Published in final edited form as:

Surgery. 2018 February ; 163(2): 243–250. doi:10.1016/j.surg.2017.07.026.

Disparities in Access to Emergency General Surgery Care in the United States

Jasmine A Khubchandani^a, Connie Shen^b, Didem Ayturk^c, Catarina I Kiefe^d, and Heena P Santry^c

^aUniversity of Massachusetts Medical School, Worcester, Massachusetts, USA

^bMcGill University School of Medicine, Montreal, Quebec, Canada

^cUniversity of Massachusetts Medical School, Department of Surgery, Worcester, Massachusetts, USA

^dUniversity of Massachusetts Medical School, Department of Quantitative Health Sciences, Worcester, Massachusetts, USA

Abstract

Background—As fewer surgeons take emergency general surgery (EGS) call and hospitals decrease emergency services, a crisis in access looms in the US. We examined national EGS capacity and county-level determinants of access to EGS care with special attention to disparities.

Methods—To identify potential EGS hospitals, we queried the database of the American Hospital Association (AHA) for “acute care general hospital,” with “surgical services,” and “emergency department,” and 1 “operating room.” Internet search and direct contact confirmed EGS services that covered the emergency room 7 days a week, 24 hours a day (24/7). Geographic and population-level EGS access was derived from Geographic Information Systems and US Census.

Results—Of the 6,356 hospitals in the 2013 AHA database, only 2,811 were EGS hospitals. Counties with greater percentages of black, Hispanic, uninsured, and low-education individuals and rural counties disproportionately lacked access to EGS care. For example, counties above the 75th percentile of African American population (10.2%) had 80% greater odds of not having an EGS hospital compared to counties below the 25th percentile of African American population (0.6%).

Conclusion—Areas without EGS services exist across the US, disproportionately affecting underserved, rural communities. Policy initiatives need to increase EGS capacity nationwide.

Corresponding Author: Heena P Santry, MD MS, Department of Surgery, University of, Massachusetts Medical School, 55 Lake Avenue North, Worcester, MA 01655, Heena.Santry@umassmemorial.org.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Introduction

In 2006, the Institute of Medicine reported a national crisis in emergency care.¹ Over the preceding decade, emergency rooms (ERs) in the United States (US) experienced a 26% increase in visits and were often operating at full capacity.² Many ERs and hospitals closed their doors resulting in a net loss of 425 ERs (9%) and 198,000 ER beds.^{1,2} Given that many ER visits result in need for urgent surgical evaluation and possible emergency surgery, surgeons play a critical role in our nation's emergency health system. General surgeons care routinely for patients with a range of emergency conditions from common and typically straightforward diseases, such as appendicitis, cholecystitis, and soft tissue abscess, to less common but potentially lifethreatening diseases, such as perforated viscus, ischemic enteritis, and necrotizing soft tissue infection; despite this need, however, there is a well documented nationwide shortage of surgeons willing to provide emergency general surgery (EGS) coverage that is worsening, placing an estimated 324 million Americans³ at risk of inadequate access to emergency surgical care.⁴⁻⁶

The evidence of a deficit in general surgeons is substantial.⁴⁻⁶ Over the years, the number of practicing general surgeons has remained stagnant at approximately 17,000, while at the same time, the US population has increased about 1% per year resulting in a 26% decline in the number of general surgeons per 100,000 US population between 1981 to 2005.^{7,8} The inability to regenerate the pool of surgeons for EGS coverage has been attributed to multiple factors.

Surgery trainees are showing decreasing interest in general surgery, often opting for other specialties, largely due to the unpredictable hours, increased liability of providing emergency care, and lesser salary of general surgeons.^{7,9,10} While the proposed size of the general surgeon workforce per 100,000 population is 7.5 in the US overall,^{12,13} nationally this ratio is only 6.4/100,000, with rural areas suffering an even greater deficit at 4.7/100,000.⁷

While the general surgery workforce crisis has been an area of substantial interest in the surgical literature,⁴⁻¹¹ EGS care as an essential component of our national emergency health system has been poorly described. Little is known about access to EGS care in the US based on geography and sociodemographic characteristics of the population. We sought to analyze disparities in access to EGS care at the hospital level. We hypothesized that vulnerable populations, including rural residents, minorities, and the socioeconomically disadvantaged, would have less access to EGS care.

Methods

Reported EGS Capability

The Annual Survey of Hospitals of the American Hospital Association (AHA), with a historic response rate of greater than 75%, is a comprehensive database of US hospitals considered the gold standard for data on hospital-level characteristics including clinical services provided.¹⁴ We queried the database of the 2013 AHA Annual Survey for the classifications of "acute care hospital," "surgical services," "ER," and at least one "operating

room (OR)” to identify acute care general hospitals that in theory provide 24/7 EGS care throughout the entire year. Academic medical centers or other teaching hospitals were included if they were nonfederal, short-term hospitals. Nonfederal, short-term specialty hospitals (e.g., orthopedic, cardiac, strictly pediatric), hospitals not accessible to the general public (e.g., Veteran’s Affairs Hospitals, prison hospitals, college infirmaries), and hospitals located in non-state US territories (e.g., Guam and Puerto Rico) were excluded.

