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National trends in perioperative epidural analgesia use for surgical patients

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Abstract

Study objective: Newer regional anesthesia techniques and minimally invasive surgeries have yielded decreased postoperative pain scores, potentially leading to decreased need for perioperative epidural analgesia. Limited literature is available on trends in usage rates of epidurals. The objective of this study was to identify trends in perioperative epidural analgesia rates among multiple fields of surgery.

Methods: All patients undergoing general, thoracic, urologic, plastic, vascular, orthopedic, or gynecological surgery in 2014–2020 were included from the National Surgical Quality Improvement Program database of over 700 hospitals in the U.S. and 11 different countries. Annual trends in epidural analgesia for all surgeries and each surgical specialty were assessed

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Author contributions

Dale N. Bongbong, BS: This author helped with conceptualization, writing of the original draft, and writing, reviewing and editing of final manuscript.

Waseem Abdou, BS: This author helped with conceptualization, writing of the original draft, and writing, reviewing and editing of final manuscript.

Engy T. Said, MD: This author helped with conceptualization, writing of the original draft, and writing, reviewing and editing of final manuscript.

Rodney A. Gabriel, MD, MAS: This author helped with conceptualization, methodology, formal analysis, data curation, writing of the original draft, and writing, reviewing and editing of final manuscript.

Declaration of competing interest

RG's institution has received funding and/or product for research purposes from Epimed, Infutronix, SPR Therapeutics, Merck, and Precision Genetics. RG is a consultant for Avanos.

CRediT authorship contribution statement

Dale N. Bongbong: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Waseem Abdou:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Engy T. Said:** Writing – review & editing, Writing – original draft, Supervision, Methodology. **Rodney A. Gabriel:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclinane.2024.111642.

by mixed effects multivariable logistic regression. The odds ratios (OR) and 99 % confidence intervals (CI) were reported.

Results: There were 3,111,435 patients from 2014 to 2020 that were included in the final analysis, in which 107,209 (3.4 %) received perioperative epidural analgesia. Among all surgeries combined, epidural use throughout the study period decreased (OR 0.98 per year, 99 % CI 0.97–0.98, $P < 0.001$). When only analyzing the surgeries with the top 5 most frequent epidural use per specialty, there was no statistically significant trend in epidural utilization (OR 0.99 per year, 99 % CI 0.99–1.00, $P = 0.09$). However, there was an increasing trend in epidural utilization in general surgery (OR 1.05 per year, 99 % CI 1.03–1.07, $P < 0.001$) and vascular surgery (OR 1.08 per year, 99 % CI 1.05–1.10, $P < 0.001$).

Conclusion: Rates of perioperative epidural analgesia use has decreased in recent years overall, however, among surgeries within the general surgery and vascular surgery specialty, utilization has increased for procedures that have the highest rates of usage.

Keywords

Epidural; Acute pain service; Regional anesthesia

1. Introduction

With the ongoing changes in anesthesia (specifically with alternative modalities for analgesia) and surgical practice (specifically with implementation of less invasive procedures) throughout the decade, the question becomes whether rates of epidural utilization for analgesia and anesthesia have changed. Epidural analgesia, whether performed in the lumbar or thoracic region, has been an effective modality for postoperative analgesia and anesthesia for many surgical procedures. The use of epidurals in a perioperative anesthetic plan has been associated with several benefits, including decreased postoperative hospital length of stay [1,2], cardiovascular complications [3,4], respiratory complications [5], postoperative opioid consumption [6], and total hospital costs [7]. Despite the described benefits of epidurals, there are downsides, including epidural placement failure [8,9], hemodynamic instability [10,11], delays in operating room workflow [12], infection [13,14], and neuraxial hematoma [15,16].

