UC Davis
UC Davis Previously Published Works

Title

Relative value units poorly correlate with measures of surgical effort and complexity

Permalink

Journal

ISSN

Authors

Shah, Dhruvil R
Bold, Richard J
Yang, Anthony D
et al.

Publication Date

DOI

Peer reviewed

RVUs poorly correlate with measures of surgical effort and complexity

Dhruvil R. Shah, MD[1], **Richard J. Bold, MD**[1], **Anthony D. Yang, MD**[1], **Vijay P. Khatri, MBCHB**[1], **Steve R. Martinez, MD, MAS**[1], and **Robert J. Canter, MD, MAS**[1]

[1]University of California Davis, Department of Surgery, Division of Surgical Oncology

Abstract

Background—The relationship between procedural relative value units (RVUs) for surgical procedures and other measures of surgeon effort are poorly characterized. We hypothesized that RVUs would poorly correlate with quantifiable metrics of surgeon effort.

Methods—Using the 2010 ACS-NSQIP database, we selected 11 primary CPT codes associated with high volume surgical procedures. We then identified all patients with a single reported procedural RVU who underwent non-emergent, inpatient general surgical operations. We used linear regression to correlate length of stay, operative time, overall morbidity, frequency of serious adverse events (SAEs), and mortality with RVUs. We used multivariable logistic regression using all pre-operative NSQIP variables to determine other significant predictors of our outcome measures.

Results—Among 14,481 patients, RVUs poorly correlated with individual length of stay (R^2=0.05), operative time (R^2=0.10), and mortality (R^2=0.35). There was a moderate correlation between RVUs and SAEs (R^2 =0.79), and RVUs and overall morbidity (R^2=0.75). However, among low to mid-level RVU procedures (11 to 35) there was a poor correlation between SAEs (R^2=0.15), overall morbidity (R^2=0.05), and RVUs. On multivariable analysis, RVUs were significant predictors of operative time, length of stay, and SAEs (OR 1.06, 95%CI: 1.05–1.07), but RVUs were not a significant predictor of mortality (OR 1.02, 95%CI: 0.99–1.05)

Conclusion—For common, index general surgery procedures, the current RVU assignments poorly correlate with certain metrics of surgeon work, while moderately correlating with others. Given the increasing emphasis on measuring and tracking surgeon productivity, more objective measures of surgeon work and productivity should be developed.

Correspondence: Robert J. Canter, MD, MAS, Division of Surgical Oncology, Suite 3010, UC Davis Comprehensive Cancer Center, 4501 X Street, Sacramento, CA 95817, Phone: (916) 734-7044, Fax: (916) 703-5267, Robert.canter@ucdmc.ucdavis.edu.

Keywords

relative value units; operative time; length of stay; adverse events; morbidity and mortality

Introduction

Since the development of a fee-for-service model for determining Medicare reimbursement
(1), relative value units (RVUs) have become a metric of physician work and productivity.
Currently, the assignment of RVUs is under the discretion of a select committee known as
the RUC (Relative Value Scale Update Committee) which has substantial influence in
determining RVU levels. Moreover, this committee is constrained by Medicare budgetary
restrictions which effectively force them to decrease the RVU levels of some services when
it recommends raising the RVU level of other services. Consequently, the process of
assigning RVUs is highly subjective and predisposed to significant external forces (2).
Moreover, there is concern that RVU levels may not accurately reflect a surgeon's work,
productivity, or "value" to his or her department, hospital or community.

Given the increasing emphasis on measuring and tracking surgeon productivity, we sought
to determine if primary procedure RVUs among general surgical operations would correlate
with other markers of surgeon work. As our main outcome variables we chose to analyze
operative time, length of stay (LOS), and morbidity and mortality rates, since these are
proxies for the physical and cognitive time invested by surgeons in the care of their patients.
We hypothesized that there would be poor correlation between primary procedure RVUs
and these endpoints.

Methods

The 2010 ACS-NSQIP database was queried for all patients who underwent non-emergent,
inpatient, general surgical operations as defined by a LOS greater than or equal to one day.
We identified frequently represented primary procedural RVUs to arrive at eleven
commonly performed general surgical procedures that represented the full breadth of
surgical complexity. As depicted in Table 1, in order to sample as diverse a group of
procedures as possible across the RVU continuum, we included laparoscopic and open
procedures, oncologic and non-oncologic procedures, and visceral vs. non-visceral
procedures. To avoid skewing our data toward high volume, low RVU procedures, we chose
to exclude appendectomy and cholecystectomy since these procedures appeared to dominant
the dataset and therefore diluted the results and significance of other procedures. In addition,
these two procedures were excluded to avoid possible heterogeneity in patient and procedure
risk factors associated with emergent operations compared to elective procedures.

To avoid possible confounding of our data from the effect of multiple procedures with
overlapping and/or additive morbidities, we limited our cases to those where only one
procedure was performed. We also excluded patients who were ASA 1 or 4 in order to
reduce the impact of co-morbid disease on our observed outcome variables. We were not
able to capture data on the variation in hospital re-admission or complications after 30 days
by procedure or RVU level. We were not able to capture data on the number of

postoperative visits or the generation of additional RVUs in the 90-day global period because of additional evaluation and management (E&M) coding or for the surgical management of postoperative complications.

Linear regression was used to correlate operative time and LOS with RVUs. For this part of our analysis, patients who experienced any post-operative morbidity or mortality were excluded since the type and severity of the morbidity could function as a modifier variable and affect operative time and LOS independent of RVU. Multivariable linear regression using all pre-operative NSQIP variables was then used to determine whether RVUs were significant predictors of these outcome variables. Descriptive statistics were used to analyze frequency of overall 30-day morbidity, SAEs, and mortality per primary procedural RVU. These outcomes were included as outcome variables in our analysis since the evaluation and management postoperative morbidity and mortality require time, work, and effort.

