Transferred Emergency General Surgery Patients Are at Increased Risk of Death: A NSQIP Propensity Score Matched Analysis

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BACKGROUND: Emergency general surgery (EGS) encompasses high-risk patients undergoing high-risk procedures. Admission source, particularly interhospital transfer, is rarely accounted for in clinical performance benchmarking. Our goal was to assess the impact of transfer status on outcomes after EGS.

STUDY DESIGN: This was a retrospective analysis of the American College of Surgeons NSQIP database (2005 to 2014). All inpatients that underwent 1 of 7 EGS procedures shown to represent 80% of EGS volume, complications, and mortality nationally were included. Admission source was classified as directly admitted vs transferred from an outside emergency department or an acute care facility. The primary outcomes were overall mortality, overall morbidity, and major morbidity. A 3:1 propensity score matched analysis was used to determine the association of admission source with outcomes. Subgroup analysis was performed for high- and low-risk EGS procedures.

RESULTS: A total of 222,519 EGS admissions were identified, of which 15,232 (6.8%) were transfers. Mean age was 46 years and 51.4% were female. Overall mortality was 3.1% for the entire cohort and 10.8% within the transfer group. After propensity score matched analysis for 33 clinical and demographic variables, transferred patients had higher rates of overall mortality (odds ratio 1.01; 95% CI 1.01 to 1.02), higher overall morbidity (odds ratio 1.07; 95% CI 1.05 to 1.09), and major morbidity (odds ratio 1.06; 95% CI 1.04 to 1.08) compared with directly admitted patients.

CONCLUSIONS: After rigorous risk adjustment, interhospital transfer status has a small effect on mortality and morbidity in the EGS population. This could suggest that it is reasonable to transfer patients and that regionalization of care should be encouraged. (J Am Coll Surg 2019;228:871−877.

Emergency general surgery (EGS) patients are at increased risk of morbidity and mortality compared with patients undergoing elective procedures.[1-3] These patients account for more than 3 million admissions in the US annually and the incidence of EGS continues to increase.[3-5] Emergency general surgery admissions include both patients admitted directly to the hospital and transferred from a different institution.

Interhospital transfers are common within the healthcare system, with an increasing incidence despite regionalization of care.[4] Earlier research has shown that patients who undergo operations after being transferred have higher acuity and worse outcomes with the consequent use of additional resources at the receiving hospital.[6] This could be explained in part by the delay in care or duplication of care, generating additional costs.[4] Even though transfers constitute a small percent of EGS admissions (approximately 1.2% to 3%), EGS transfers have increased by 150% in the last decade.[4,7,8] Earlier research has also found

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that EGS patients admitted to higher-quality trauma centers had a nearly 33% lower risk of mortality.[9] In addition, EGS patients admitted to hospitals with a higher volume of EGS cases had also lower mortality rates.[10] These data suggest a trend toward regionalization of EGS.[4,9]

Previous work focused on understanding the population of transferred EGS patients, which found that more than half of these patients did not require intervention at the receiving hospital in the form of an operation or a procedure.[4,11] Additionally, it has been shown that patients with a higher number of comorbidities and hepatobiliary and resuscitation EGS diagnoses were more likely to be transferred, and uninsured and minority patients were less likely to be transferred.[4,11] However, these studies used administrative databases, which lacked key clinical data (ie physiological status at arrival) to appropriately risk-adjust patients.[4,8,11] Our goal was to assess the impact of transfer status on patients who underwent an EGS procedure. Our hypothesis was that even after strict risk adjustment, transfer status would be an independent predictor of morbidity and mortality.

METHODS

Participants

A retrospective analysis of the American College of Surgeons NSQIP database from 2005 to 2014 was performed. We included all adults (aged 18 years or older) that underwent 1 of the 7 previously defined EGS procedures: appendectomy, cholecystectomy, laparotomy, colectomy, small bowel resection, peptic ulcer repair, and lysis of adhesions. These cases have been shown to be responsible for 80% of the operative volume, mortality, and complications of EGS nationally.[3] We also performed subgroup analysis dividing these procedures into high and low risk. Based on earlier work from our group, appendectomy and cholecystectomy were defined as low risk, and laparotomy, colectomy, small bowel resection, peptic ulcer repair, and lysis of adhesions were defined as high risk.[1] As for our main exposure, admission source was classified as directly admitted to the hospital vs transferred from an outside emergency department or an acute care facility. The Partners Human Research Committee, the IRB of Partners Healthcare, approved this study.