Throughout the last decade, there have been several alternative modalities described for postoperative analgesia, including but not limited to, intrathecal morphine, fascial plane blocks, peripheral nerve blocks, perioperative intravenous lidocaine infusions, cryoneurolysis, as well as pharmacologic agents including non-opioids and opioids [17–19]. Additionally, minimally invasive surgeries offer the potential for decreased tissue damage and requirement for epidural analgesia [20,21]. Given these changes in alternative analgesia modalities and surgical approaches, it is unclear how practices in epidural utilization for non-obstetric surgery has evolved. There is a sparsity of studies that analyze such trends in perioperative epidural use among the array of surgical subspecialties. In this study, we sought to analyze trends in epidural use rates for non-obstetric surgeries using the National Surgical Quality Improvement Program database. We hypothesize that trends in epidural utilization will differ depending on the specific surgical specialty.

2. Methods

2.1. Study sample

Because the database was public and de-identified, it was exempt from our Institutional Review Board (Human Research Protections Program) and consent requirement was waived. The American College of Surgeons (ACS) NSQIP Participant Data File from 2014 to 2020 was used for this study (user guided can be found at https://www.facs.org/media/yaol5yoj/nsqip_puf_userguide_2020.pdf). NSQIP is a database that is well defined throughout the surgical literature and has been used to measure perioperative outcomes [22–24]. This database is case-mixed adjusted and conducts Inter-Rater Reliability Audit of selected sites, which involved the review of medical charts, selected either randomly or based on prespecified criteria. In 2020, NSQIP collected data from more than 700 hospitals in 49 U.S. states and 11 countries [25]. This manuscript adhered to the Strengthening the Reporting of Observational Studies in Epidemiology and Enhancing the Quality and Transparency of Health Research guidelines [26].

For the study population, inclusion criteria were: (1) non-obstetric surgery, including general, thoracic, urologic, plastic, vascular, orthopedics, and gynecology surgery; and (2) surgeries amenable to an epidural. This was defined as only surgeries in which at least one epidural was performed for that surgery in the dataset. Exclusion criteria were: (1) patients who underwent cesarean delivery; and (2) any surgical procedure that appeared <100 times in the dataset.

2.2. Primary objective and study variables

The primary objective of this study was to measure trends in epidural analgesia utilization across non-obstetric surgical patients from 2014 to 2020 within the NSQIP database. The primary outcome of interest was receipt of epidural, which was defined and established a priori at initiation of the study design. This was captured by a description of “Epidural” in the variable “anesthes” (primary anesthetic) and/or “anesthes_other” (secondary anesthetic). The following variables were included as potential confounders on our statistical models: year of surgery, surgical service (general, thoracic, urological, plastics, gynecological, orthopedic, and vascular surgery), history of severe obstructive pulmonary disease (COPD), history of bleeding disorder, age (≥ 65 year of age versus <65 years of age), body mass index (BMI, ≥ 35 kg/m^2 versus <35 kg/m^2), American Society of Anesthesiologists physical status score (ASA PS, ≥ 4 versus <4), preoperative international normalized ratio (INR, ≥1.5 versus <1.5), and preoperative platelet count (< 70,000 versus ≥70,000). To take a conservative approach, patients with unknown values for age (n = 2 [0 %]), BMI (n = 84,211 [2.7 %]), ASA PS (n = 3996 [0.1 %]), INR (n = 1,711,713 [55.0 %]), and platelet (287,276 [9.2 %]) were imputed to be in the reference cohort. There were only a small proportion of cases with unknown values for age, BMI, and ASA PS. We assumed that a majority of missingness for these laboratory values (e.g., INR, platelets) were due to not being indicated clinically preoperatively, and thus they were imputed to be normal.

2.3. Statistical analysis

R Statistical Programming Language (version 4.2.2) was used to perform all statistical analyses. The study population was divided into two cohorts – those that did or did not receive epidural analgesia. Unadjusted comparisons between cohorts were calculated by chi-squared analysis. To measure the trend in epidural use per year, we performed a mixed effects multivariable logistic regression. The dependent variable was the receipt of an epidural. The primary independent variable was year of procedure, which was represented as a continuous integer variable (e.g. the year 2014 was assigned 0, 2015 was assigned 1, 2016 was assigned 2, etc). The other covariates included in this model surgical service, age, BMI, ASA PS classification score, severe COPD, bleeding disorder, preoperative INR, and preoperative platelets. The random effect was the surgical procedure (based on the Current Procedural Terminology code description). A mixed effects logistic regression analysis was performed using: (1) the entire surgical population and then (2) individually with each surgical service. The odds ratio (OR) and the 99 % confidence interval (CI) were reported – this was used instead of the standard 95 % CI due to the large study sample size. Statistical significance was determined if the 99 % CI did not include 1.00 within its range. Regarding secondary outcomes, we then reported the top 5 procedures (based on unique Current Procedural Terminology code) utilizing epidurals for each surgical service. As a subgroup analysis, which was defined and established a priori at initiation of the study design, we then performed another mixed effects multivariable logistic regression in which only the top 5 procedures for each surgical service was only included. The model was performed similarly as above.

