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Variability in General Surgical Procedures in Rural and Urban U.S. Hospital Inpatient Settings

EXECUTIVE SUMMARY

INTRODUCTION

To address community need for surgery, rural hospitals in the United States have historically relied on a workforce consisting primarily of general surgeons as opposed to surgical sub-specialists. However, the pool of general surgeons is declining[1] and current general surgery graduates may not receive training in the range of procedural skills required by rural hospitals.[2] General surgeons are vital members of the rural health care team, performing emergency operations, underpinning the trauma care system, backing-up primary care physicians, and contributing to the financial viability of small hospitals.[3-6] Yet relatively few general surgeons practice in rural locations[7] and their numbers on a per capita basis decreased markedly between 1981 and 2004, declining from 8 per 100,000 in 1981 to just over 5 per 100,000 in 2005.[8] Many rural general surgeons are approaching retirement age, and recruiting today's graduates to rural practice, where workload demands are often high, can be difficult. [1,9]

The declining proportions of surgical trainees who choose general surgery over sub-specialty careers and a narrowing range of procedural skills among recent graduates in general surgery may have an adverse impact on the ability of rural hospitals to offer surgical services for their patients. Because little is known about the differences in surgical practice in rural versus urban settings, this study examines rural and urban differences in commonly performed inpatient surgical procedures that could typically be handled by general surgeons as opposed to subspecialists. It also examined factors, such as complication rates, among patients in rural and urban settings who underwent these general surgical procedures.

METHODS

We conducted a cross-sectional study of a probability sample of hospital patients undergoing 367,438 general surgery inpatient procedures in rural and urban hospitals in 24 states, as recorded in the 2005 National Inpatient Sample. The main outcome measures included: (1) the frequency of inpatient general surgical procedures performed; (2) the frequency of other inpatient surgical procedures performed; (3) serious complications occurring during the hospitalization; and (4) predicted resource demand, length of stay, and mortality.

RESULTS

Surgical procedures that would typically be handled by general surgeons comprised 21.4% of all inpatient procedures in rural hospitals compared to 17.9% in urban hospitals ($p<0.001$). In small rural and isolated rural areas this proportion increased to 24.4% and 23.8%, respectively. Among the types of surgical procedures typically handled by general surgeons, cholecystectomies,

appendectomies, bowel procedures, and herniorrhaphies were proportionately more common in rural hospitals. Although not typically performed by general surgeons, obstetric-gynecologic and orthopedic procedures were also proportionately more common in rural hospitals. Rural patients had fewer serious complications across these procedures than urban patients (9.4% vs. 12.7%, $p<0.001$). Predicted resource demand (i.e., predicted inpatient costs of care) ($p<.001$), predicted average length of inpatient hospital stay ($p<.05$) and predicted risk of mortality ($p<.01$) were significantly lower for rural compared to urban patients.

DISCUSSION AND POLICY IMPLICATIONS

Rural hospitals concentrate on relatively common, low complexity inpatient procedures that can be handled by general surgeons, especially those who receive additional training in obstetric/gynecology and orthopedics, and these procedures are performed on relatively low-risk patients, in terms of their predicted resource demand, length of stay and mortality. Complication rates also tend to be lower in rural settings. To be able to continue providing these services, rural hospitals need to be able to hire general surgeons who have competence in a broad array of routine general surgical procedures, and ideally would also be able to perform obstetric/gynecologic procedures, such as caesarian sections, and orthopedic procedures, such as open reduction and internal fixation of some fractures. One way to accomplish this would be to increase rural training tracks within general surgery residency programs that would provide a high case load of common general surgery, ob-gyn, and orthopedics procedures. As the U.S. rural population grows and ages, the urgency of implementing strategies to sustain the rural general surgery workforce should not be underemphasized.