Investigation of True EGS Capacity

To confirm EGS capacity at these potential EGS hospitals, we first undertook a grassroots examination of EGS capacity at all hospitals that appeared to be EGS capable based on the AHA query. We researched hospital websites for evidence of 24/7 EGS services. If the website did not confirm EGS services, Chief Medical Officers and/or ERs were called directly to ask if the hospital provided EGS coverage 24 hours a day. Hospitals that stabilized patients but transferred them elsewhere for all operations, conducted elective operations only, or did not provide 24/7 OR access were eliminated. Second, as part of a larger survey, all hospitals presumed to be offering 24/7 EGS access (through AHA data combined with grassroots investigation) were contacted for further details on their specific EGS practices via the surgeons responsible for EGS services at those hospitals. Hospitals that responded that they did not provide 24/7 EGS care in response to the survey were also eliminated. The remaining hospitals were labeled “EGS hospitals”. With a final survey response of 60%, fewer than 2.0% of responders noted that they did not provide 24/7 EGS care. Because our initial approach resulted in a misclassification rate of <2.0% for responders, we classified all remaining hospitals thought to be EGS capable based on our initial AHA query, internet searches, and direct hospital contact as “EGS hospitals” for the purposes of the analysis presented here (Figure 1).

Analysis

In order to measure access to the EGS care based on geography and county sociodemographic makeup, locations of EGS hospitals were overlaid on US maps using Maptitude Geographic Information Systems software (Caliper Corp, Newton, MA, 2016). The 2010 US Census data on race, ethnicity, and socioeconomic variables, including insurance status, poverty level, and education level, were overlaid on maps of hospital distribution to identify population-level disparities in access to EGS care. Poverty was mapped as the percentage of county population living <200% (EDITOR ASK THE AUTHORS IF THEY REALLY MEAN 2005) below poverty level as defined by the US Department of Health and Human Services. Insurance coverage was mapped as percentage of county population without health insurance. Conversely, owing to the relatively low overall rate of Bachelor’s level education in the US, the percentage of the county population greater than age 25 with a Bachelor’s degree was mapped. The percentage categories for black race, Hispanic ethnicity, education-level, insurance status, and poverty were generated using the Fisher-Jenks “Optimal Breaks,” or “Natural Breaks,” algorithm. This method parses data into classes, where each class is a cluster of values that minimizes within-group variance and maximizes any single group’s mean from the mean of other groups.¹⁵

We measured lack of access to EGS hospitals at the county-level based on these same sociodemographic characteristics as well as for county population. First, we calculated the 25th and 75th percentile among all US counties for each variable of interest. We then calculated odds of having no EGS hospital in any given county based on whether or not the county is greater than or less than the 75th and 25th percentile, respectively, for any given variable.

Results

Distribution of EGS Capacity in the US

The AHA Annual Survey reported data on 6,356 hospitals. After querying AHA data, 1,546 hospitals were eliminated, because they did not provide acute care (e.g., long-term care hospitals, rehabilitation hospitals, chronic psychiatric facilities). Subsequently, based on a combination of querying AHA data, reviewing hospital websites, calling hospitals, and mailing a survey to presumed EGS-capable hospitals, we eliminated nine hospitals not located in a US territory, seven hospitals that were closed, 1,023 specialty hospitals (e.g., cardiac, orthopedic, pediatric), 79 hospitals with no ER, 412 hospitals with no OR, 226 hospitals with no available general surgeon, and 243 hospitals performing only outpatient or elective surgery (Figure 1). The remaining 2,811 hospitals where an adult with a general surgery emergency might be able to receive care were then mapped for the geographic analyses presented below. Figure 2 shows the distribution of EGS hospitals in the US by county population density.

In general, EGS hospitals were more likely to be in the more densely populated of the 3,242 counties; 90.7% of the counties without a single EGS hospital (EGS “deserts”) had <50,000 population, and all counties with >500,000 population had at least one EGS hospital. When comparing county-level access to at least one EGS hospital, with a median US county population of 25,939, counties with a population greater than the 75th percentile of the overall US county population (65,854) had nearly 82% lesser odds of not having an EGS hospital compared to counties with a population below the 25th percentile of the overall US county population (11,096) (Table 1).

Racial and Ethnic Disparities in Access to EGS Care

Figure 3 shows EGS hospitals by county-level percentage of African American and Hispanic population. Table 1 shows that with a median county-level percentage of African Americans of 2.2%, counties greater than the 75th percentile of the county-level African American population (10.2%) had 80% greater odds of not having an EGS hospital compared to counties less than the 25th percentile of the county-level African American population (0.6%). Similar disparities are apparent for the distribution of Hispanic populations and EGS hospitals across counties (Table 1).

Socio-economic Disparities in Access to EGS Care

Figure 4 also shows EGS hospitals by county-level rates of uninsurance, persons living in poverty, and adults with a college degree. Again, as shown in Table 1, with a median county-level percentage of uninsurance of 13.9%, counties greater than the 75th percentile of the

county-level uninsured population (17.5%) had 85% greater odds of not having an EGS hospital compared to counties less than the 25th percentile of the county-level uninsured population (10.2%). Similarly, disparities are apparent for poverty level and for college education and EGS hospital distribution across counties.