Database

The NSQIP is a large, national database that acquires data from participant institutions; data collection procedures are as described by the NSQIP program. The NSQIP gathers data from all member institutions, which include a variety of hospitals, including academic, nonacademic, rural, and urban medical institutions. Case sampling is based on an 8-day cycle that facilitates a random sampling of cases.[12] More than 150 variables contain data on preoperative laboratory values, patient comorbidities, postoperative course information, and outcomes data (morbidity and mortality) of up to 30 days. The NSQIP database is completely de-identified and adheres to the Health Insurance Portability and Accountability Act.

Outcomes measures

All outcomes were evaluated within 30 days of initial operation based on the NSQIP database. The primary outcomes measures were death within 30 days of operation and presence of any complication or of a major complication. We defined major complication as a deep incisional or organ space surgical site infection, stroke, CVA, cardiac arrest requiring CPR, MI, 1 or more occurrences of septic shock, pulmonary embolism, unplanned intubation, or acute renal failure. Complications included infectious (urinary tract infection, pneumonia, *Clostridium difficile* infection), neurologic (stroke/CVA and peripheral nerve injury), wound (superficial, deep, or organ space surgical site infection, and wound dehiscence), respiratory (unplanned re-intubation or failure to wean at or before 48 hours), hematologic (episode of bleeding requiring transfusion during or after procedure), renal (renal insufficiency, and acute renal failure), thromboembolic (pulmonary embolism or deep vein thrombosis), cardiac (cardiac arrest and MI), and septic (sepsis or septic shock).

Data analysis

Comparisons between continuous variables were carried out with *t*-tests and categorical variables were compared using chi-square test. Propensity score matching was used for the primary analysis outcomes of all-cause mortality, major morbidity, and total morbidity. Initially, multivariate logistic regression was used to identify risk factors associated with the main outcomes. All covariates $p \leq 0.1$ or were potential confounders were included in model building. Covariates included in model building were: age, race, sex, diabetes status, functional status, history of COPD, history of hypertension, earlier open wound, history of smoking, preoperative steroid use, presence of ascites within 30 days, history of congestive heart failure, percentage of disseminated cancer, weight loss >10% within the previous 6 months, presence of pneumonia, acute renal failure within 48 hours of operation, currently on dialysis, presence of sepsis spectrum, American Society of Anesthesiologists class, previously diagnosed bleeding disorder, and preoperative transfusion requirement. Additionally, preoperative laboratory values were included as covariates, including sodium level, albumin level, BUN level, aspartate aminotransferase (serum glutamic oxaloacetic transaminase), alkaline phosphatase, bilirubin level, WBC

count, hematocrit, and platelet level. International normalized ratio and partial thromboplastin time preoperative laboratory values were excluded from regression analysis due to >50% missing values. Missing data were considered to be missing at random and multiple imputation was used to address this. An iterative Markov Chain Monte Carlo method based on multivariate normal distribution was used for the imputation process. Using all of these variables, a propensity score was generated for each patient. A 3:1 matching macro assigned matched transferred EGS patients with nontransferred EGS patients based on the propensity score. This 3:1 match was done to maximize the available patients. Propensity scores were used to minimize the selection bias between the transfer and nontransfer cohorts. This process was also performed for high-risk procedures and for low-risk procedures separately. Significance level was set at 0.05