Variability in General Surgical Procedures in Rural and Urban U.S. Hospital Inpatient Settings

INTRODUCTION

General surgery in rural hospitals is facing a crisis precipitated by the declining production of general surgeons,[1] and the narrower range of procedural skills performed by recent general surgery graduates.[2] General surgery encompasses broad procedural knowledge in areas, such as the gastrointestinal tract, breast, skin and soft tissue, and the endocrine system, and with special training may also include procedural knowledge in areas, such as obstetrics/gynecology, urology, and orthopedic injury.[10] Because they possess broad procedural skills, general surgeons are vital members of the rural health care team, performing emergency operations, underpinning the trauma care system, backing-up primary care physicians, and contributing to the financial viability of small hospitals.[3-6] Yet relatively few general surgeons practice in rural locations[7] and their numbers on a per capita basis decreased markedly between 1981 and 2004, declining from 8 per 100,000 in 1981 to just over 5 per 100,000 in 2005.[8] Many rural general surgeons are approaching retirement age, and recruiting today's graduates to rural practice, which is often characterized by high workload demand, has become increasingly difficult.[1,9]

Compounding this situation is the fact that the percentage of general surgeons pursuing additional sub-specialty fellowship training increased from 55% in 1992 to over 70% by 2004.[11] Some of these fellowship-trained surgeons restrict their practices to their sub-specialty after finishing and no longer take call as general surgeons. Also, as sub-specialist training has grown, the focus of general surgery training has narrowed with most recent graduates performing few cases in areas such as obstetrics-gynecology (ob-gyn) and orthopedics.[2] Consequently, new entrants to the general surgery workforce may not be comfortable performing the broad range of procedures required of many rural surgeons.[12,13]

Given these changes affecting the general surgery workforce, examination of rural and urban differences in inpatient general surgery scopes of practice, other commonly performed inpatient procedures, and surgical patient characteristics is warranted. A survey of general surgeons from 2005 found that rural surgeons tended to perform a broader range of procedures and feel less well-prepared by their residency experience than their urban peers.[14] In contrast, a study using National Inpatient Sample data from 2001 showed that the range of inpatient procedures typically performed by general surgeons was relatively limited in rural hospitals.[15] Similarly, a study in North Carolina showed that compared to urban practice, rural surgical practice tended to focus more narrowly on the most common general surgical procedures.[16] However, none of these studies examined range of practice issues across the continuum of rural hospital settings or in the context of the disease severity of patients undergoing inpatient general surgery procedures. To help inform rural general surgery policy, we examined rural and urban differences in inpatient general surgery scope of practice, other inpatient surgical procedures, and surgical patient characteristics using national data from 2005. According to the American Board of Surgery, (ABS) general surgery encompasses broad procedural knowledge in areas, such as the gastrointestinal tract, breast, skin and soft tissue, and the endocrine system,[10] so these were the types of procedures we classified as falling within the purview of general surgery. The ABS also indicates that with special training, general surgeons may also address areas, such as gynecology, urology, and orthopedic injury and hand surgery, so we also examined the frequency of these other types of procedures in rural hospitals.

METHODS

SAMPLE

The National Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP), from the Agency for Healthcare Research and Quality (AHRQ),[17] provides the largest all-payer, hospital-oriented database in the United States. The NIS samples all patient discharges from approximately 20% of U.S. community hospitals, stratified by hospital ownership/control, bed size, teaching status, region and urban/rural location. Data collected includes clinical and resource use information included in a typical discharge abstract. Of the 37 states included in the 2005 NIS sample, the 24 selected for this study permitted disclosure of hospital ZIP codes and identification numbers, allowing linkage with other data sources, including the 2005 American Hospital Association (AHA) hospital survey database and version 2.0 of the Rural Urban Commuting Area (RUCA) codes. These 24 states (AZ, CA, CO, CT, FL, IL, IA, KY, MD, MA, MN, MO, NC, NH, NJ, NY, NV, OR, RI, UT, VT, WA, WI and WV) represent all four U.S. Census Bureau Regions of the country, and contain 5,469,420 of the 7,995,048 discharges and 629 of the 1,054 hospitals in the overall sample. Patient discharges were selected if they had a procedure code (International Classification of Diseases, 9th Revision, Clinical Modification; ICD-9-CM), and their primary procedure code indicated a surgical procedure. Discharges were excluded if their primary procedure codes fell within the Clinical Classification Software (CCS)[18] groupings 29, 58, 130-143, 155, 156, 159-162 and 177-231, as these are areas in which general surgeons would be unlikely to intervene. In addition, circumcisions (ICD-9-CM procedure code 640) were excluded for infant boys under 12 months of age. This yielded a final sample of 2,166,745 discharges, of which 367,438 were general surgery inpatient procedures.

