | |
| 7 Huntington, 2015 | CH | 1,474,531 | 8 | 59.5/57.8 | 52/43.3 | HCS | 1 | | | |
| 8 Castillo-Angeles, 2019 | MC | 222,519 | 10 | 55.5/44 | 48/48.7 | HCS | 1 | | | |
| 9 Ogola, 2018 | MC | 3,006,615 | 1 | 78.1/59 | 49/46 | HCS | 1 | | | |
| 10 Kummerow Broman, 2016 | U | 2091 | 5 | 57 | 53 | HCS | 1 | | | |
| 11 Yelverton, 2018 | CH | 25,021,217 | 10 | 60/58 | 49/46 | HCS | 1 | | | |
| 12 Diaz, 2010 | U | 3,439 | 4.75 | 47 | Survivors: $25,612; not survivors: $161,653 | 4.4/3 | Broad: 21; narrow: 33; any procedure: 45% | 15 | | |
# Appendix 2

| Author, date       | Setting | Participants (#) | Length (y) | Ave age (y) T/NT | % Male T/NT | Database | Cost ($) T/NT | LOS (d) T/NT | Intervention (%) | Reoperation (%) |
|-------------------|---------|------------------|------------|-----------------|-------------|----------|--------------|---------------|----------------|----------------|
| Fernadès-Taylor, 2021 | U       | 47,442,892       | 5          | 57/42.3         | 47.4/41.6   | NEDS     |              |               |                 |                |
| Bruenderman, 2020   | U       | 200              | 0.41       | 59              |             | HCS      |              | 4 d or less (42%); 5–9 d (30%); 10 d or more (28%) |                |
| Keeven, 2019       | U       | 167,636          | 3          |                 |             | NSQIP    |              | 64            | EDT (4.8%), IPT (7.0), NHT (7.3), DA (2.9) |
| Philip, 2019       | U       | 334              | 2          | 60              | 45.2        | HCS      |              | 7/4           | 7/4            | 10/5           |
| Lucas, 2013        | U       | 53,464           | 1          | 59/54           | 46/46       | NSQIP    |              |               | EDT (10), IPT (14), NHT (13), DA (10) |
| DeWane, 2018       | U       | 12,245           | 2          | 60              | 45.2        | NSQIP    |              |               | EDT (54.8) IPT (54.1), NHT (61.4), DA (53.8) |
| Holena, 2011       | U       | 9958             | 6          | 52/53           | 55/57.2     | NSQIP    |              |               | NSQIP (10), IPT (10), NHT (10), DA (10) |
| Philip, 2020       | U       | 1801             | 5          | 59/59.9         | 49.1/45.6   | NSQIP    |              |               | NIS (8,687/6,759) |
|                   | MC      | 10,730,245       | 3          | 60.1/58.7       | 43.3/3.0    | NIS      |              |               |                 |

*Average decreased from 9.2 days to 7.4 throughout the study.

‡$750,600–8,240,754 for the 417 unnecessary transfers.

HCS, health care system; HCUP, Healthcare Cost and Utilization Project; SID, State Inpatient Databases; SEDD, Emergency Department Databases; MISAD, Medicare Inpatient Standard Analytical and Denominator; LA, local admit; EDT, emergency department transfer; IPT, inpatient transfer; T, transferred; NT, not transferred; U, university; CH, community hospital; MC, multicenter.

**Appendix 3. Search strategy used**

### Ovid MEDLINE

| # | Search statement |
|---|-----------------|
| 1 | General Surgery/ |
| 2 | exp Surgical Procedures, Operative/ |
| 3 | (general surgery or surgical procedure* or surgery or surgeries).tw. |
| 4 | 1 or 2 |
| 5 | exp Emergencies/ |
| 6 | exp Emergency Medicine/ |
| 7 | exp Emergency Service, Hospital/ |
| 8 | exp Emergency Medical Services/ |
| 9 | (emergency or emergencies or emergent or acute or urgent).tw. |
| 10 | 5 or 6 or 7 or 8 or 9 |
| 11 | exp Patient Transfer/ |
| 12 | exp "Transportation of Patients"/ |
| 13 | ("transportation of patients" or interhospital transfer* or inter-hospital transfer* or interfacility transfer* or inter-facility transfer* or transfer patient* or (patient* adj5 transfer*)).tw. |
| 14 | 11 or 12 or 13 |
| 15 | exp Hospitals, Rural/ |
| 16 | exp Rural Health Services/ |
| 17 | (critical access hospital* or rural or remote or regional*).tw. |
| 18 | 15 or 16 or 17 |
| 19 | 4 and 10 and 14 and 18 |

### EMBASE

| # | Search statement |
|---|-----------------|
| 1 | exp surgery/ |
| 2 | (general surgery or surgical procedure* or surgery or surgeries).tw. |
| 3 | 1 or 2 |
| 4 | exp emergency/ |
| 5 | exp emergency medicine/ |
| 6 | exp hospital emergency service/ |
| 7 | exp emergency health service/ |
| 8 | exp emergency ward/ |
| 9 | (emergency or emergencies or emergent or acute or urgent).tw. |
| 10 | 4 or 5 or 6 or 7 or 8 or 9 |
| 11 | exp patient transport/ |
| 12 | ("transportation of patients" or interhospital transfer* or inter-hospital transfer* or interfacility transfer* or inter-facility transfer* or (patient* adj5 transfer*)).tw. |
| 13 | 11 or 12 |
| 14 | exp rural health care/ |
| 15 | exp community hospital/ |
| 16 | (critical access hospital* or rural or remote or regional*).tw. |
| 17 | 14 or 15 or 16 |
| 18 | 3 and 10 and 13 and 17 |
Cochrane Library
1. MeSH descriptor: [General Surgery] explode all trees
2. MeSH descriptor: [Surgical Procedures, Operative] explode all trees
3. (general surgery OR surgical procedure* OR surgery OR surgeries):ti,ab,kw
4. #1 OR #2 OR #3
5. MeSH descriptor: [Emergencies] explode all trees
6. MeSH descriptor: [Emergency Medicine] explode all trees
7. MeSH descriptor: [Emergency Service, Hospital] explode all trees
8. MeSH descriptor: [Emergency Medical Services] explode all trees
9. (emergency OR emergencies OR emergent OR acute OR urgent):ti,ab,kw
10. #5 OR #6 OR #7 OR #8 OR #9
11. MeSH descriptor: [Patient Transfer] explode all trees
12. MeSH descriptor: [Transportation of Patients] explode all trees
13. (“transportation of patients” OR interhospital transfer* OR inter-hospital transfer* OR interfacility transfer OR inter-facility transfer OR transfer patient* OR [patient’ NEAR transfer*]):ti,ab,kw
14. #11 OR #12 OR #13
15. MeSH descriptor: [Hospitals, Rural] explode all trees
16. MeSH descriptor: [Rural Health Services] explode all trees
17. (critical access hospital* OR rural OR remote OR regional*):ti,ab,kw
18. #15 OR #16 OR #17
19. #4 AND #10 AND #14 AND #18

Scopus
(TITLE-ABS-KEY (“general surgery” OR “surgical procedure*” OR surgery OR surgeries) AND TITLE-ABS-KEY (emergency OR emergencies OR emergent OR acute OR urgent) AND TITLE-ABS-KEY (“transportation of patients” OR interhospital transfer* OR inter-hospital transfer* OR interfacility transfer OR inter-facility transfer OR “transfer patient*” OR [patient’ W/5 transfer*]) AND TITLE-ABS-KEY (“critical access hospital*” OR rural OR remote OR regional*))

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