Discussion

Nearly a decade after the Institute of Medicine declared our nation's emergency care system at a breaking point, and both surgeons and the lay press brought national attention to a crisis in EGS care,^{1,4,8,16} we found a nation unprepared to deliver such care, in particular to the most vulnerable Americans. We found that the 2,811 hospitals that do provide EGS care are distributed unevenly across the US Rural residents, minorities, and the socioeconomically disadvantaged are at high risk of living in an EGS desert with little or no access to EGS care compared to their white, affluent, and urban counterparts. These disparities in access to EGS care substantiate the findings that poor, black, and Hispanic patients are affected disproportionately by ER closures in both urban and rural communities and that rural communities have been particularly hard hit by a declining general surgery workforce.^{4–11,17,18} Supply and demand issues in less populated areas will result necessarily in fewer hospitals or perhaps fewer hospitals providing EGS care. Moreover, given that all populations are susceptible to surgical emergencies, our findings highlight the need for a national imperative to achieve EGS equity even if geographic equality is not practical. Thus, while not feasible to have all Americans in close proximity to a hospital well-equipped to provide round-the-clock EGS care (equality), we must take steps to assure high quality outcomes for all EGS patients, regardless of race/ethnicity, socioeconomic status, or place of residence (equity).

While general surgery emergencies can and do impact anyone, minorities, those living in poverty, the un/under-insured, and those with lower educational attainment have been shown to experience worse EGS outcomes, in particular if they reside in rural areas.^{19–25} Our findings that these same factors are associated with living in an EGS desert might explain why some patients are particularly vulnerable to lesser than acceptable standards of care (e.g., laparoscopic procedures for appendicitis), greater complication rates, and increased mortality.^{19–21,26,27} Those living in an EGS desert—whether due to distance, poverty, lack of insurance, education level, or race/ethnicity might delay care for elective needs only to present emergently in need of a general surgeon who may not be available or may be unable to provide emergency care due to insufficient hospital resources (e.g., anesthesia staff, intensive care unit). In fact, hospitals with greater proportions of socioeconomically disadvantaged patients provide more emergency surgery for conditions typically treated electively.^{26,27} Meanwhile, rural residents transferred for emergency operations, including common procedures, such as inguinal hernia repairs and cholecystectomies, traveled an average of 67 miles, with the longest distance traveled greater than 300 miles and were found to require higher level resources compared to those who were not transferred in.²⁸ The time needed to arrange transfer or travel to an EGS-capable hospital may be a contributing factor to these poorer outcomes among socio-economically and geographically vulnerable EGS patients. Ideally, our national public health goal would be to prevent all Americans from reaching a point at which they require EGS care; however, that minorities, the

socioeconomically disadvantaged, and rural residents experience worse outcomes suggests a “separate and unequal” emergency care system in our nation today despite efforts—such as the governmental subsidies to critical access (fewer than 25 beds, greater than 35 miles by road from nearest hospital) and safety net hospitals (provide disproportionate care to indigent populations)—to assure access to care for our most vulnerable populations.^{28–34} Yet, in our nation’s Veterans’ Affairs (VA) health system, geographically and sociodemographically diverse veterans with EGS conditions experienced no differences in treatment or outcomes.³⁵ This finding may be attributable to the fact that the VA is a single, integrated health system with uniform oversight despite the variable patient population. The US health care system, conversely, consists of multiple competing interests across vastly different regional economies. Ultimately, the disparate treatment and outcomes of EGS patients from these underserved communities across the US are multifactorial, including unconscious bias among providers,¹⁴ baseline socio-economic deprivation,³⁶ culturally-rooted, health seeking behaviors,^{37–41} access to primary/preventative care facilitated typically via health insurance in our nation,^{41–44} and disparities in access to EGS care. Therefore, while it is impractical to develop health care facilities in all of the vulnerable communities we have described, achieving equity in EGS care will require a multipronged approach through system-wide alterations aimed at decreasing the number of EGS deserts across the US through a shared public health approach targeting improved quality, outcomes, and costs for the more than 2.4 million Americans a year who will need care for a general surgery emergency.¹⁴

At the approximately 1,300 critical access hospitals across the US and the other 38% hospitals classified as rural according to the census bureau, general surgeons often function as advanced endoscopists and elective general surgeons while providing emergency urologic, obstetric, gynecologic, facial trauma, hand trauma, and general surgery care.^{45–48} Having a general surgeon on staff is estimated to generate approximately \$2.7 million in annual revenue and \$1.4 million in annual payroll, to and create 26 jobs at rural hospitals.¹⁴ Therefore, without a pool of new graduates to replace retiring older surgeons, many rural hospitals face closure.^{7,11} Augmenting the pool of general surgeons to provide EGS coverage at rural hospitals is an ongoing challenge that *may* improve EGS access nationally. Positive experiences in rural based clerkships in medical school and enthusiastic role models have been shown to increase interest in general surgery among medical students.^{49–52} Therefore, educators should gear medical school curriculum toward increasing student interest in surgery, while surgeons and residents should understand the profound influence the tone they set has on their students’ career choices. Still, once committed to training in surgery, current trends suggest low likelihood residents choosing broad-based general surgery careers.^{4,9,10,53–55} State and federal health care legislation that includes provisions for financial incentives similar to loan repayment plans for primary care physicians utilized for the National Health Service Corps^{56–58} may increase resident interest in non-specialized general surgery. Where current training paradigms are possibly not preparing residents to enter into general surgery practices,^{54,55} strong mentorship, innovations in surgical training (e.g., apprenticeships in rural surgery), and transition to practice programs may be warranted.^{59–61} Finally, given increasingly hospital-based models of employment for surgeons, hospital administrators should create more lifestyle-friendly rural practice

environments with ample assistance in the form of mid-level practitioners and surgical assistants as well as cross-coverage opportunities.^{9,10} These myriad changes may increase the number of surgeons who choose to make their professional homes at rural hospitals, thereby increasing access to EGS in more remote areas of the US.