SAEs were defined as the presence of one or more of the following: organ space infection, wound dehiscence, septic shock, myocardial infarction, cardiac arrest, CVA, coma, renal failure, pneumonia, re-intubation, pulmonary embolism, or bleeding (3, 4). We also performed multivariable logistic regression using all pre-operative NSQIP variables, including RVUs, to determine if RVUs were significant predictors of overall morbidity, SAEs, and mortality. Missing variables were excluded, and statistical analyses were performed using STATA.

Because NSQIP patient information is de-identified, this study was exempt from University of California, Davis institutional review board approval.

Results

A total of 14,481 patients met inclusion criteria. The frequency of primary procedures and associated RVUs are depicted in Table 1. Laparoscopic Roux-en-Y gastric bypass was the most frequently performed procedure (44%), followed by laparoscopic (16%) and open (10%) partial colectomy.

As depicted in Figures 1A and 2A, there was substantial variability in median LOS and median operative time, particularly among the low to mid-level RVU procedures (11 to 35). The median LOS for patients who did not experience any post-operative morbidity ranged from 1 (IQR: 1–2) day for thyroidectomy to 9 (IQR: 8–11) days for trans-hiatal esophagectomy. Median operative time was shortest for repair of abdominal wall hernia (88.5, IQR: 57–128) and longest for Whipple procedure (351, IQR: 280–421).

As depicted in Figures 1B and 2B, increasing RVUs poorly correlated with LOS (R^2=0.06) and total operative time (R^2=0.10) at the individual patient level. However, linear regression did reveal a relatively strong correlation when evaluating median LOS (R^2=0.68) and median operative time (R^2=0.76) at the aggregate procedural level. Among patients undergoing low to mid-level RVU procedures (11 to 35), the correlation with median LOS (R^2=0.24) and median operative time (R^2=0.66) became weaker. On multivariable linear regression (data not shown), RVUs were a statistically significant predictor of both operative time ($p<0.001$) and length of stay ($p<0.001$).

We also analyzed the correlation between RVU level and median LOS and operative time irrespective of whether post-operative morbidity occurred. We observed no significant differences in our results with poor correlation between RVU level and median LOS and operative time, particularly for low and mid-level RVU procedures. We then repeated our analyses after excluding laparoscopic gastric bypass operations. It is interesting to note that we did observe some differences in our results with this approach. For example, the correlation coefficients between RVUs and morbidity ($R^2=0.75$), RVUs and mortality ($R^2=0.42$), RVUs and serious adverse events ($R^2=0.74$), RVUs and median length of stay ($R^2=0.77$), and RVUs and median operative time ($R^2=0.68$) were all improved.

As depicted in Figure 3, there was substantial variation in 30-day overall morbidity and frequency of SAEs between procedure RVUs, especially among mid-level (11 to 35) RVU procedures. For example, the lowest RVU procedure, repair of abdominal wall hernia was associated with greater 30-day overall morbidity (11%) than simple mastectomy (6%), total thyroidectomy (2%), laparoscopic Nissen fundoplication (4%), and laparoscopic Roux-en-Y gastric bypass (5%). In addition, laparoscopic Roux-en-Y gastric bypass, despite having one of the higher RVU designations, had one of the lowest rates of post-operative morbidity, frequency of SAEs, and mortality. These rates were substantially lower than laparoscopic partial colectomy, which is assigned 3 fewer RVUs (an approximately 10% difference) by the current system.

There was a trend towards increasing morbidity and frequency of SAEs with procedures assigned RVUs greater than 35. For example, Whipple procedure (52.8 RVUs) had the highest 30-day overall morbidity and frequency of SAEs (45% and 35%, respectively), while trans-hiatal esophagectomy (44.2 RVUs) had the second highest (32% and 21%, respectively), and partial hepatectomy (39 RVUs) had the third highest (25% and 22% respectively).

On regression analysis, among the entire spectrum of procedures, there was a moderate correlation between RVUs and overall morbidity ($R^2=0.75$) and SAEs ($R^2=0.79$), as shown in Figures 4A and 5A. However, similar to median LOS and median operative time, among the low to mid-level RVUs (11 to 35) there was a much weaker correlation between RVUs and overall morbidity ($R^2=0.05$) and SAEs ($R^2=0.15$), as depicted in Figures 4B and 5B.

Although postoperative mortality rates were overall low, the highest rates were observed among trans-hiatal esophagectomy (5%), distal gastrectomy (3%), partial colectomy (2%), and Whipple procedure (2%). These mortality rates also correlated relatively poorly with increasing RVU levels ($R^2=0.36$).

On multivariable analysis (data not shown) RVUs were a statistically significant predictor of SAEs (OR 1.06, 95%CI: 1.05–1.07), but not mortality (OR 1.02, 95%CI: 0.99–1.05).

Discussion

Limited data exist validating the assumption that RVUs proportionately and accurately reflect the time and work required by surgeons to provide complete care to their patients. Resnick et al (5) demonstrated the substantial disconnect between revenues generated and

Finally, our outcome measures are metrics that primarily quantify surgeon time spent as a representation of actual work performed. However, we acknowledge they are also not ideal markers to measure surgeon productivity since were unable to track the amount of procedures performed by a surgeon within a time period. It is possible that skilled and experienced surgeons can perform a particular operation faster, more frequently, and with less associated morbidity than other less experienced surgeons, and thus be more productive while working the same amount of time. Despite this potential inverse relationship between operative time and surgeon work, we felt that outcome variable was an important objective metric to use since it is one of the criteria used by the RUC to determine RVUs (13). However, the RUC primarily uses survey data, which are highly subjective, to estimate operative time.