The University of Washington Human Subjects Division approved this study.

SURGICAL PROCEDURES

Surgical procedures were classified by surgical specialty and procedure type using their CCS codes. The CCS was developed by AHRQ "for clustering patient diagnoses and procedures into a manageable number of clinically meaningful categories."[19] General surgery classification by CCS followed the method used in VanBibber et al.,[15] with the exception of liver and pancreas procedures. General surgery procedures were identified and grouped by CCS code into: *cholecystectomy and common bile duct* (84); *appendix* (80); *large and small bowel* (72, 73, 75, 78, 79, 96); *skin* (168, 169, 172); *hernia* (85, 86); *breast* (165-167); *esophagus and stomach* (71, 74, 94); *other abdominal* (e.g., laparoscopy) (87, 89, 90, 92, 99); and *spleen, thyroid and miscellaneous* (10, 34, 66, 67, 81, 105, 176). Ob-gyn procedures were identified and grouped into: *ovary and tube* (119-123); *uterine* (124,125); *abortion/D&C* (126-128); *prolapse/incontinence* (106, 129); and *caesarean section* (c-section) (134). Because general surgeons may perform c-sections in some rural areas, these are also analyzed separately from other obstetric and gynecologic procedures. Orthopedic procedures were identified and grouped into: *arthroscopy and joint procedures* (149, 150); *upper extremity fracture/dislocation* (145); *hip and femur fracture/dislocation* (146); *lower extremity fracture/dislocation* (147); *other fracture/dislocation* (148); *knee* (151, 152); *hip* (153, 154); *amputation* (157); and *spine* (3, 158).

URBAN AND RURAL CLASSIFICATION

We used RUCA codes[20] to classify hospitals according to their degree of rurality. RUCA codes offer a flexible way of differentiating among rural and urban areas and can define locations with more precision than county- or metropolitan statistical area-based taxonomies: RUCA codes classify ZIP codes into 33 categories according to core population and work commuter flow patterns. We grouped hospitals into: urban (RUCA codes 1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, and 10.1); large rural (RUCA codes 4.0, 4.2, 5.0, 5.2, 6.0, and 6.1); small rural (RUCA codes 7.0, 7.2, 7.3, 7.4, 8.0, 8.2, 8.3, 8.4, 9.0, 9.1, 9.2); and isolated small rural areas (RUCA codes 10.0, 10.2, 10.3, 10.4, 10.5, and 10.6.

SEVERITY MEASURES

Severity measures examined included disease staging (complications during the hospitalization), defined as "the likelihood of organ failure or death as a result of disease progression, independent of treatment"[21] (Disease Staging, version 5.21.3, MedStat). We coded two hierarchical variables from disease staging: 1) *any complications* (local complications + systemic or multiple site complications + death vs. no complications); 2) *serious complications* (systemic/multiple site + death only vs. no or only local complications). Other severity measures examined were three predictive scales developed from disease staging: resource demand, defined as a patient's predicted charge as a percentage of the average of predicted charges over all patients; length of stay, defined as a patient's predicted length of stay as a percentage of the average length of stay over all patients; and mortality risk for hospital stays, defined by dividing a patient's predicted mortality by the overall rate of in-hospital mortality multiplied by 100 (measures also developed by MedStat). Each of these predicted measures was dichotomized as being within the top quartile of predicted risk vs. being in the bottom three quartiles.). Prediction equations for these scales also incorporate patient age, gender, diagnoses, procedures and discharge status.