Table 1. Descriptive Statistics of Cases Stratified by Admission Source

Variable	Direct admission (n = 207,287)	Transferred (n = 15,232)	p Value
Age, y, median (IQR)	44 (29–60)	55.5 (38–70)	<0.001
Male, n (%)	100,841 (48.7)	7,332 (48.1)	0.22
White, n (%)	130,029 (71.3)	10,928 (80.8)	<0.001
Diabetes with treatment, n (%)	15,977 (7.7)	2,136 (14.0)	<0.001
Dyspnea at rest, n (%)	2,481 (1.2)	730 (4.8)	<0.001
Total or partial functional dependence, n (%)	10,283 (4.9)	2,109 (13.9)	<0.001
COPD, n (%)	6,404 (3.1)	1,433 (9.4)	<0.001
Hypertension, n (%)	54,559 (26.3)	6,436 (42.3)	<0.001
Disseminated cancer, n (%)	2,770 (1.3)	446 (2.9)	<0.001
Open wound, n (%)	2,249 (1.1)	633 (4.1)	<0.001
Smoked within the year, n (%)	41,984 (20.3)	3,984 (26.2)	<0.001
Steroid use within 30 d, n (%)	5,788 (2.8)	1,131 (7.4)	<0.001
Presence of ascites, n (%)	3,570 (1.7)	653 (4.3)	<0.001
Congestive heart failure, n (%)	1,305 (0.6)	374 (2.5)	<0.001
Weight loss ≥10%, n (%)	2,424 (1.2)	454 (2.9)	<0.001
Acute renal failure within 24 h, n (%)	2,052 (0.9)	589 (3.8)	<0.001
Pneumonia, n (%)	4,905 (2.4)	1,012 (6.6)	<0.001
On dialysis within 2 wk, n (%)	1,660 (0.8)	434 (2.9)	<0.001
Sepsis spectrum, n (%)			<0.001
None	129,425 (62.6)	7,667 (50.4)	
SIRS	49,045 (23.7)	2,924 (19.3)	
Sepsis	22,858 (11.0)	2,742 (18.0)	
Septic shock	5,509 (2.7)	1,874 (12.3)	
Coagulation disorder, n (%)	9,638 (4.7)	1,902 (12.5)	<0.001
Transfusion of ≥1 U packed RBC, n (%)	2,213 (1.1)	663 (4.4)	<0.001
ASA class >3, n (%)	16,255 (7.9)	4,018 (26.4)	<0.001
Serum sodium, mmol/L, median (IQR)	138 (136–140)	138 (135–140)	<0.001
BUN, mg/dL, median (IQR)	13 (10–17)	15 (11–25)	<0.001
Serum creatinine, mg/dL, median (IQR)	0.8 (0.7–1.0)	0.9 (0.7–1.3)	<0.001
Serum albumin, g/dL, median (IQR)	4.1 (3.6–4.4)	0.9 (0.7–1.3)	<0.001
Total bilirubin, mg/dL, median (IQR)	0.7 (0.5–1)	0.7 (0.5–1.1)	<0.001
Serum SGOT, IU/L, median (IQR)	23 (18–30)	24 (17–35)	<0.001
Alkaline phosphatase, IU/L, median (IQR)	76 (61–95)	79 (61–104)	<0.001
Platelets, $\times 10^9$/L, median (IQR)	238 (197–287)	232 (182–291)	<0.001
WBC, $\times 10^9$/L, median (IQR)	12.5 (9.3–15.8)	12.4 (8.7–16.6)	<0.001
Hematocrit, %, median (IQR)	40.9 (37.4–44)	38.7 (33.7–42.8)	<0.001
PTT, s, median (IQR)	29 (26.2–32)	30 (26.6–34.9)	<0.001
INR, median (IQR)	1.1 (1.0–1.2)	1.2 (1.1–1.4)	<0.001

ASA, American Society of Anesthesiologists; INR, international normalized ratio; IQR, interquartile range; PTT, partial thromboplastin time; SGOT, serum glutamic oxaloacetic transaminase (aspartate transaminase); SIRS, systemic inflammatory response syndrome.

for all analysis. All statistics were performed with STATA, version 15 (Stata Corp).

RESULTS

In the study period (2005 to 2014), a total of 222,519 patients who underwent 1 of the 7 EGS procedures defined previously were identified from the NSQIP database. Mean age was 46 years and 51.4% were female. Interhospital transfers comprised 6.85% of our study population. There were significant differences in demographics and clinical characteristics between transferred and nontransferred patients (Table 1). Transferred patients were more likely to be white (80.8% vs 71.3%; $p < 0.001$) and older (55.5 years vs 44 years, $p < 0.001$). They were more likely to be total or partially dependent (13.9% vs. 4.9%; $p < 0.001$) and have significant pre-existing comorbidities (Table 1). Interestingly, there was no significant difference in sex (48.7% males versus 48.1%; $p = 0.22$).