In addition, there are other less easily quantifiable factors that comprise surgeon work that are not abstracted by NSQIP. These include time spent in pre-operative activities such as counseling, operative planning, committee work, and especially administrative work which has increased substantially, comprising 10 to 15% of surgeon work (14). Among surgeons at academic centers, medical education and outreach activities are still not represented in RVU productivity despite attempts to develop metrics for such activities (15). These activities may comprise a significant portion of surgeon work that may strengthen or weaken the correlation of RVUs with surgeon work for which we are unable to control in our dataset.

In summary, our data indicate that the current RVU based system poorly correlates with certain metrics of surgeon work, while moderately correlating with others. Given the increasing emphasis on measuring and tracking surgeon productivity, more objective measures of surgeon work and productivity should be developed.

References

1. Hsiao WC, Yntema DB, Braun P, Dunn D, Spencer C. Measurement and analysis of intraservice work. JAMA : the journal of the American Medical Association. 1988; 260:2361–2370. [PubMed: 3172406]

2. Beyer DC, Mohideen N. The role of physicians and medical organizations in the development, analysis, and implementation of health care policy. Seminars in radiation oncology. 2008; 18:186–193. [PubMed: 18513628]

3. Ehlert BA, Durham CA, Parker FM, Bogey WM, Powell CS, Stoner MC. Impact of operative indication and surgical complexity on outcomes after thoracic endovascular aortic repair at National Surgical Quality Improvement Program Centers. Journal of vascular surgery. 2011; 54:1629–1636. [PubMed: 21944918]

4. Ingraham AM, Cohen ME, Ko CY, Hall BL. A current profile and assessment of north american cholecystectomy: results from the american college of surgeons national surgical quality improvement program. Journal of the American College of Surgeons. 2010; 211:176–186. [PubMed: 20670855]

5. Resnick AS, Corrigan D, Mullen JL, Kaiser LR. Surgeon contribution to hospital bottom line: not all are created equal. Ann Surg. 2005; 242:530–537. discussion 537–539. [PubMed: 16192813]

6. Little DC, St Peter SD, Calkins CM, Shah SR, Murphy JP, Gatti JM, Gittes GK, Sharp RJ, Andrews WS, Holcomb GW 3rd, Ostlie DJ, Snyder CL. Relative value units correlate with pediatric surgeons' operating time: when perceived myth becomes reality. Journal of pediatric surgery. 2006; 41:234–238. discussion 234–238. [PubMed: 16410140]

7. Nguyen KT, Gart MS, Smetona JT, Aggarwal A, Bilimoria KY, Kim JY. The relationship between relative value units and outcomes: a multivariate analysis of plastic surgery procedures. Eplasty. 2012; 12:e60. [PubMed: 23308307]

8. Shah DR, Martinez SR, Canter RJ, Yang AD, Bold RJ, Khatri VP. Comparative morbidity and mortality from cervical or thoracic esophageal anastomoses. Journal of surgical oncology. 2013; 108:472–476. [PubMed: 24108568]

9. Connors RC, Reuben BC, Neumayer LA, Bull DA. Comparing outcomes after transthoracic and transhiatal esophagectomy: a 5-year prospective cohort of 17,395 patients. Journal of the American College of Surgeons. 2007; 205:735–740. [PubMed: 18035255]

10. Behrman SW, Rush BT, Dilawari RA. A modern analysis of morbidity after pancreatic resection. The American surgeon. 2004; 70:675–682. discussion 682–673. [PubMed: 15328799]

11. Degiuli M, Sasako M, Calgaro M, Garino M, Rebecchi F, Mineccia M, Scaglione D, Andreone D, Ponti A, Calvo F. Morbidity and mortality after D1 and D2 gastrectomy for cancer: interim analysis of the Italian Gastric Cancer Study Group (IGCSG) randomised surgical trial. European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology. 2004; 30:303–308.

12. Nguyen NT, Masoomi H, Magno CP, Nguyen XM, Laugenour K, Lane J. Trends in use of bariatric surgery, 2003–2008. Journal of the American College of Surgeons. 2011; 213:261–266. [PubMed: 21624841]

13. McCall N, Cromwell J, Braun P. Validation of physician survey estimates of surgical time using operating room logs. Medical care research and review : MCRR. 2006; 63:764–777. [PubMed: 17099125]

14. Satiani B. Use, misuse, and underuse of work relative value units in a vascular surgery practice. Journal of vascular surgery. 2012; 56:267–272. [PubMed: 22579074]