HOSPITAL CHARACTERISTICS

The 2005 AHA hospital survey database[22] was used to link additional hospital characteristics. These were: number of general and intensive care medical+surgical beds; public hospital status; critical access hospital status; and percent payer type (Medicare, Medicaid, private insurance, other).

ANALYTIC PLAN

Analyses employed the NIS weighting formula so that estimates are nationally representative. Significance tests were calculated with SUDAAN v. 10.1 (Research Triangle Institute, Research Triangle Park, NC, 2004), which adjust standard errors to account for the complex sample design. Weighted means and percentages are presented for surgical procedures, severity measures, and hospital characteristics by urban/rural status and degree of rurality. Chi-square p-values are presented separately for urban vs. rural and for degree of rurality.

RESULTS

Out of a census of 3,062 (1,770 urban, 1,292 rural) hospitals in the 24 states examined, the sample included 629 (364 urban, 265 rural) hospitals offering operative procedures (Table 1). Among the sampled rural hospitals, 97% performed inpatient surgical procedures. Among urban hospitals this figure was 99% (p=.03). Among the most isolated rural hospitals, 93% provided inpatient surgical services (Table1). Table 1 also reveals that surgery patients in rural hospitals were significantly more likely to have Medicare (p<0.001) or Medicaid (p=.007) health insurance coverage and less likely to have private health insurance coverage (p<0.001). In isolated rural hospitals, over half of the surgery patients had Medicare coverage and only about one-quarter were privately insured.

Among hospitals performing inpatient surgical services, general surgery procedures accounted for a significantly greater proportion of the overall inpatient surgical caseload in rural hospitals than in urban ones (21.4% vs. 17.9% respectively, p<.001) (Table 2). General surgery procedures accounted for roughly 24% of the surgical caseload in small rural and isolated rural hospital settings. Also among hospitals performing inpatient surgical services, ob-gyn and orthopedic procedures accounted for a greater proportion of surgical cases in rural hospitals than in urban ones (18.7% vs. 14.5%, p<.001; and 19.0% vs. 15.9%, p<.001, respectively). Table 3 presents the most common types of inpatient procedures that are typically performed by general surgeons. Compared to urban hospitals, rural hospitals had: a significantly higher proportion of cholecystectomies and related procedures (20.9% vs. 14.3%, p<.001), appendectomies (15.6% vs. 12.0%, p<.001), bowel procedures, such as colon resections (19.8% vs. 18.4%,

p=0.02), and herniorrhaphies (6.5% vs. 5.6%, p<.001); a proportion that were not significantly different for breast procedures (3.6% vs. 3.6%, p=.91) or skin procedures (e.g. surgical flaps) (13.8% vs. 15.1 %, p=.05); and a significantly lower proportion of esophagus and stomach procedures (7.3% vs. 12.7%, p<.001), other abdominal procedures (i.e. laparoscopic procedures other than cholecystectomies, etc.) (7.5% vs. 8.5%, p=.02), and spleen, thyroid and other miscellaneous general surgical procedures (5.0% vs. 9.7%, p<.001). As can also be seen in Table 3, among hospitals in small rural locations and hospitals in isolated rural locations, appendectomies and skin procedures made a greater contribution to operative caseload than in large rural hospitals.