When compared with patients admitted directly from home, transferred patients arrived in a worse physiological status (Table 1). They were 1.5 times more likely to arrive with sepsis (18% vs 11%; $p < 0.001$) and 4 times more likely to experience septic shock (12.3% vs 2.7%; $p < 0.001$) before the operation. In addition, preoperative laboratory values were significantly different for transferred patients, with higher serum creatinine levels, lower albumin levels, and higher serum glutamic oxaloacetic transaminase and alkaline phosphatase.

In unadjusted analysis, transferred patients had higher overall mortality compared with patients admitted directly from home (10.8% vs 3.1%; $p < 0.001$). They were also more likely to have any complication develop (37.8% vs 16.8%; $p < 0.001$), including being more likely to undergo reoperation (9.1% vs 3.4%; $p < 0.001$). Transferred patients had longer postoperative hospitalization length of stay (5 days vs 2 days, $p < 0.001$) (Table 2).

After risk adjustment, propensity score matched analysis showed that transfer status was a significant predictor of overall mortality (odds ratio 1.01; 95% CI 1.01 to 1.02). Transferred patients were more likely to have any complication (odds ratio 1.07; 95% CI 1.05 to 1.09) and a major complication (odds ratio 1.06; 95% CI 1.04 to 1.08) develop. Increased risk of overall mortality was also associated with increased age, comorbidities, and preoperative laboratory values. After subgroup analysis, transfer status was not associated with an increased risk of mortality, any complication, or a major complication (all, $p > 0.05$) for patients undergoing low-risk procedures. For high-risk procedures, transfer status was associated with an increased risk of any complication or a major complication ($p = 0.008$ and $p \leq 0.001$, respectively) (Table 3).

DISCUSSION

This study shows that even though transfer status is a significant independent predictor of overall morbidity and mortality for patients undergoing an EGS procedure, the effect is very small. Even after taking into account the health status of patients at arrival, transferred patients who underwent an EGS procedure had similar outcomes compared with patients that were admitted directly from home. To our knowledge, this is the first study to report the outcomes of a nationally representative sample of transferred EGS patients that includes risk adjustment through propensity score matched analysis in the modeling process.

These results generate controversy between the role of regionalization of emergency general surgical care and the risks and benefits of interhospital transfers. Jonasson[13] suggested that surgical patients likely benefit from transfer to an institution with more advanced resources available and this was used as an argument for regionalization of emergency surgical care. However, multiple recent studies have shown that surgical patients transferred to a different institution have worse outcomes, including morbidity and mortality. Huntington and colleagues[6] found that patients transferred for operations represented a higher acuity population than nontransferred patients and, even when matched by comorbidities, they had worse outcomes. DeWane and colleagues[7] reported that transfer status was an independent contributor to death in patients requiring emergent colon resection. On the other hand, the transfer of patients has been associated with improved outcomes for other patient populations, including trauma patients[14-16] and patients presenting with an ST-elevation MI.[17] Recently, Ingraham and colleagues[18] suggested that

Table 2. Postoperative Characteristics Stratified by Admission Source

Variable	Direct admission (n = 207,287)	Transferred (n = 15,232)	p Value
Death, n (%)	6,324 (3.1)	1,647 (10.8)	<0.001
Any complications, n (%)	34,906 (16.8)	5,762 (37.8)	<0.001
Major complications, n (%)	19,734 (9.5)	4,027 (26.4)	<0.001
Length of hospital stay, d, median (IQR)	2 (1−5)	5 (1−11)	<0.001
Reoperation, n (%)	6,947 (3.4)	1,383 (9.1)	<0.001

IQR, interquartile range.

Table 3. Propensity Score Matched Analysis Predicting Main Outcomes

	Transfer status					
	All emergency general surgery		High-risk procedure		Low-risk procedure	
Variable	OR	95% CI	OR	95% CI	OR	95% CI
Mortality	1.01	1.01−1.02	1.01	0.97−1.03	0.99	0.99−1.00
Any complication	1.07	1.05−1.09	1.03	1.01−1.05	1.00	0.98−1.03
Major complication	1.04	1.04−1.08	1.05	1.03−1.07	1.01	0.99−1.03

OR, odds ratio.

interhospital transfer status was not an independent risk factor for mortality or morbidity after surgical management of necrotizing soft tissue infection.