15. Berger JR, Maher RF Jr. An innovative approach for calculating the work relative value units of clinical activities otherwise concealed. Academic medicine : journal of the Association of American Medical Colleges. 2011; 86:853–857. [PubMed: 21617515]
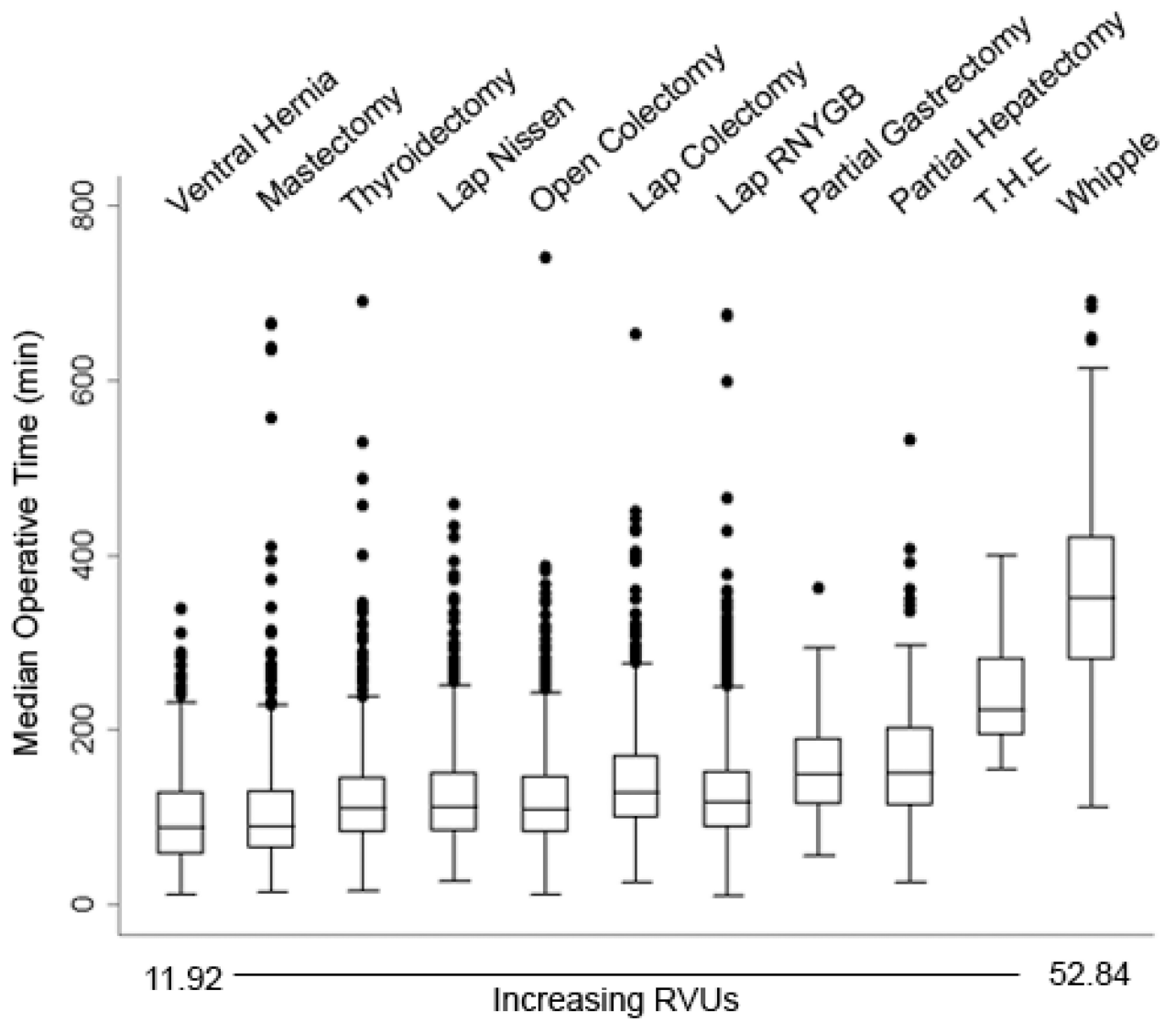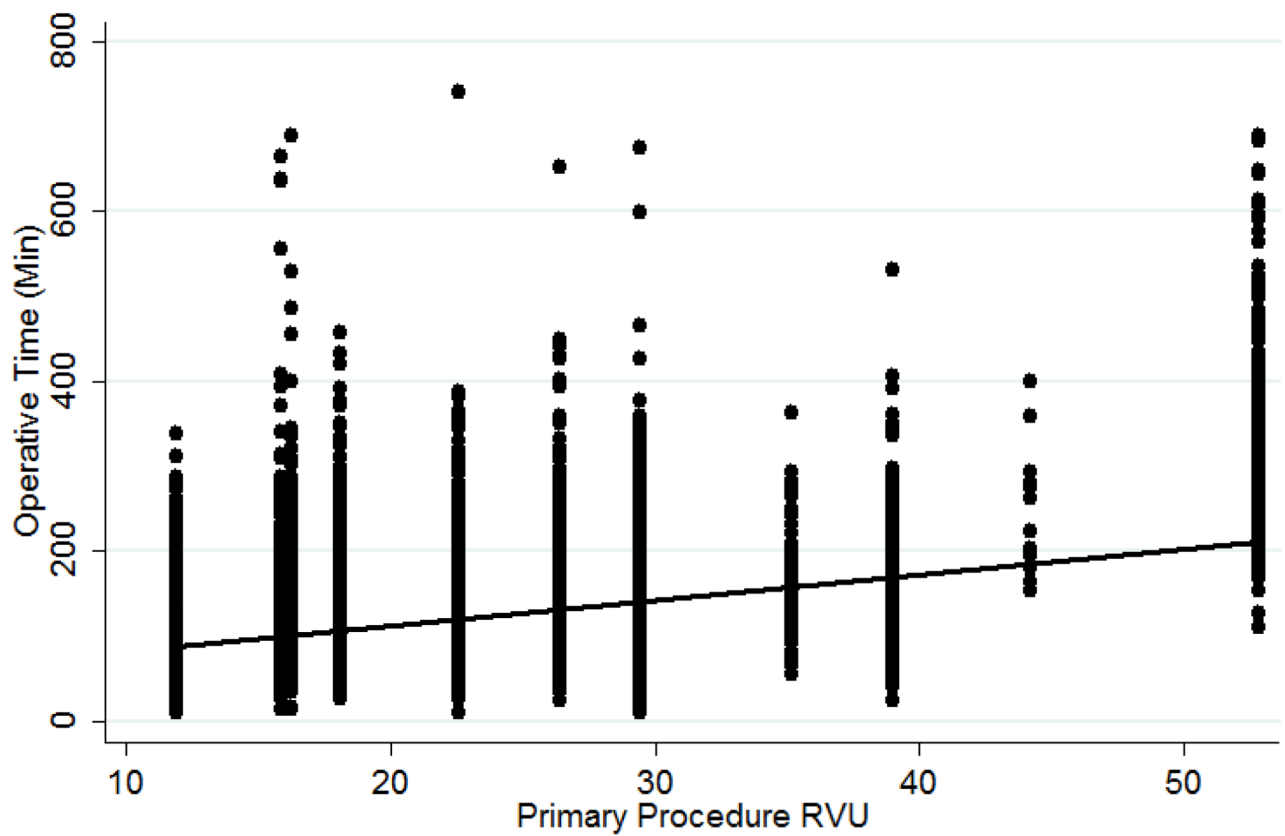
A.
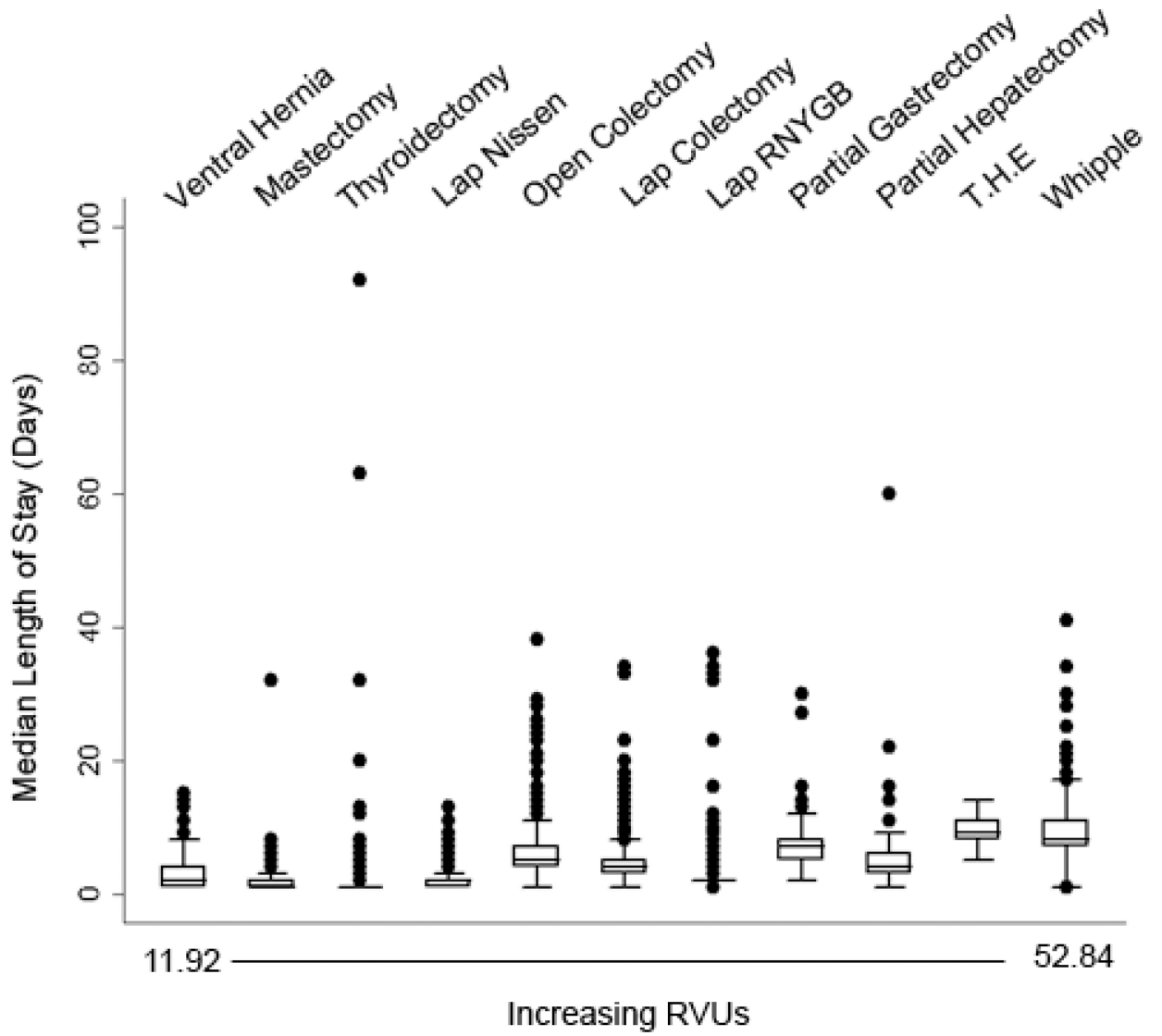
B.
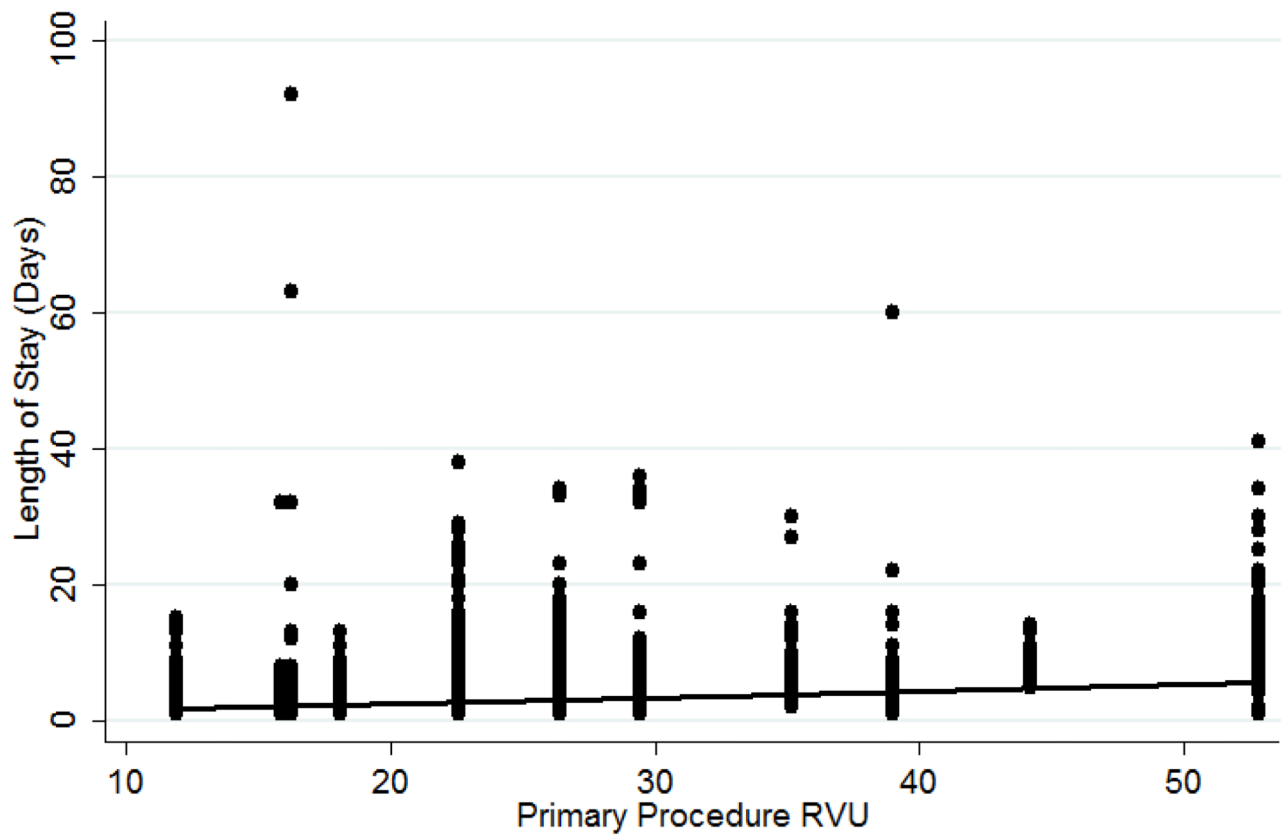
Figure 1.
A. Median length of stays in days (horizontal line) along with interquartile range (boxed region) per primary procedure RVU in patients with no 30-day post-operative complications. All other dots represent patient outliers. Abbreviations: RNYGB - roux-n-y gastric bypass, T.H.E - trans-hiatal esophagectomy.
B. RVU vs. individual length of stay (days) in patients with no 30-day post-operative complications.
$R^2=0.06$