3. Results

After exclusion, there were 3,111,435 patients from 2014 to 2020 that were included in the final analysis, in which 107,209 (3.4 %) received perioperative epidural analgesia. The majority of the epidurals were performed in 2017 (15.8 %). Patients undergoing general surgery comprised the highest proportion of the patients receiving epidurals (n = 64,977, 60.6 %). Patients undergoing plastic surgery comprised the lowest proportion (n = 231, 0.2 %). Patients receiving an epidural had a higher proportion of patients with geriatric age, BMI < 35 kg/m^2, ASA PS ≥ 4, severe COPD, no bleeding disorder, normal INR, and platelets ≥70,000 (all P < 0.0001) (Table 1).

3.1. Annual trends in epidural use

The overall rate of epidural use from 2014 to 2020 was 3.8 % and 3.1 %, respectively (Fig. 1). On mixed effects multivariable analysis, there was a trend for decreased epidural use throughout the study period (OR 0.98 per year, 99 % CI 0.97–0.98, P < 0.001) (Table 2).

On subgroup analysis for each surgical specialty, all surgical services had a trend for decreased epidural use during the time period, except for plastic surgery (OR 1.05 per year, 99 % CI 0.98–1.12, P = 0.18) and vascular surgery (OR 1.07 per year, 99 % CI 1.05–1.09, P < 0.001) (Table 3).

The rate of epidural use from 2014 to 2020 within: (1) general surgery was 3.8 % to 3.5 %; (2) thoracic surgery was 14.8 % to 9.2 %; (3) urological surgery was 8.2 % to 7.4 %; (4) plastics surgery was 2.1 % to 3.2 %; (5) gynecological surgery was 3.3 % to 2.2 %; (6) orthopedic surgery was 2.0 % to 1.6 %; and (7) vascular surgery was 4.5 % to 5.6 %.

3.2. Subgroup analysis: annual trends in epidural use among surgeries with highest epidural rates

Next, we analyzed only the top 5 surgeries per surgical specialty that had the highest rates of epidural use overall (Supplementary Table 1). The General Surgery procedures that had the overall highest proportion of epidural analgesia use during this study period included pancreatectomies (up to 31.2 %) and pelvic exenteration for colorectal malignancy (30.7 %). The thoracic surgery procedure with the highest overall proportion of epidural use was pneumonectomies (27.5 %). The urology procedure with the highest overall percentage of epidural use was cystectomies (up to 22.5 %). The plastic surgery procedure with the highest overall percentage of epidural use was myocutaneous/fasciocutaneous flaps (1.5 %). Among gynecology surgeries, total abdominal hysterectomies with omentectomy had the highest percentage of epidural use (22.6 %). Among vascular surgery, abdominal aneurysm repairs had the highest percentage of epidural use (30.1 %).

On subgroup analysis, we modeled annual trends in epidural utilization via a mixed effects multivariable logistic regression when only including the surgeries with the top 5 most frequent epidural use per specialty. There was no statistically significant trend in epidural utilization from 2014 to 2020 (OR 0.99 per year, 99 % CI 0.99–1.00, $P = 0.09$) (Table 4).

However, there was an increasing trend in epidural utilization in general surgery (OR 1.05 per year, 99 % CI 1.03–1.07, $P < 0.001$) and vascular surgery (OR 1.08 per year, 99 % CI 1.05–1.10, $P < 0.001$), whereas there was a decreasing trend in gynecological surgery (OR 0.92 per year, 99 % CI 0.90–0.95, $P < 0.001$) and orthopedic surgery (OR 0.94 per year, 99 % CI 0.93–0.95, $P < 0.001$) (Fig. 2).