Even with the aforementioned recruitment strategies, it is unlikely all rural hospitals, in particular CAHs with fewer than 25 beds, will be fully staffed by general surgeons year round, 24 hours a day.⁶² Still, there appears to be a long held belief among various provider and not just surgeons that even basic EGS diseases cannot be managed without the immediate expertise of a general surgeon. Anecdotally, to this day most general surgeons are required to provide ED coverage for staff privileges at most hospitals across the US, even if the facility cannot provide round the clock OR services or the critical care for often needed for EGS patients. Interestingly,, a study of rural EGS patients who lacked access to surgical evaluation found that nearly one third did not require any intervention at the tertiary care center.²⁸ Therefore, empowering the existing non-surgeon workforce to identify rapidly and appropriately which patients truly need to be treated by a surgeon may alleviate local deficits in general surgery coverage, decrease the travel burden on EGS patients not requiring immediate surgery, and ameliorate overcrowding of tertiary care ERs. This approach has been successful for injured patients through the wide dissemination of Advanced Trauma Life Support (ATLS), a curriculum that trains first line emergency room providers, irrespective of their specialty to identify and manage immediate lifethreats rapidly and appropriately triage injured patients.⁶³ Just as not all injured patients require transfer to a regional trauma center, not all those presenting with common abdominal and skin/soft tissue complaints will need to be transferred to be seen immediately by a general surgeon when one is not available locally. Importantly, implementing a clear, evidence-based, algorithm-guided training paradigm for the ‘optimal care of the EGS patient’ will only be possible with: acceptance by surgeons, primary care providers, emergency room physicians, and hospital administrators alike; the involvement of surgeons nationally in generating and disseminating a robust curriculum, availability of telemedicine consult services as have been utilized for stroke care,^{64,65} and the enthusiastic participation of internists/hospitalists in managing non-operative surgical disease when transfer is not warranted. This approach would represent a transformative change in initial EGS management and triage and would greatly enhance EGS equity while containing costs.

Addressing geographic disparities alone, however, will do little to address the poor, uninsured, and minorities who reside in our nation’s urban/suburban areas. Receiving care at an approved stroke center, typically in metropolitan and non-rural areas, has improved both processes and outcomes for some minority patients experiencing a similarly time-sensitive health condition.^{66–68} Thus, adopting a similar ‘centers of excellence model’ for EGS care may both narrow the urban-rural divide in EGS care and augment EGS capacity across vulnerable populations irrespective of their county socio-demographic profiles. To do so, how ever, would require re-envisioning the Acute Care Surgery paradigm with a new scope of equity across the arena of EGS care . The paradigm of acute care surgery was proposed by leading trauma surgeons as a care delivery model incorporating trauma surgery, general surgery, and surgical critical care just over a decade ago and has been shown to improve outcomes.^{69,70} This model,however has been viewed largely from the perspective of the

proponents of the acute care paradigm as an isolated, hospital-based service line; but, our prior research suggests that the resource intensiveness of a round-the-clock acute care surgery service may not be practical at all hospitals, in particular, the smaller hospitals lacking a trauma center capable of providing 24/7 coverage.^{71,72} Therefore, this paradigm of acute care surgery should be understood, by surgeon leaders, hospital administrators, and regional public health officials alike, as a network for patients presenting for EGS care centered around an EGS Center of Excellence (i.e., the hospitals with an acute care surgery service).

These various stakeholders should come together with the goal of providing monetary support, infrastructure, and human capital to develop evidence-based triage criteria (to supplement education and training cited above), strong referral networks (with telemedicine components) for immediate transfer/acceptance of patients in need of EGS care from a critical care-certified surgeon, compensation schemes for the care of uninsured patients similar to trauma activation payments, and surgical home models (with e-medicine components) for socio-economically vulnerable and geographically distant patients to ensure follow-up and decrease complications. The overall costs to the health care system along with human suffering due to delay in access to care and substandard care would be decreased if the paradigm of acute care surgery were to re-envisioned and implemented as a tiered level of capability (e.g. Level 1, 2, 3), and regionalized with a hub and spoke Center of Excellence model with verification criteria as are in place currently for trauma care, stroke care, and multiple other high risk diseases.

The existence of unconscious bias has been documented among a number of health care providers across specialties, including general and acute care surgeons.^{73,74} Unconscious bias has been implicated in disparate clinical decision-making and poor health outcomes in a number of surgical and unexpected conditions,^{75–78} but this finding has been inconsistent;^{79,80} however, in light of the disparities in access to EGS care we describe, we believe that the goal of equity in EGS care cannot be achieved without combining broad measures for increasing the general surgery workforce, training non-surgeons in the optimal evaluation of the EGS patient, and regionalization of EGS care without unconscious bias training for all providers who participate in the care of patients who present with abdominal and skin/soft tissue complaints that may require emergency surgery. Self-awareness training, education in ‘blind spot’ recognition, and implementation of ‘physician interaction’ checklists are all approaches that have been explored in health care settings to attempts to decrease the negative effects of unconscious bias; these initiatives may play an important role in improving EGS equity across all domains of emergency health care delivery where a person with a potential general surgery may present.^{81–83}