Several reasons could explain why EGS transferred patients are at increased risk of morbidity and mortality. Transferred EGS patients were more likely to be severely ill on presentation to the operating hospital.[7,11] Our results showed that overall, transferred patients were much sicker than patients directly admitted from home. They had more comorbidities, were less functionally dependent, and had higher odds of presenting with sepsis and septic shock. Physiological clinical data at presentation have been cited as a major limitation of earlier studies that have used administrative databases.[4,11] The NSQIP database is unique in that it provides multiple variables that help assess the health status of patients at arrival to the institutions. These variables contribute to the risk adjustment of patients who are admitted directly from home compared with the transferred patients. Yelverton and colleagues[11] described the risk of transfer status on EGS outcomes using an administrative data set, the National Inpatient Sample database, and found that transferred patients had a >100% increased odds of death. In our study, although the odds of death were increased by only 1%, we still found that transfer status was an independent predictor of mortality. Risk adjustment for this population suggests that this could be a more accurate measure of the effect of transfer status in EGS patients. Another potential reason for transferred patients to have worse outcomes is delay in treatment. Although rapid recognition of severe EGS patients by the medical team is extremely important to initiate a rapid transfer to a higher-level hospital, there will be an inherent delay in definitive care even in the most efficient transfer.[19-21] Overall, the benefit of being transferred to an institution with more appropriate resources should outweigh the risk of postponing care.[4,13,22-25]

Interhospital transfers require higher resource use, including the costs of the duplication of care at each facility and of transportation between facilities. Based on earlier literature, inclusion of transfers would leave tertiary referral centers at a disadvantage for value-based payment modifiers and would not provide a complete picture of the quality of care delivered across hospitals.[26] However, we found that the effect of transfer status was very small, which could suggest that it is relatively safe to transfer patients. In addition, the effect of transfer status disappeared when we separated EGS procedures into high and low risk. For high-risk procedures, transfer status was not a predictor of mortality, but it was a predictor of any/major complication. Even though this was statistically significant, the effect was small. Transfer status was not a significant predictor of mortality, or any/major complications in low-risk procedures. Leberer and colleagues[27] found similar results for appendectomies. Their study showed that even though transferred patients had increased complexity, they did not experience greater postoperative complications compared with those admitted directly to their institution. Along the same lines, Huntington and colleagues[6] found that outcomes such as mortality and length of stay have improved for transferred patients over time by creating centers of excellence or a multitiered system to systematize transfers. The regionalization of care has worked in the trauma and oncologic surgery population with favorable outcomes.[28] Our study showed that the critical patients could be transported safely, therefore, centralizing resources could potentially reduce costs and improve outcomes within the EGS population. These data do not attempt to address the complex issues of the effect that regionalization of EGS care would have on the surgeon workforce, hospital resources, and surgical access.

Our study has several limitations. First, NSQIP does not contain details about the transferring facility, and it does not provide information on the time interval between diagnosis and operation at the receiving institution. Second, there are several factors that influence the decision-making process of physicians in determining whether to initiate transfers that might not be measurable or present in the NSQIP database. Another limitation is that even though NSQIP goes beyond administrative

claims, which allowed risk adjustment, there might be other unmeasured variables that could influence the impact of transfer status on EGS outcomes. We also have to consider the inherent limitations of a retrospective study. Finally, NSQIP only contains information about patients managed surgically and does not provide information on transferred EGS patients that did not undergo a procedure in the receiving institution.

CONCLUSIONS

After rigorous risk adjustment, transferred patients that underwent EGS had a small increased risk of mortality and morbidity compared with patients admitted directly from home. This suggests it is generally safe and reasonable to transfer EGS patients and regionalization of EGS care is feasible from a patient outcomes standpoint. This could potentially lead to cost reduction and better outcomes. Nevertheless, transfer status in the EGS population should be taken into account for clinical performance benchmarking. Additional studies are needed to define the role of regionalization of EGS care and to develop the best processes and guidelines to determine which EGS patients should be transferred.