4. Discussion

In the setting of advancements in surgical techniques (e.g., minimally invasive approaches) and alternative modalities for analgesia (e.g., nerve blocks, multimodal analgesia) over the last decade, we reported an overall decreasing trend for perioperative epidural utilization when accounting for all surgical procedures amenable to epidurals. However, on a subgroup analysis which included only the surgical procedures with the most common epidural utilization, there was no change in trend. When specifically analyzing procedures with highest epidural use among general surgery or vascular surgery, there was an increasing trend. Limited available literature has analyzed trends in use of epidurals across the various non-obstetric surgical specialties. Our findings are consistent with a survey study based on a population in Europe which reported that, among 15 hospitals, 55 % reported decreased use of perioperative epidural use [27].

Due to limitations of this dataset, we could not directly measure the cause of these trends for epidural use, but we can theorize that it may be associated with trends evolving

within surgical approaches and alternative analgesia modalities. The primary analysis – which included all surgical procedures amenable to epidural use – was interesting in that it demonstrated a decreasing annual trend in epidural use. Furthermore, this was seen specifically for general, thoracic, urological, gynecological, and orthopedic surgery. In contrast, epidural use for vascular surgery demonstrated a trend consistent with increasing epidural use annually. An important question to explore is the reasons behind the overall decreasing trend of epidural utilization among non-obstetric surgical populations. While epidural analgesia for minimally invasive surgeries such as laparoscopic has been associated with lower time to first bowel opened, time to walking, and resting pain levels at the first postoperative days, it was also associated with increased overall complication rate, cost, increased length of stay when compared to patient-controlled analgesia [28,29]. One study found that decreasing epidural use for postoperative analgesia for minimally invasive lobectomy did not affect morbidity or mortality rates [30]. Thus, as more surgeries are performed with minimally-invasive techniques, this may coincide with decreasing epidural usage.

Furthermore, wider spread use of alternative modalities for analgesia may partly explain the overall decreasing trend for epidural use. Such modalities include fascial plane blocks, peripheral nerve blocks, intrathecal morphine, and wound infiltration and continuous local anesthetic administration. The transversus abdominis plane block has been described to provide analgesia, reduced time to bladder catheter removal, earlier time to ambulation, and reduced 24-h morphine consumption [31,32]. Peripheral nerve blocks have also been found to reduce need for postoperative analgesia, spinal puncture, urinary retention, and late onset back pain [33]. Intrathecal morphine has been reported to decrease postoperative hypotension incidence, intravenous fluid requirements, hospital stay, and respiratory complication incidence [34]. Wound infiltration and continuous local anesthetic administration have also been described to provide adequate postoperative pain control [35,36].

However, the use of alternative analgesia modalities may not always lead to decreased use of epidurals. On subgroup analysis, we analyzed only the cases that demonstrated the highest utilization of epidural use per surgical service. While there was no overall difference in the annual trend when pooling all surgical services together, there were increases in annual use for general and vascular surgery. For general surgery, these included more invasive procedures including pancreatectomy, pelvic exenteration, and open abdominal aortic aneurysm repairs. For vascular surgery, these included procedures including abdominal aorta repairs and aortic bypass surgeries. The increased rate of epidural use for general surgery may be explained by its association with superior pain control on the day of surgery and postoperative surgery with, for instance, pancreatectomy [37,38], which the current study identified as the most common general surgery procedure [39,40]. While limited literature is available regarding the impact of epidural use on pelvic exenteration outcomes, it has been recommended by the PelvEx Collaborative, an international collaborative group across five continents that examines outcomes for patients undergoing pelvic exenteration [41], as well as for standard first-line postoperative pain management in additional literature [42]. Superior outcomes with epidural anesthesia may explain the increased rate of use thereof for the more invasive vascular surgery procedures. For instance, epidural

anesthesia during abdominal aorta repair has been associated with reduced postoperative pain scores, rescue systemic opiate use, myocardial infarction, number needed to treat for one additional beneficial outcome, time to tracheal intubation, postoperative respiratory failure, gastrointestinal bleeding, and time spent in the intensive care unit compared to postoperative systemic opioid-based analgesia [39,40,43]. Sparse literature is available regarding aortic bypass surgery although epidural anesthesia was found to not alter the postoperative hypercoagulability response [44].