There are some important limitations to our work. The US Census data were used to characterize EGS deserts and the most recent data was five years older than our study period. In particular, insurance data were prior to implementation of the Affordable Care Act. Our own findings revealed weaknesses of the AHA Annual Survey, and it is possible that we misclassified the characteristics of the EGS hospitals due to other discrepancies in data collection, in particular those 1,154 hospitals that did not reply to our survey. Additionally, we used having at least one OR as our search criteria; while this may not represent EGS

capacity accurately, it is a starting point and the minimum necessary. Therefore, EGS capacity is likely even less than we documented. Large numbers of missing data on trauma center verification limited our ability to correlate EGS capacity with trauma capacity. Closures of health systems are dynamic; in the time it took us to analyze and map our data, the EGS capacity may have changed. Importantly, while EGS is generally accepted to include a range of diseases from appendicitis to necrotizing soft tissue infection, we did not have data on hospital case mix to verify or establish the actual EGS care rendered in our sample. To the best of our knowledge, however, our study is the first analysis at the national level of access to EGS care at the hospital level with a focus on socio-demographic disparities at a time when health care access for our nation's most vulnerable populations may well worsen. We maintain that our detailed, sequential efforts to confirm 24/7 EGS services are an acceptable proxy to begin examining such a vexing public health concern that is expected to worsen as our population ages, and more patients require EGS care.

Conclusion

Our analysis of access to EGS care is timely and brings attention to one important but neglected facet of our emergency health system in the US. More than 2 million Americans year will need EGS care annually; in comparison, approximately 1.4 million will require treatment for myocardial infarction, 1.2 million will need management for serious injuries, and 900,000 will need care for strokes.^{84–87} Still, achieving timely access to high quality and cost-effective EGS care has been lacking in the national policy and public health focus of these other conditions. General surgery emergencies are equal opportunity diseases that require urgent surgical evaluation and potential operative intervention, but rural, poor, uneducated, and minority patients disproportionately lack access to EGS care. That our current system of emergency care, already at its breaking point at baseline, is more ill-equipped to meet the basic EGS needs of some Americans versus others should be alarming to surgeons, public health advocates, and policy makers. Efforts should be directed toward strengthening EGS capacity in the US and revitalizing the general surgery workforce to aligning hospital priorities with population level health needs that are vital to ensure EGS equity that is timely, high quality EGS care for all patients irrespective of place of residence, socioeconomic status, or race/ethnicity.

Acknowledgements

This research is supported by grants from the Agency for Healthcare Research Quality (R01HS022694) to HPS, National Institutes of Health/National Institute of Mental Health to CIK (R01MH112138), National Institutes of Health/National Center for Advancing Translational Sciences to CIK (U54 RR 026088) and Patient-Centered Outcomes Research Institute to CIK (ME-1310-07682).

References

1. Future of Emergency Care: Hospital-based Emergency Care at the Breaking Point. Washington, DC: Institute of Medicine ;2006.
2. Kellermann AL . Crisis in the Emergency Department. The New England Journal of Medicine. 2006;355:1300–1303.17005946
3. Turnbull AE , Krall JR , Ruhl AP , A scenario-based, randomized trial of patient values and functional prognosis on intensivist intent to discuss withdrawing life support. Crit Care Med. 2014;42(6):1455–1462.24584065

4. Fischer JE . The impending disappearance of the general surgeon. JAMA. 2007;298(18):2191–2193.18000204
5. A growing crisis in patient access to emergency surgical care. Bull Am Coll Surg. 2006;91(8):8–19.
6. Goldberg RF , Reid-Lombardo KM , Hoyt D , Will there be a good general surgeon when you need one? J Gastrointest Surg. 2014;18(5):1032–1039.24352612
7. Thompson MJ , Lyng DC , Larson EH , Tachawachira P , Hart LG . Characterizing the general surgery workforce in rural America. Arch Surg. 2005;140(1):74–79.15655209
8. Lyng DC , Larson EH , Thompson MJ , Rosenblatt RA , Hart LG . A Longitudinal Analysis of the General Surgery Workforce in the United States, 1981–2005. JAMA Surg. 2008;143(4):345–350.
9. Richardson JD . Workforce and lifestyle issues in general surgery training and practice. Arch Surg. 2002;137(5):515–520.11982462
10. Hudkins JR , Helmer SD , Smith RS . General surgery resident practice plans: a workforce for the future? Am J Surg. 2009;198(6):798–803.19969132
11. Cofer JB , Burns RP . The Developing Crisis in the National General Surgery Workforce. Journal of the American College of Surgeons. 2008;206(5):790–795.
12. Jonasson O , Kwakwa F , Sheldon GF . Calculating the workforce in general surgery. JAMA. 1995;274(9):731–734.7650827
13. Kwakwa F , Jonasson O . The general surgery workforce. Am J Surg. 1997;173(1):59–62.9046886
14. !!! INVALID CITATION !!! .
15. Jenks GF . The Data Model Concept in Statistical Mapping. International Yearbook of Cartography. 1967;7:186–190.
16. Davis R Shortage of surgeons pinches US hospitals. USA Today 2 26, 2008.
17. Shen Y- C , Hsia RY . Changes in emergency department access between 2001 and 2005 among general and vulnerable populations. American journal of public health. 2010;100(8): 1462–1469.20558800
18. Hsia RY , Srebotnjak T , Kanzaria HK , McCulloch C , Auerbach AD . System-level health disparities in California emergency departments: minorities and Medicaid patients are at higher risk of losing their emergency departments. Ann Emerg Med. 2012;59(5):358–365.22093435
19. Causey MW , McVay D , Hatch Q , The impact of race on outcomes following emergency surgery: an American College of Surgeons National Surgical Quality Improvement Program assessment. American journal of surgery. 2013;206(2):172–179.23870390
20. Havens JM , Olufajo OA , Cooper ZR , Haider AH , Shah AA , Salim A . Defining Rates and Risk Factors for Readmissions Following Emergency General Surgery. JAMA Surg. 2015:1–7.
21. Hall EC , Hashmi ZG , Zafar SN , Zogg CK , Cornwell EE , H. Haider A Racial/ethnic disparities in emergency general surgery: explained by hospital-level characteristics? American journal of surgery. 2015;209(4):604–609.25683233
22. Shahan CP , Bell T , Paulus E , Zarzaur BL . Emergency general surgery outcomes at safety net hospitals. J Surg Res. 2015; 196(1): 113–117.25805367
23. Haider AH , Scott VK , Rehman KA , Racial disparities in surgical care and outcomes in the United States: A comprehensive review of patient, provider, and systemic factors. Journal of the American College of Surgeons. 2013;216(3):482–492.23318117
24. Eberhardt M , Pamuk E . The Importance of Place of Residence: Examining Health in Rural and Nonrural Areas. American journal of Public Health 2004;94(10):1682–1686.15451731
25. Raphael D Health inequities in the United States: prospects and solutions. J Public Health Policy. 2000;21(4):394–427.11214374
26. Ingraham AM , Cohen ME , Raval MV , Ko CY , Nathens AB . Comparison of hospital performance in emergency versus elective general surgery operations at 198 hospitals. J Am Coll Surg. 2011;212(1):20–28 e21.21184955
27. Havens JM , Peetz AB , Do WS , The excess morbidity and mortality of emergency general surgery. J Trauma Acute Care Surg. 2015;78(2):306–311.25757115
28. Misericola B , Sihler K , Douglas M , Ranney S , Dreifus J . Transfer of acute care surgery patients in a rural state: a concerning trend. J Surg Res. 2016;206(1):168–174.27916358
29. Critical Access Hospitals Payment System Washington, DC: MedPac;2016.