A.

B.

Figure 2.
A. Median operative time in minutes (horizontal line) along with interquartile range (boxed region) per primary procedure RVU in patients with no 30-day post-operative complications. All other dots represent patient outliers. Abbreviations: RNYGB - roux-n-y gastric bypass, T.H.E - trans-hiatal esophagectomy.
B. RVU vs. individual operative time (minutes) in patients with no 30-day post-operative complications.
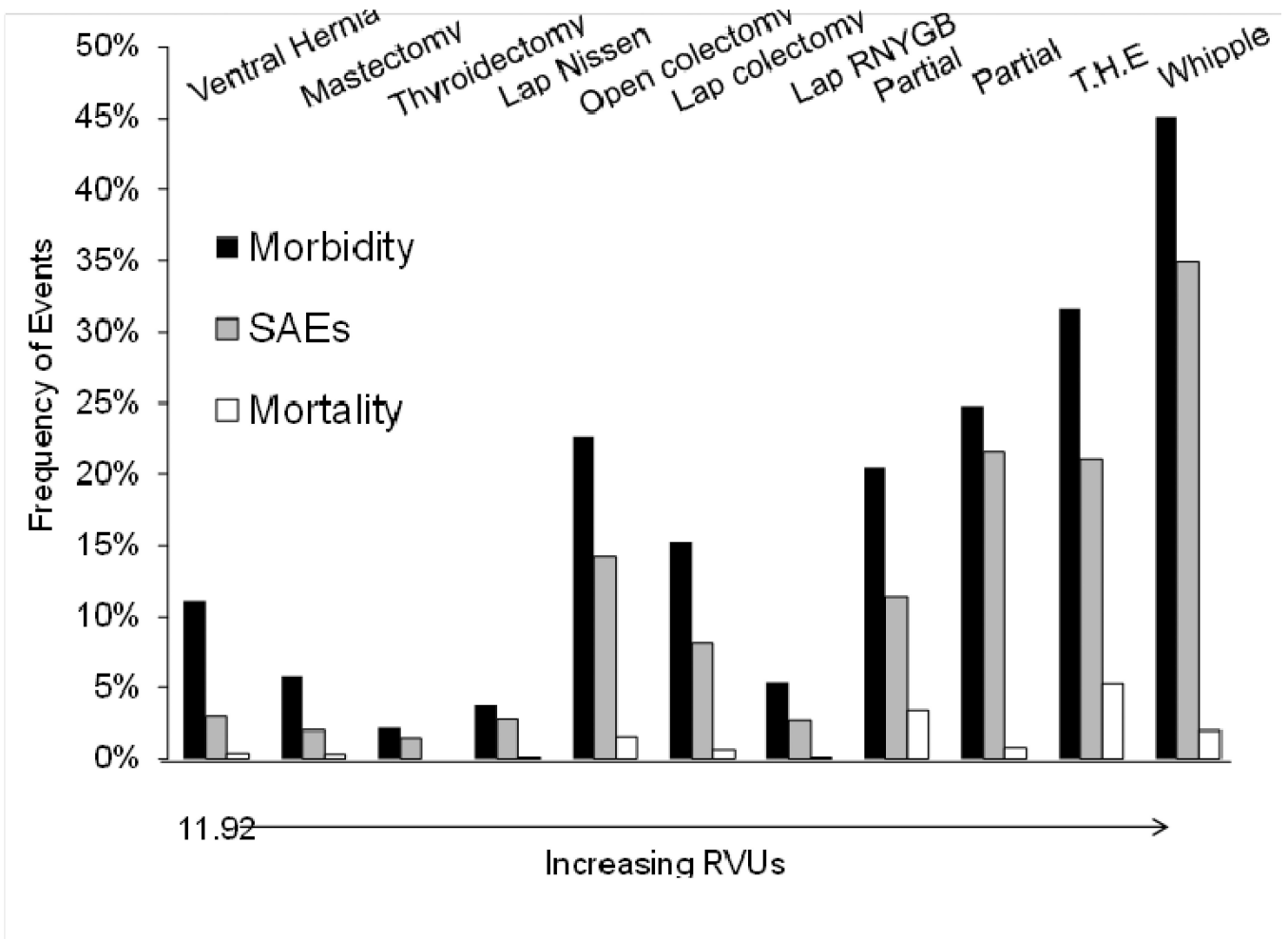$R^2=0.10$