There are many known and established benefits of epidural analgesia, including decreased postoperative morbidity and mortality, pneumonia incidence, postoperative pain, and postoperative complication rate [45–48]. With advancement in more minimally invasive surgeries, consideration of epidural analgesia may decrease overall; but remains an important analgesia modality for more invasive procedures. Thus, the importance of a dedicated acute pain service could not be highlighted more. Such service could be comprised of a consistent and experienced team of anesthesiologists that provide the following benefits: (1) technical skills for epidural placement; (2) strong relationships with surgical services; (3) experienced daily management of epidural infusions; (4) expertise in combining epidural analgesia with multimodal pain protocols; and (5) early recognition and adequate management of side effects and complications of epidural anesthesia. Such services have been shown to be successful in reducing total opioid consumption and hospital length of stay in open abdominal cases [6,49,50].

In addition, we reported an association between epidural analgesia use and BMI, in which morbidly obese patients had lower odds of receiving an epidural. While studies are limited on this association, it has indeed been found in previous literature in patients undergoing labor in addition to increasing difficulty and time to discovery [51]. While the current study revealed an association of severe COPD with increased perioperative epidural analgesia use, mixed results have been found in relevant literature. One study reported decreased incidence of postoperative pneumonia and 30-day mortality for patients with COPD undergoing abdominal surgery [52] while a subsequent study revealed no difference in pulmonary complications, 30-day mortality, or composite comorbidity between patients receiving perioperative epidural analgesia alone versus general anesthesia with or without epidural analgesia [53]. The association with geriatric age may be explained by previous literature reporting that for elderly patients, epidurals have been associated with decreased rates of postoperative pain [54], delirium [55], nausea [54], and increased satisfaction ratings [56].

There are several notable limitations to this study, mainly attributable to the retrospective nature of the study and the underlying limitations of the NSQIP database. Data may be inaccurately recorded, which may have led to over- or under-estimation of epidural utilization. Furthermore, NSQIP does not capture all health care institutions in the United States, but rather a select population of institutions that contribute data to NSQIP. Therefore, it is unclear if the results presented in this manuscript is generalizable to the true practice among all healthcare institutions countrywide. Furthermore, NSQIP does not provide outcomes data specific to epidural complications (e.g., epidural hematoma), which would be a useful additional analysis for this study. While this study provides a general overview;

we acknowledge that a more detailed analysis of the impact of Medicare and private insurance policies on perioperative protocols is necessary. The transition of total hip and knee arthroplasties from inpatient to outpatient procedures by Medicare, followed by private insurers, has significantly influenced perioperative practices, particularly in the adoption of motor-sparing analgesic techniques to facilitate early ambulation and discharge. This shift highlights the critical role of insurance mandates in shaping clinical practices. Additionally, the variation in practice patterns across different countries, institutions, and even within the same institution over time, is not captured within this study. These differences, influenced by factors such as anesthesiologists' expertise, surgeon preferences, resource availability, and the implementation of enhanced recovery protocols, can be critical for interpreting the results of our study. A major limitation of the publicly-available NSQIP is that it does not provide granular details regarding institution or anesthesiologist, therefore, we could not control for inter-institution nor inter-anesthesiologist differences. Future studies that include subgroup analyses to explore these variations can present a more comprehensive analysis that reflects the complexity of perioperative care across diverse clinical environments.