30. 2015 Balanced H Budget Act of 1997. 105th Cong (1997).
31. Critela Access Hospital Finance 101 Manual. National Rural Health Resource Center;2012.
32. Sutton JP , Stensland J , Zhao L , Cheng M . Achieving equity in Medicare disproportionate share payments to rural hospitals: an assessment of the financial impact of recent and proposed changes to the disproportionate share hospital payment formula. J Rural Health. 2002;18(4):494–502.12380892
33. Kane NM , Singer SJ , Clark JR , Eeckloo K , Valentine M . Strained local and state government finances among current realities that threaten public hospitals' profitability. Health Aff (Millwood). 2012;31(8):1680–1689.22869645
34. McKethan A , Nguyen N , Sasse BE , Kocot SL . Reforming the Medicaid disproportionate-share hospital program. Health Aff (Millwood). 2009;28(5):w926–936.19689986
35. Zogg CK , Jiang W , Chaudhary MA , Racial disparities in emergency general surgery: Do differences in outcomes persist among universally insured military patients? The journal of trauma and acute care surgery. 2016;80(5):764–777.26958790
36. Misercola B , Sihler K , Douglas M , Ranney S , Dreifus JD Transfer of acute care surgery patientsHealth inequities in a rural state: a concerning trendthe United States: prospects and solutions. J Surg ResPublic Health Policy. 20162000;20621(14):168–174394–174427.
37. Do YK , Carpenter WR , Spain P , Race, healthcare access and physician trust among prostate cancer patients. Cancer Causes Control. 2010;21(1):31–40.19777359
38. Loh KW , Majid HA , Dahlui M , Roslani AC , Su TT . Sociodemographic predictors of recall and recognition of colorectal cancer symptoms and anticipated delay in help seeking in a multiethnic Asian population. Asian Pac J Cancer Prev. 2013;14(6):3799–3804.23886185
39. Vu M , Azmat A , Radejko T , Padela AI . Predictors of Delayed Healthcare Seeking Among American Muslim Women. J Womens Health (Larchmt). 2016;25(6):586–593.26890129
40. Rauscher GH , Ferrans CE , Kaiser K , Campbell RT , Calhoun EE , Warnecke RB . Misconceptions about breast lumps and delayed medical presentation in urban breast cancer patients. Cancer Epidemiol Biomarkers Prev. 2010;19(3):640–647.20200436
41. Cunningham PJ . What accounts for differences in the use of hospital emergency departments across U.S. communities? Health Aff (Millwood). 2006;25(5):w324–336.16849363
42. Pande AH , Ross-Degnan D , Zaslavsky AM , Salomon JA . Effects of healthcare reforms on coverage, access, and disparities: quasi-experimental analysis of evidence from Massachusetts. Am J Prev Med. 2011;41(1):1–8.21665057
43. Freeman HE , Corey CR . Insurance status and access to health services among poor persons. Health Serv Res. 1993;28(5):531–541.8270419
44. Garfinkel SA , Corder LS . Health services utilization in the U.S. population by health insurance coverage. Natl Med Care Util Expend Surv B. 1986(13): 1–38.
45. Halverson A Skills course helps rural surgeons stay current. Bull Am Coll Surg. 2016;101(4):37–39.
46. Halverson AL , DaRosa DA , Borgstrom DC , Evaluation of a blended learning surgical skills course for rural surgeons. Am J Surg. 2014;208(1):136–142.24815526
47. Halverson AL , Hughes TG , Borgstrom DC , Sachdeva AK , DaRosa DA , Hoyt DB . What surgical skills rural surgeons need to master. J Am Coll Surg. 2013;217(5):919–923.24041561
48. Eilrich FC C , Whitacre BE , Brooks L , Doekson GA , St. Clair CF . The Economic Impact of a Rural General Surgeon and Model for Forecasting Need Stillwater, OK: National Center for Rural Health Works;2010.
49. Marshall DC , Saliccioli JD , Walton SJ , Pitkin J , Shalhoub J , Malietzis G . Medical student experience in surgery influences their career choices: a systematic review of the literature. J Surg Educ. 2015;72(3):438–445.25544332
50. Schmidt LE , Cooper CA , Guo WA . Factors influencing US medical students' decision to pursue surgery. J Surg Res. 2016;203(1):64–74.27338536
51. Berman L , Rosenthal MS , Curry LA , Evans LV , Gusberg RJ . Attracting surgical clerks to surgical careers: role models, mentoring, and engagement in the operating room. J Am Coll Surg. 2008;207(6):793–800, 800 e791–792.19183524