Table 1. Hospital Characteristics by Rural-Urban Category, 2005 National Inpatient Sample

	Urban	Total Rural	p Value	Large Rural	Small Rural	Isolated Rural	p Value
Unweighted hospital sample size, No.	364	265		94	114	57	
Estimated hospital population, No.	1,770	1,292		455	558	279	
Performed surgical procedures, No. (%)	1,755 (99)	1,248 (97)	.03	450 (99)	538 (96)	259 (93)	--*
Performed General surgery, No. (%)	1,726 (98)	1,194 (92)	.005	450 (99)	533 (96)	210 (75)	< .001
Performed Ob-Gyn surgery, No. (%)	1,607 (91)	1,052 (82)	< .001	440 (97)	455 (82)	157 (56)	< .001
Performed Orthopedic surgery, No. (%)	1,701 (96)	1,023 (79)	< .001	450 (99)	431 (77)	142 (51)	< .001
Procedures performed, mean	5,076	690	< .001	1,464	314	179	< .001
General med+surg adult beds†‡, mean	130.1	35.1	< .001	55.7	24.3	21.6	< .001
ICU med+surg adult beds†‡, mean	14.6	3.5	< .001	6.7	2.1	1.1	< .001
Public Hospitals‡, No. (%)	188 (11)	416 (32)	< .001	85 (19)	199 (38)	132 (47)	< .001
Critical Access Hospitals‡, No. (%)	58 (3)	687 (53)	< .001	69 (15)	388 (70)	230 (82)	< .001
Payer type, surgery patients, mean§ %							
Medicare	42.1	47.5	< .001	45.4	46.2	53.7	NS
Medicaid	11.4	13.9	.007	13.9	13.9	14.1	NS
Private insurance	37.9	29.4	< .001	31.7	30.0	24.3	.05
Other	8.6	9.2	NS	9.0	9.9	8.0	NS

*P value omitted due to small cell size.

†Estimate excludes 93 hospitals missing on bed size.

‡Data from American Hospital Association 2005 Annual Survey.

§Estimates exclude 12 hospitals with no surgical patients.

While ob-gyn procedures accounted for a relatively higher proportion of all procedures in rural hospitals, most specific types of ob-gyn procedures did not differ significantly between rural and urban hospitals with the exception of dilation and curettage (D&C) and related procedures, which made up a significantly lower proportion of ob-gyn procedures in rural locations (Table 3). Orthopedic procedures also comprised a relatively higher proportion of all procedures in rural hospitals. Of the specific type of orthopedic procedures, spinal procedures, the most prevalent procedure group in urban hospitals, was among the least prevalent in rural hospitals, while knee and hip procedures dominated the specialty in rural hospitals (Table 3).

Patients undergoing general surgery procedures in rural hospitals were significantly less likely than their counterparts in urban hospitals to have any complications (45.3% vs. 48.7%, p<.001) or serious complications (9.4% vs. 12.7%, p<.001) recorded during hospitalization (Table 4). Patients in hospitals in small rural locations and hospitals in isolated rural locations were the least likely to have serious complications.

Table 2. Proportion of Operating Room Procedures by Specialty by Rural-Urban Category, 2005 National Inpatient Sample

	Urban (n=1,968,359)	Total Rural (n = 198,386)	p Value	Large Rural (n = 148,032)	Small Rural (n = 39,541)	Isolated Rural (n = 10,813)	p Value
General surgery, %	17.9	21.4	< .001	20.4	24.4	23.8	< .001
Ob-Gyn surgery, total, %	14.5	18.7	< .001	18.1	21.8	16.3	NS
Caesarian section	8.5	9.8	NS	9.3	12.0	8.5	NS
Other Ob-Gyn	5.9	8.9	< .001	8.8	9.8	7.8	NS
Orthopedic surgery, %	15.9	19.0	< .001	18.6	19.7	22.0	NS

Compared to patients undergoing general surgery procedures in urban hospitals, those in rural hospitals were significantly less likely to be in the upper quartile of predicted resource demand (53.1% vs. 58.6%, p<.001), predicted length of stay (42.4% vs. 45.1%, p<.05), and predicted mortality (22.2% vs. 25.0%), p<.01) (Figure 1).