5. Conclusions

Annual changes in the rates of perioperative epidural analgesia varies among different surgical subspecialties. When pooled together, there was an overall decrease trend in epidural use from 2014 to 2020 within NSQIP. However, when analyzing the procedures that historically used the most epidurals within general and vascular surgery, the rate has increased.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- Based on data mainly from the U.S., perioperative epidural usage has decreased from 2014 to 2020.
- Epidural usage has increased in open vascular and general surgeries from 2014 to 2020.
- General surgery procedures had the highest rate of epidural utilization

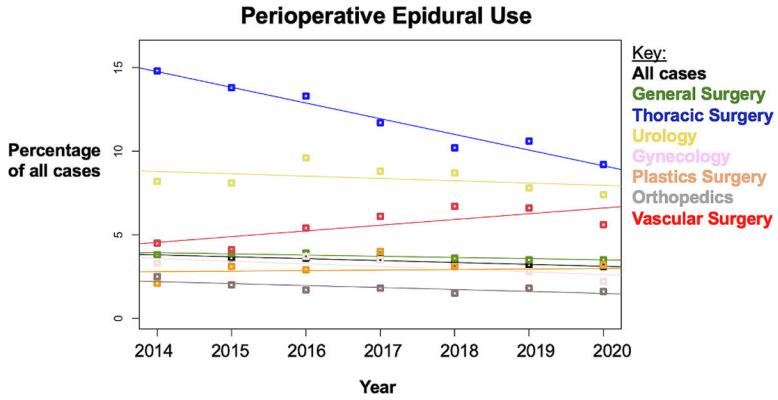

Fig. 1.

Rates of perioperative epidural analgesia use among: (1) all cases and (2) surgical specialties.

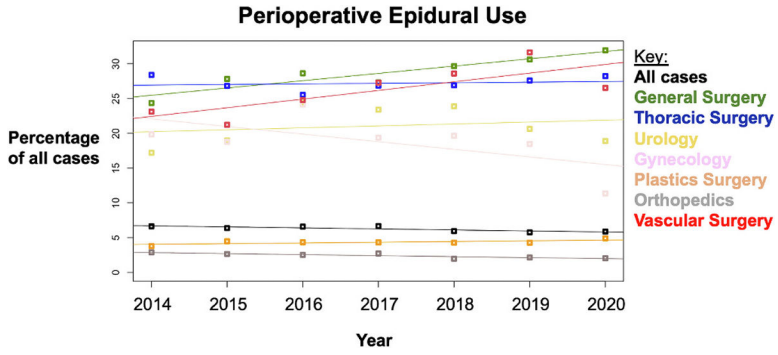

Fig. 2.

Rates of perioperative epidural analgesia use when including only the top five surgeries per surgical specialty with highest perioperative epidural use rates.

Table 1

Baseline characteristics of the no epidural versus epidural cohorts. Chi-square test was used to compare statistically significant differences between cohorts.

	No Epidural	Epidural	*P*-value
	n **(%)**	***n*** **(%)**	
Total	3,004,226	107,209	
Year			<0.0001
2014	328,165 (10.9)	12,967 (12.1)	
2015	391,470 (13.0)	14,752 (13.8)	
2016	445,779 (14.8)	16,887 (15.8)	
2017	455,247 (15.2)	16,925 (15.8)	
2018	463,526 (15.4)	15,784 (14.7)	
2019	500,007 (16.6)	16,480 (15.4)	
2020	420,032 (14.0)	13,414 (12.5)	
Surgical Specialty			<0.0001
General Surgery	1,685,618 (56.1)	64,977 (60.6)	
Thoracic	45,136 (1.5)	5976 (5.6)	
Urology	95,102 (3.2)	8673 (8.1)	
Plastics	7742 (0.3)	231 (0.2)	
Gynecology	252,229 (8.4)	8029 (7.5)	
Orthopedics	850,037 (28.3)	15,376 (14.3)	
Vascular	68,362 (2.3)	3947 (3.7)	
Age ≥ 65 years old	1,222,680 (40.7)	50,628 (47.2)	<0.0001
[a]BMI ≥ 35 kg/m2	711,299 (23.7)	20,953 (19.5)	<0.0001
[b]ASA PS ≥ 4	175,949 (5.9)	8247 (7.7)	<0.0001
Severe [c]COPD	132,608 (4.4)	6687 (6.2)	<0.0001
Bleeding Disorder	117,178 (3.9)	2458 (2.3)	<0.0001
Preoperative [d]INR ≥ 1.5	51,282 (1.7)	847 (0.8)	<0.0001
Preoperative Platelets <70 K	296,050 (9.9)	5979 (5.6)	<0.0001

Abbreviations

[a]BMI, body mass index

[b]ASA PS, American Society of Anesthesiologists Physical Status.