52. Pointer DT ., Freeman MD , Korndorffer JR ., Meade PC , Jaffe BM , Slakey DP . Choosing Surgery: Identifying Factors Leading to Increased General Surgery Matriculation Rate. *Am Surg*. 2017;83(3):290–295.28316314
53. Polk HC, ., Bland KI , Ellison EC , A Proposal for Enhancing the General Surgical Workforce and Access to Surgical Care. *Ann Surg*. 2012.
54. Sheldon GF . Access to care and the surgeon shortage: American Surgical Association forum. *Ann Surg*. 2010;252(4):582–590.20881763
55. Stitzenberg KB , Sheldon GF . Progressive specialization within general surgery: adding to the complexity of workforce planning. *J Am Coll Surg*. 2005;201(6):925–932.16310697
56. Rauner T , Fannell J , Amundson M , Harrison JN , Sauer M , Pathman DE . Partnering Around Data to Address Clinician Retention in Loan Repayment Programs: The Multistate/NHSC Retention Collaborative. *J Rural Health*. 2015;31(3):231–234.25953626
57. Pathman DE , Konrad TR , King TS , Taylor DH ., Koch GG Outcomes of states' scholarship, loan repayment, and related programs for physicians. *Med Care*. 2004;42(6):560–568.15167324
58. Pathman DE , Morgan JC , Konrad TR , Goldberg L . States' experiences with loan repayment programs for health care professionals in a time of state budget cuts and NHSC expansion. *J Rural Health*. 2012;28(4):408–415.23083087
59. Drake FT , Aarabi S , Garland BT , Accreditation Council for Graduate Medical Education (ACGME) Surgery Resident Operative Logs: The Last Quarter Century. *Ann Surg*. 2017;265(5): 923–929.28398961
60. Klingensmith ME , Cogbill TH , Luchette F , Factors influencing the decision of surgery residency graduates to pursue general surgery practice versus fellowship. *Ann Surg*. 2015;262(3):449–455; discussion 454–445.26258313
61. Cogbill TH , Shapiro SB . Transition from Training to Surgical Practice. *Surg Clin North Am*. 2016;96(1):25–33.26612017
62. Frangou C A Crisis in Coverage General Surgery News. Washington, DC2017.
63. Bell RM , Krantz BE , Weigelt JA . ATLS: a foundation for trauma training. *Ann Emerg Med*. 1999;34(2):233–237.10424930
64. Carr BG , Matthew Edwards J , Martinez R . Regionalized care for time-critical conditions: lessons learned from existing networks. *Acad Emerg Med*. 2010;17(12):1354–1358.21122020
65. Park S , Schwamm LH . Organizing regional stroke systems of care. *Curr Opin Neurol*. 2008;21(1):43–55.18180651
66. Seabury S , Bogner K , Xu Y , Huber C , Commerford SR , Tayama D . Regional disparities in the quality of stroke care. *Am J Emerg Med*. 2017.
67. Aparicio HJ , Carr BG , Kasner SE , Racial Disparities in Intravenous Recombinant Tissue Plasminogen Activator Use Persist at Primary Stroke Centers. *J Am Heart Assoc*. 2015;4(10):e001877.26467999
68. Bhattacharya P , Mada F , Salowich-Palm L , Are racial disparities in stroke care still prevalent in certified stroke centers? *J Stroke Cerebrovasc Dis*. 2013;22(4):383–388.22078781
69. The Committee to Develop the Reorganized Specialty of Trauma SCC, and Emergency Surgery. Acute Care Surgery: Trauma, Critical Care, and Emergency Surgery. *The Journal of Trauma: Injury, Infection, and Critical Care*. 2005;58(3):614–616.
70. Chana P , Bunrs E , Arora S , Darzi A , Faiz O . A Systematic Review of the Impact of Dedicated Emergency Surgical Services on Patient Outcomes. *Annals of Surgery*. 2015;263(1):20–27.
71. Collins CE , Pringle PL , Santry HP . Innovation or rebranding, acute care surgery diffusion will continue. *J Surg Res*. 2015;197(2):354–362.25891673
72. Madore JC , Collins CE , Ayturk MD , Santry HP . The impact of acute care surgery on appendicitis outcomes: Results from a national sample of university-affiliated hospitals. *J Trauma Acute Care Surg*. 2015;79(2):282–288.26218698
73. Sabin J , Nosek BA , Greenwald A , Rivara FP . Physicians' implicit and explicit attitudes about race by MD race, ethnicity, and gender. *J Health Care Poor Underserved*. 2009;20(3):896–913.19648715