Figure 1. Proportion of General Surgery Patients in Top 25% for Predicted Resource Demand, Length of Stay and Mortality Risk by Rural-Urban Category, 2005 National Inpatient Sample

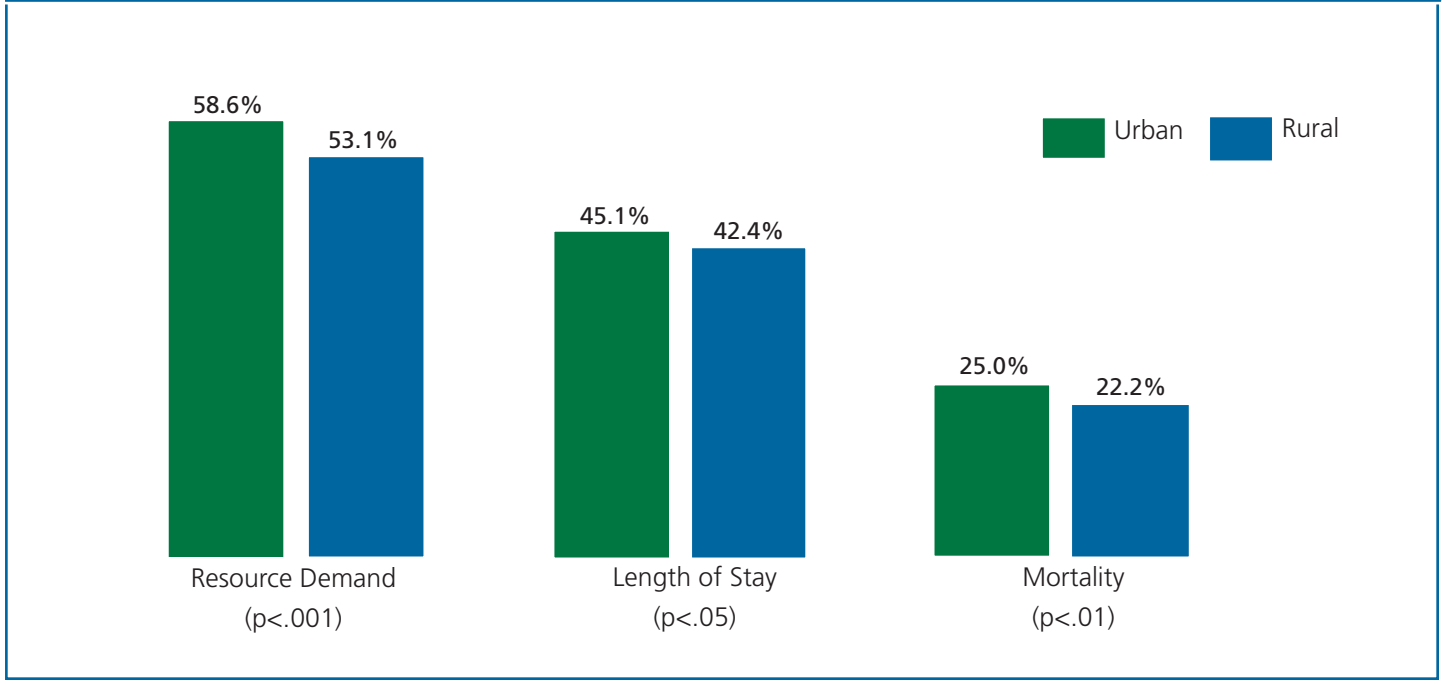

Table 3. Proportion of Specific General Surgery Procedures by Rural-Urban Category, 2005 National Inpatient Sample

General Surgery	Urban (n = 328,411)	Total Rural (n = 39,027)	p Value	Large Rural (n = 28,069)	Small Rural (n = 8,608)	Isolated Rural (n = 2,350)	p Value
Cholecystectomy & common bile duct, %	14.3	20.9	< .001	21.1	20.2	20.9	NS
Appendix, %	12.0	15.6	< .001	14.7	17.9	17.9	.01
Bowel (large and small), %	18.4	19.8	.02	20.0	19.4	18.9	NS
Skin, %	15.1	13.8	.05	13.0	15.8	16.2	.01
Hernia, %	5.6	6.5	< .001	6.4	6.4	8.0	NS
Breast, %	3.6	3.6	NS	3.8	3.1	3.6	NS
Esophagus and stomach, %	12.7	7.3	< .001	7.7	6.3	5.2	NS
Other abdominal (e.g., laparoscopy), %	8.5	7.5	.02	7.8	7.3	5.0	.007
Spleen, thyroid and miscellaneous, %	9.7	5.0	< .001	5.6	3.4	4.4	< .001