Figure 3.
Frequency of overall 30-day morbidity, serious adverse events (SAEs), and mortality by procedure RVU. Abbreviations: RNYGB - roux-n-y gastric bypass, T.H.E - trans-hiatal esophagectomy.
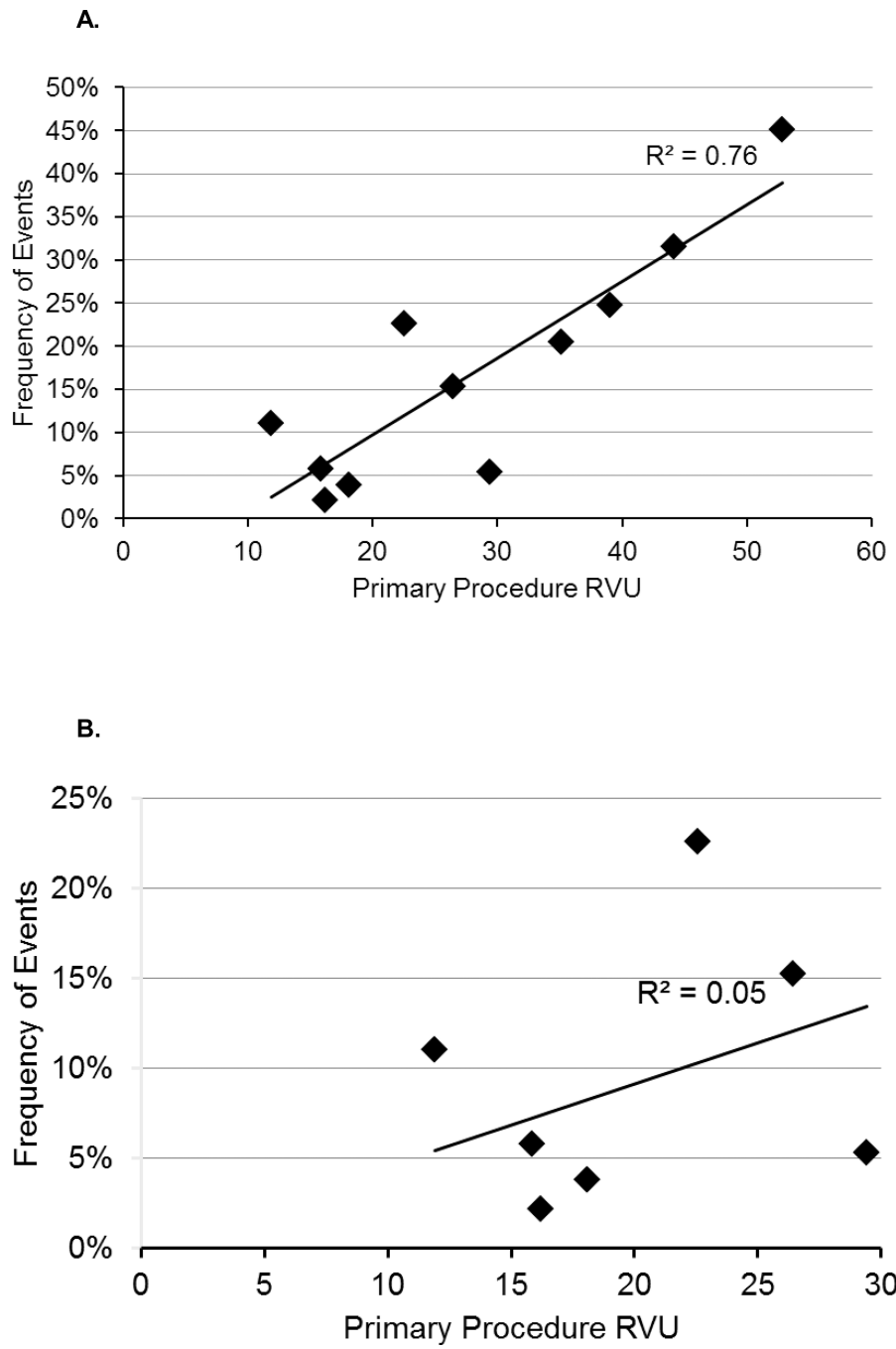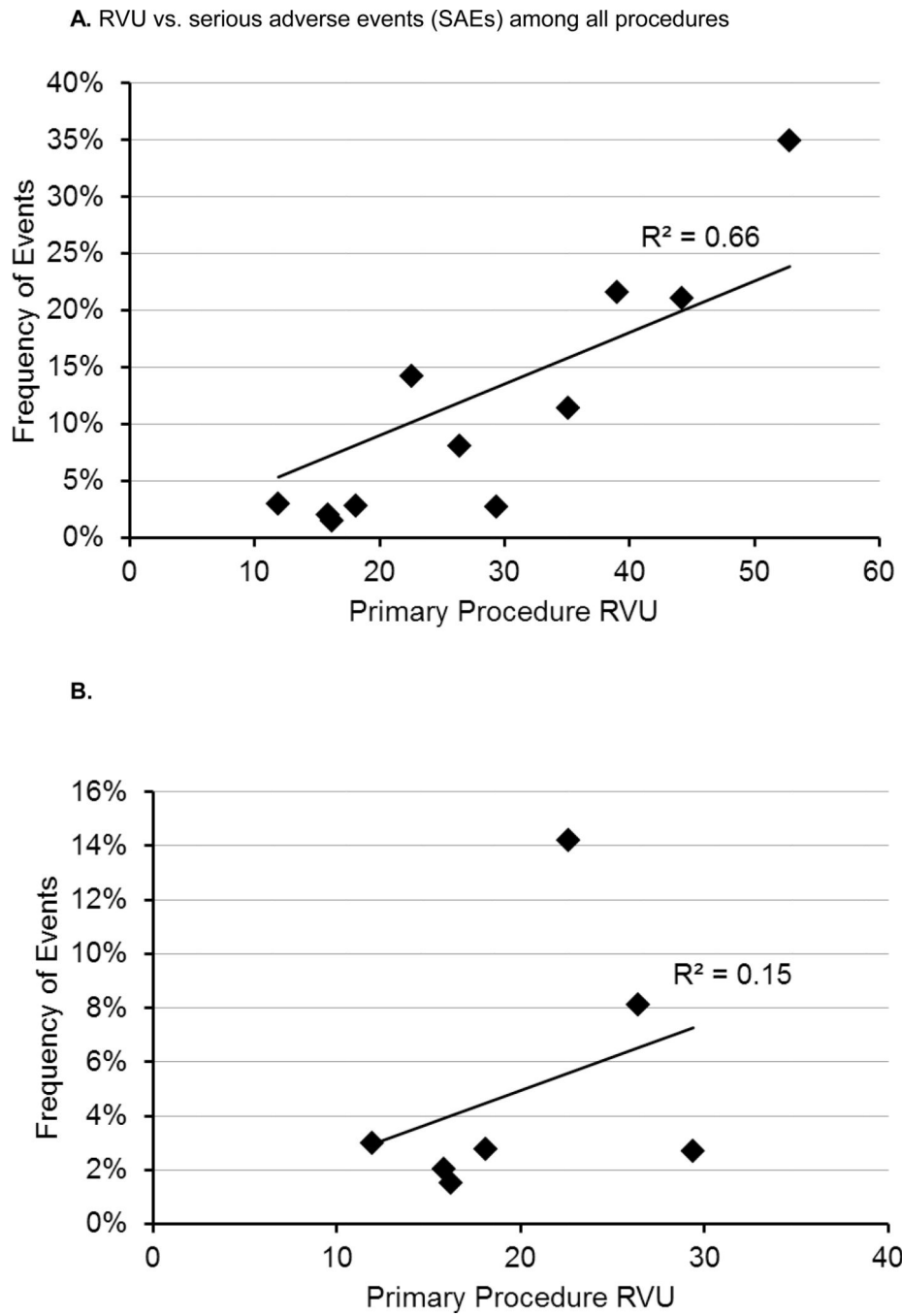
A.