74. Haider AH , Schneider EB , Sriram N , Unconscious race and class bias: its association with decision making by trauma and acute care surgeons. *J Trauma Acute Care Surg.* 2014;77(3):409–416.25159243
75. Santry HP , Wren SM . The role of unconscious bias in surgical safety and outcomes. *Surg Clin North Am.* 2012; 92(1):137–151.22269267
76. Green A , Carney D , Pallin D , Implicit Bias among Physicians and its Prediction of Thrombolysis Decisions for Black and White Patients. *Journal of General Internal Medicine.* 2007;22(9): 1231–1238.17594129
77. Bolorunduro OB , Haider AH , Oyetunji TA , Disparities in trauma care: are fewer diagnostic tests conducted for uninsured patients with pelvic fracture? *American journal of surgery.* 2013;205(4): 365–370.23375757
78. Schulman KA , Berlin JA , Harless W , The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med.* 1999;340(8):618–626.10029647
79. Oliver MN , Wells KM , Joy-Gaba JA , Hawkins CB , Nosek BA . Do physicians' implicit views of African Americans affect clinical decision making? *J Am Board Fam Med.* 2014;27(2): 177–188.24610180
80. Haider AH , Schneider EB , Sriram N , Unconscious race and social class bias among acute care surgical clinicians and clinical treatment decisions. *JAMA Surg.* 2015;150(5):457–464.25786199
81. White AA , Logghe HJ , Goodenough DA , Self-Awareness and Cultural Identity as an Effort to Reduce Bias in Medicine. *J Racial Ethn Health Disparities.* 2017.
82. White AA , Stubblefield-Tave B . Some Advice for Physicians and Other Clinicians Treating Minorities, Women, and Other Patients at Risk of Receiving Health Care Disparities. *J Racial Ethn Health Disparities.* 2017;4(3):472–479.27287277
83. Hannah SD , Carpenter-Song E . Patrolling your blind spots: introspection and public catharsis in a medical school faculty development course to reduce unconscious bias in medicine. *Cult Med Psychiatry.* 2013;37(2):314–339.23681466
84. MacKenzie EJ , Rivara FP , Jurkovich GJ , A national evaluation of the effect of trauma-center care on mortality. *N Engl J Med.* 2006;354(4):366–378.16436768
85. Celso B , Tepas J , Langland-Orban B , A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. *J Trauma.* 2006;60(2):371–378.16508498
86. Santry HP , Ayturk MD , Kiefe CI . Trends in Surgical Health Shocks. Unpublished.
87. Agarwal S , Sud K , Thakkar B , Menon V , Jaber WA , Kapadia SR . Changing Trends of Atherosclerotic Risk Factors Among Patients With Acute Myocardial Infarction and Acute Ischemic Stroke. *Am J Cardiol.* 2017.

Figure 1.

Flow chart of the exclusion criteria used to craft final list of hospitals capable of providing 24/7 access to emergency general surgery care

Figure 2. Distribution of Emergency General Surgery Across the United States.

This map shows the distribution of EGS (2,811) hospitals in the continental US by state and county population density. Each dot represents a hospital reported by the Annual Survey of Hospitals by the American Hospital Association to be an “acute care hospital” providing “surgical services” with both an “emergency room” and at least one “operating room.” Maroon dots represent EGS hospitals (EGS hospital = hospital providing emergency general surgery care 24 hours daily)

Figure 3. Access to Hospitals Providing Emergency General Surgery Care Based on Race and Ethnicity

Figure 3a. EGS Hospitals (2,811) Mapped Over US County Percent African American Population. **Figure 3b.** EGS Hospitals (2,811) Mapped Over US County Percent Hispanic Population (EGS hospital = hospital providing emergency general surgery care 24 hours daily)

Figure 4. Access to Hospitals Providing Emergency General Surgery Care Based on Socioeconomic Characteristics.

Figure 4a. EGS Hospitals (2,811) Mapped Over US County Percent Uninsured Population.

Figure 4b. EGS Hospitals (2,811) Mapped Over US County Percent Population Living less

than 200% below Federal Poverty Level **Figure 4c.** EGS Hospitals (2,811) Mapped Over US

County Percent of Adults >25 Years Old with at Least a Bachelor's Degree. (EGS hospital = hospital providing emergency general surgery care 24 hours daily)

Table 1.

Odds of Lacking Access to an EGS Hospital According to the 3,242 US Counties' Population Characteristics

	Aggregate County Population Statistics				Odds of >75 th Percentile County having No EGS hospital vs <25 th Percentile County (95% CI)
	Mean (SD)	Median	25 th Percentile	75 th Percentile	
Overall County Population	98,125 (315,241.4)	25,939	11,096	65,854	0.18 (0.14–0.22)
Percentage Non-Hispanic Black Population	8.9% (14.4)	2.2%	0.6%	10.2%	1.80 (1.48–2.18)
Percentage Hispanic Population	10.8% (19.1)	3.7%	1.8%	9.6%	1.93 (1.58–2.34)
Percentage Population Living in Poverty	14.7% (8.5)	13.2%	9.3%	17.8%	2.31 (1.89–2.83)
Percentage Population Without Health Insurance	14.4% (5.9)	13.9%	10.2%	17.5%	1.85 (1.52–2.25)
Percentage Population With College Degree	20.2% (8.9)	17.95%	13.9%	23.6%	0.15 (0.11, 0.18)