Obstetrics & Gynecology Surgery	Urban (n = 108,876)	Total Rural (n = 16,359)	p Value	Large Rural (n = 12,071)	Small Rural (n = 3,512)	Isolated Rural (n = 776)	p Value
Caesarian Section, %	8.5	9.8	NS	9.3	12.0	8.5	NS
Ovary and tube, %	18.6	18.9	NS	18.3	20.5	19.6	NS
Uterine, %	60.4	60.5	NS	61.7	57.0	56.6	NS
D&C and related procedures, %	5.6	3.8	< .001	3.5	4.5	4.3	NS
Prolapse and Incontinence, %	6.8	7.1	NS	7.2	6.0	11.0	NS

Orthopaedic Surgery	Urban (n = 293,222)	Total Rural (n = 34,570)	p Value	Large Rural (n = 25,281)	Small Rural (n = 7,130)	Isolated Rural (n = 2,159)	p Value
Arthroscopy/joint procedures, %	0.3	0.3	NS	0.3	0.3	0.2	NS
Upper extremity fracture/dislocation, %	2.3	2.8	.05	2.9	2.9	1.8	NS
Hip/femur fracture/dislocation, %	11.4	15.9	< .001	16.0	16.5	12.8	NS
Lower extremity fracture/dislocation, %	7.5	9.8	< .001	9.8	11.1	6.5	NS
Other fracture/dislocation, %	3.9	3.3	.04	3.1	4.4	2.4	.01
Knee, %	23.1	31.2	< .001	30.4	32.9	35.4	NS
Hip, %	19.1	23.7	< .001	23.2	24.0	28.7	.05
Amputation, %	4.4	4.3	NS	4.5	4.2	3.3	NS
Spine, %	28.0	8.6	< .001	9.9	3.8	8.9	.03

Table 4. Proportion of General Surgery Patients with Complications by Rural-Urban Category, 2005 National Inpatient Sample

	Urban (n = 328,411)	Total Rural (n = 39,027)	p Value	Large Rural (n = 28,069)	Small Rural (n = 8,608)	Isolated Rural (n = 2,350)	p Value
Any complications, %	48.7	45.3	< .001	45.8	44.3	43.6	.31
Serious complications, %	12.7	9.4	< .001	10.0	8.1	7.8	.05

DISCUSSION

These analyses revealed substantial differences in inpatient procedure patterns and patient characteristics between rural and urban settings and explored these differences across the spectrum of rural locations. The tables show that among rural hospitals, inpatient general surgery procedures clustered around the most common types of operations performed with a major emphasis on relative low technology procedures and this finding was magnified in small rural and isolated rural locations. Procedures falling outside the scope of typical general surgery training, such as ob-gyn and orthopedics procedures, also accounted for a high proportion of inpatient procedures in rural settings. Moreover, general surgery procedures in rural hospitals were performed on relatively low-risk patients, despite the finding that rural patients are more likely to have Medicare or Medicaid health insurance coverage. One would expect that on balance rural patients might be at higher risk and have more co-morbidity than their urban peers, as Medicaid is a marker for low socioeconomic status and Medicare is a marker for advancing age or other serious illness, such as kidney disease requiring dialysis. This suggests that higher risk rural-dwelling patients are being sent to larger, presumably, urban hospitals that have greater capacity to perform high risk surgery in complicated individuals, while lower risk patients with a lower risk of complications are being treated closer to their homes. Further research would be needed to explore the topic of rural surgical referral and transfer patterns in depth.