[c]COPD, chronic obstructive pulmonary disease.

[d]INR, international normalized ratio.

Table 2

Results of mixed effects multivariable logistic regression modeling various covariates to use of perioperative epidural.

	OR (99 % CI)	*P*-value
Time (increasing year)	0.98 (0.97–0.98)	<0.001
Surgical Specialty		
General Surgery	Reference	
Thoracic	1.16 (1.10–1.22)	<0.001
Urology	1.29 (1.20–1.39)	<0.001
Plastics	0.63 (0.58–0.69)	<0.001
Gynecology	0.99 (0.83–0.93)	<0.001
Orthopedics	1.18 (1.10–1.27)	<0.001
Vascular	0.97 (0.92–1.04)	0.52
Age ≥ 65 years old	1.02 (1.00–1.03)	0.009
[a]BMI ≥ 35 kg/m2	0.95 (0.94–0.97)	<0.001
[b]ASA PS ≥ 4	0.88 (0.86–0.90)	<0.001
Severe [c]COPD	1.07 (1.04–1.09)	<0.001
Bleeding Disorder	0.56 (0.54–0.58)	<0.001
Preoperative [d]INR ≥ 1.5	0.41 (0.39–0.44)	<0.001
Preoperative Platelets <70 K	0.92 (0.89–0.94)	<0.001

Abbreviations

[a]BMI, body mass index

[b]ASA PS, American Society of Anesthesiologists Physical Status.

[c]COPD, chronic obstructive pulmonary disease.

[d]INR, international normalized ratio.

Table 3

Results of mixed effects multivariable logistic regression modeling annual rates of epidural use. The model controlled for surgical service, age, [a]BMI, [b]ASA PS classification score, [c]COPD, bleeding disorder, preoperative [d]INR, and preoperative platelet count. The random effect was surgical procedure based on the Current Procedural Terminology code description.

	OR (99 % CI)	*P*-value
All Surgical Services	0.98 (0.97–0.98)	<0.001
General Surgery	0.98 (0.97–0.98)	<0.001
Thoracic	0.96 (0.95–0.98)	<0.001
Urology	0.98 (0.92–0.99)	0.009
Plastics	1.05 (0.98–1.12)	0.18
Gynecology	0.98 (0.97–0.99)	0.005
Orthopedics	0.95 (0.94–0.95)	<0.001
Vascular	1.07 (1.05–1.09)	<0.001

Abbreviations

[a]BMI, body mass index

[b]ASA PS, American Society of Anesthesiologists Physical Status.

[c]COPD, chronic obstructive pulmonary disease.

[d]INR, international normalized ratio.

CI, confidence interval.

Table 4

Results of mixed effects multivariable logistic regression modeling annual rates of epidural use when only included the top 5 surgical procedures with epidural use per surgical service. The model controlled for surgical service, age, [a]BMI, [b]ASA PS classification score, [c]COPD, bleeding disorder, preoperative [d]INR, and preoperative platelet count. The random effect was surgical procedure based on the Current Procedural Terminology code description.

	OR (99 % CI)	*P*-value
All Surgical Services	0.99 (0.99–1.00)	0.09
General Surgery	1.05 (1.03–1.07)	<0.001
Thoracic	1.01 (0.99–1.03)	0.54
Urology	1.00 (0.99–1.02)	0.84
Plastics	1.02 (1.00–1.03)	0.04
Gynecology	0.92 (0.90–0.95)	<0.001
Orthopedics	0.94 (0.93–0.95)	<0.001
Vascular	1.08 (1.05–1.10)	<0.001

Abbreviations

[a]BMI, body mass index

[b]ASA PS, American Society of Anesthesiologists Physical Status.

[c]COPD, chronic obstructive pulmonary disease.

[d]INR, international normalized ratio.

CI, confidence interval.