Author Contributions

Study conception and design: Castillo-Angeles, Uribe-Leitz, Jarman, Feeney, Salim, Havens

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Invited Commentary

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The authors analyzed data from NSQIP to demonstrate that patients undergoing emergency general surgery (EGS) operations after transfer from another acute care facility or emergency room had higher risks of 30-day mortality (10.8%) and morbidity when compared with patients directly admitted to the hospital where they received operations (3.1% mortality). Although this finding of increased mortality associated with transfer agrees with previous studies using administrative data,[1] the authors use the clinical elements within NSQIP to develop a robust 3:1 propensity score-matched analysis. Although the increased risk of mortality associated with interhospital transfer persisted after these risk adjustments, the odds ratio (OR) of mortality attributable to the transfer process seems small, at 1.01. With low-risk EGS (appendectomy, cholecystectomy), no differences were found in the OR of mortality or morbidity associated with transfer. High-risk EGS patients (laparotomy, lysis of adhesions, small bowel resection, large bowel resection, peptic ulcer repair) had a small increased OR of morbidity attributable to transfer, and no significant increased OR of mortality when transferred before surgery.

Dr Castillo-Angeles and colleagues concluded that their findings may support regionalization of EGS. In doing so, they acknowledge the complexity that regionalization of EGS may entail. Interhospital transfer of patients is not likely to be a perfectly uniform patient exposure. It certainly seems plausible that longer and more complex hospital transfers may result in delayed definitive surgical intervention for high-risk EGS patients. This, in turn, could generate a subset of patients in which transfers may, in fact, lead to significantly increased risk of mortality or morbidity. Considering previous work looking at delay in treating peptic ulcer perforation for example, 1 of the 5 high-risk EGS cases included in this study, makes this more than a theoretic concern.[2] Given that nearly 20% of Americans live in rural areas where travel times to the hospital they initially present at may itself be lengthy, transfers to other hospital facilities could potentially further prolong time to definitive surgical intervention. It could certainly be of greater value if this NSQIP cohort of 222,519 patients was further analyzed, looking specifically for the time interhospital transfers entailed. Although this is not likely something directly available within the NSQIP database of 2009 to 2015, one wonders if the receiving NSQIP hospitals' ZIP code or hospital service area (HSA) could be used as a proxy measure of transfer time. If so, this could allow for analyzing those patients likely to experience longer/more complex interhospital transfers and determining if the transfer exposure itself might lead to significantly increased morbidity or mortality in these cases. Were this kind of subanalysis possible using this NSQIP data, the work could more fully inform the development of guidelines on the regionalization of EGS care. It is worth noting that the most recent iteration of NSQIP does, in fact, capture ZIP code characteristics at the patient level. Future analyses of transfers using NSQIP may better allow for such level of detail.

The current comparison of patients undergoing EGS procedures after interhospital transfer compared with those receiving surgical intervention directly at the hospital at which they presented, uses a degree of clinical risk adjustment that is impressive. Nevertheless, even with carefully defined NSQIP abstraction and coding, it may still be difficult to assure entirely accurate accounting of morbidity in transferred EGS patients. As a specific example, patients undergoing emergency surgery (EGS) at a non-NSQIP hospital may have complications from their procedure, such as deep space infection, sepsis or septic shock, or respiratory failure requiring ventilator support, leading to transfers to NSQIP hospitals. Once there, they could plausibly undergo yet another emergency procedure (EGS). This second EGS operation could then be sampled into the NSQIP database and attributed to the receiving hospital. But the methodology of NSQIP will not necessarily always have a clear accounting of the previous surgery the patient received at the transferring hospital, nor will attribution of the morbidity/complications be made to the receiving NSQIP hospital, ie it was present before and/or at the time of operation at the NSQIP facility. However, an otherwise identical patient undergoing an identical sequence of events after an initial EGS operation at a NSQIP hospital, resulting in the same kind of deep space infection or sepsis/septic shock or respiratory failure as previously described, and now requiring a second EGS operation at that same NSQIP hospital, or any other facility for that matter, would have any/all such developments attributed to the index NSQIP hospital as morbidity/complication. Within 30 days of the index EGS procedure, registered nurse abstracters make every effort to find clinical data, even those occurring outside of the index NSQIP facility.

This asymmetric morbidity coding and attribution could have unintended side effects for purposes of this transfer analysis, potentially compromising a complete accounting for morbidity and complications in the transferred patient population. Seemingly, the only way to avoid such potential accounting limitations in patients transferring between hospitals would be to have all US hospitals