B.

Figure 4.

A. RVU vs. serious adverse events (SAEs) among all procedures

B.

Figure 5.

Table 1

Case mix, operative time, length of stay (LOS), morbidity, and serious adverse events (SAE) by RVUs. Only patients with a single RVU coded were included (N=14481).

RVU	CPT	Procedure	N(%)	*Median LOS (IQR)	*Median OR Time (IQR)	Morbidity (%)	SAE (%)	Mortality (%)
11.92	49560	Repair of first abdominal wall hernia	533 (4)	2 (1–4)	88.5 (57–128)	11	3	<1
15.85	19303	Simple mastectomy	639 (4)	1 (1–2)	89 (64–130)	6	2	<1
16.22	60240	Total thyroidectomy	1470 (10)	1 (1–1)	110 (83–145)	2	1	0
18.1	43280	Laparoscopic Nissen fundoplication	1043 (7)	2 (1–2)	111 (84–151)	4	3	<1
22.59	44140	Open partial colectomy	1487 (10)	5 (4–7)	109 (82–147)	23	14	2
26.42	44204	Laparoscopic partial colectomy	2245 (16)	4 (3–5)	128 (99–170)	15	8	<1
29.4	43644	Laparoscopic roux-n-y gastric bypass	6306 (44)	2 (2)	117 (88–152)	5	3	<1
35.14	43632	Distal gastrectomy with gastrojejunostomy	88 (1)	7 (5–8)	149 (115–190)	20	11	3
39.01	47120	Partial liver resection	250 (2)	4 (3–6)	151 (113–201.5)	25	22	<1
44.18	43107	Trans-hiatal esophagectomy	19 (<1)	9 (8–11)	223 (194–281)	32	21	5
52.84	48150	Whipple	401 (3)	8 (7–11)	351 (280.5–421)	45	35	2

*Only patients without any post-operative morbidity or mortality were included in these calculations.