POLICY DISCUSSION

Our observations have implications for rural general surgery education. As has been argued by other authors,[12,15,23-25] the production of general surgeons with competence in a core set of "traditional" general surgical procedures, plus additional competence in a smaller set of selected ob-gyn and orthopedics procedures, could address a substantial proportion of the inpatient surgery needs of rural hospitals. Our findings lend further credence to this approach as a nationwide strategy. While a handful of programs currently offer rural-oriented training, most general surgery residencies do not.[23,24]

Furthermore, there is no compelling reason why core competencies for rural practice could not be acquired within most, if not all, existing general surgery residencies without the need for extending the length of training or even basing the training in rural locations. Several organizations, including the influential American Surgical Associations' Blue Ribbon Committee on Surgical Education, the American College of Surgeons, and the Residency Review Committee for Surgery, have recommend that surgical residency training be restructured to permit earlier entry into subspecialty training following 2 to 3 years of basic core surgical education.[26,27] Such restructuring runs the risk of accelerating subspecialization at the expense of producing graduates committed to rural general surgery careers. However, if this effort could be aligned with financial and other incentives to stimulate medical students to choose rural general surgery careers,[8] such restructuring could spur interest in "rural training tracks" emphasizing "routine general surgery, ob-gyn and orthopedics procedures, while reducing the effort spent on training residents in more complex general surgical cases that are unlikely to be performed in rural settings.[2]

With the advent of accountable care organizations and more coordinated systems of care, our findings also have implications for creating more rational rural-urban referral networks. Rural hospitals concentrate on relatively common, low complexity general surgery procedures performed on relatively low-risk patients. Presumably, more complex cases are referred to high volume, tertiary care settings, but considerable variability exists in rural-urban referral patterns.[28] Additional research further characterizing the underlying reasons for rural-urban referral patterns and describing deviation from the norm could be used to stimulate a greater emphasis on standardized approaches to regionalization across rural and urban settings. Having such information could guide rural hospital administrators as they make decisions about staffing and investing in expensive technologies needed to support operative care. In addition, more information is needed about orthopedic and obstetric/gynecology specialist penetration into rural areas and how the content of their practices differs from their urban counterparts.

This study is subject to several limitations. While the 2005 NIS provided a representative sample of short stay hospitalizations, 26 states and the District of Columbia were not included in this analysis. While it possible that our findings may, therefore, not be generalizable to all rural U.S. locations, the 24 states included in this study represent the four major U.S. Census Bureau Regions, so it is unlikely this potential bias is a major issue. Also, the use of administrative data characterizing inpatient procedures presented an opportunity to examine the range of surgical services provided in hospital settings, but did not permit assignment of these procedures to individual surgeons. Other data sources would be needed to explore the relative contribution of general surgeons, obstetrician-gynecologists, orthopedic surgeons, and other specialists to inpatient surgery in rural and urban settings. This study was not able to explore surgery occurring outside of the hospital inpatient setting, so rural-urban differences in outpatient procedures were not examined. Finally, this study did not examine minor surgical and endoscopic procedures, which are known to be major components of rural general surgical practice.[4,29,30] Despite these limitations, this national study does offer the advantages of examining general surgery, ob-gyn and orthopedic inpatient procedures in large rural, small rural and isolated rural settings and in the context of the severity of illness of the patients undergoing these procedures.

If current societal trends continue, there will not be enough new general surgeons to replace the existing pool of rural general surgeons as they retire. Powerful strategies to address this looming crisis must be advanced quickly, as the production of a general surgeon requires many years of medical school and residency training. One critically important solution lies in training a cadre of new general surgeons who are prepared to address the needs of rural practice. Our findings suggest that a renewed emphasis on rural training tracks within existing programs may be warranted. Another solution would be to implement more rational, data-driven approaches to rural-urban referral patterns. As the rural population grows and ages, the urgency of implementing these and other strategies to sustain the rural general surgery workforce should not be underemphasized.

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