Title

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Journal

Anesthesia & Analgesia, 126(6)

ISSN

0003-2999

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Publication Date

2018-06-01

DOI

10.1213/ane.0000000000002503

Peer reviewed

Use of Regional Anesthesia for Outpatient Surgery Within the United States: A Prevalence Study Using a Nationwide Database

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BACKGROUND: Regional anesthesia is of benefit for outpatient surgery given its demonstrated improvement in analgesia and decrease in complications, resulting in shorter average recovery room times and lower hospital readmission rates. Unfortunately, there are few epidemiological studies outlining the overall utilization of peripheral nerve blocks (PNBs) in this setting. Therefore, the primary objective of this study was to report the overall utilization of several types of PNBs among all candidate cases in the outpatient setting within the United States.

METHODS: We identified all cases from the National Anesthesia Clinical Outcomes Registry that were performed as an outpatient surgery. We reported the frequency of various types of PNBs among all candidate cases, defined as cases that potentially could have received a PNB. Changes in prevalence of PNB utilization from 2010 to 2015 were analyzed by using logistic regression.

RESULTS: Of the 12,911,056 outpatient surgeries in the National Anesthesia Clinical Outcomes Registry, 3,297,372 (25.5%) were amenable to a PNB. However, the overall PNB frequency was only 3.3% of the possible cases. The overall utilization for PNB of the brachial plexus, sciatic nerve, and femoral nerve were 6.1%, 1.5%, and 1.9%, respectively. The surgical procedures generating the highest volume of PNBs were shoulder arthroscopies and anterior cruciate ligament reconstruction, in which 41% and 32% received a PNB, respectively. During this time period, there was a significant increase in overall PNB utilization for both single-injection and continuous PNB ($P < .0001$). However, the proportion of continuous PNB to single-injection PNB did not increase significantly.

CONCLUSIONS: While the overall frequency of PNB is relatively low, there was a significant increase in its prevalence during the study period. Regional anesthesia offers significant positive impact for perioperative outcomes and hospital efficiency metrics; however, it is not clear what is limiting its widespread use. Future studies are necessary to identify barriers and disparities in care to implement methods to increase regional anesthesia volume nationwide where beneficial and appropriate. (Anesth Analg 2017;XXX:00–00)

Over 50% of all surgical procedures within the United States are now performed on an outpatient basis,[1] often within dedicated high-volume ambulatory surgery centers requiring a rapid turnover of cases. Regional anesthesia is of benefit in this environment given its demonstrated improvement in analgesia and decrease in complications, resulting in shorter average recovery room times and lower hospital readmission rates.[2–6] Unfortunately, there are few epidemiological studies outlining the overall utilization of peripheral nerve blocks (PNBs) in this setting. Those that are available are extremely focused on specific surgical procedures (eg, rotator cuff repair)[7–9] or anatomic locations (eg, knee or shoulder).[9,10]

In contrast, epidemiological data on the utilization of regional anesthetics and analgesics at the national level involving a multitude of anatomic locations and surgical procedures would provide information regarding trends in practice, disparities in care, and geographical and facility-specific differences. Large-scale studies are potentially important to define the utilization of PNBs in the outpatient setting and permit policy makers, administrators, and educators to have valuable information.

Therefore, the primary objective of this study was to report the overall utilization of several types of PNBs among all candidate cases in the outpatient setting using a large national database, the National Anesthesia Clinical Outcomes Registry (NACOR). We hypothesize that there was an increase in overall regional anesthesia utilization over this study period. Furthermore, we aimed to describe the frequency of both single injections and continuous infusions by anatomic location. Finally, we aimed to characterize prevalence in regional anesthesia utilization over this study period.

METHODS

Data Source

NACOR is a voluntary submission registry with institutions that participate in the sharing of anesthesia-related data

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Accepted for publication August 23, 2017.

Funding: Financial support from National Library of Medicine (NLM) training grant number T15LM011271.

Conflicts of Interest: See Disclosures at the end of the article.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (www.anesthesia-analgesia.org).

Implications Statement: We report the use of regional anesthesia in outpatient surgeries using nationwide data. This analysis looks at all cases amenable to nerve blocks and reports the overall frequency of various common nerve blocks. Furthermore, annual trends in utilization of regional anesthesia (single-injection and continuous infusions via catheters) are reported.

Reprints will not be available from the authors.

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DOI: 10.1213/ANE.0000000000002503

and outcomes to evaluate the quality of care both locally and nationally.[11] Because the database is deidentified, it meets the criteria of the Health Insurance Portability and Accountability Act to protect personal information and was exempt from the consent requirement by the University of California, San Diego institutional review board (San Diego, CA). NACOR accepts case-level administrative, clinical, and quality-capture data from voluntary participating anesthesia practices and health care facilities in the United States. Electronic data are obtained from these institutions, typically on a monthly basis, and data elements are mapped to fields in the NACOR schema in accordance with a publicly available data dictionary. Incoming data are loaded into NACOR and are subject to both manual and automated review to identify systematically missing elements, mis-coding and inadvertent corruption. NACOR contains various data regarding patient demographics, billing, procedural, diagnostic, and provider information. The article adheres to the applicable EQUATOR guidelines. We performed a retrospective observational study assessing the prevalence of PNBs in outpatient surgery.

Study Sample

All surgeries identified as "outpatient surgery" from NACOR were identified from 2010 to mid-2015. Among these cases, the presence of the following nerve blocks (Common Procedural Terminology [CPT] code) was determined: cervical plexus (64413), brachial plexus single injection (64415), brachial plexus with continuous infusion by catheter (64416), axillary nerve (64417), suprascapular nerve (64418), intercostal nerve(s) (64420 and 64421), ilioinguinal/iliohypogastric nerves (64425), sciatic nerve single injection (64445), sciatic nerve with continuous infusion by catheter (64446), femoral nerve single injection (64447), femoral nerve with continuous infusion by catheter (64448), lumbar plexus with continuous infusion (64449), and other peripheral nerve or branch (64450). Cases that contained any of these CPT codes were defined as having received a PNB.

Other collected data included the year of surgery, the facility type in which the surgery was performed, CPT code of the primary surgical procedure, and the US geographical region. Possible facility types included university hospitals, large community hospitals (>500 inpatient beds), medium-sized community hospitals (100–500 beds), small-sized community hospitals (<100 beds), specialty hospitals, attached surgery centers, freestanding surgery centers, and outpatient clinics (ie, pain clinic). The US geographical regions included Northeast, Midwest, South, and West.

Statistical Analysis

R, a software environment for statistical computing (RStudio, Boston, MA), was used to perform all statistical analyses. The objective of the study was to characterize the percentage of cases that received at least one type of block (numerator) among all cases that potentially could get a block (denominator). To calculate the denominator, all surgical cases with at least one associated block were classified as a potential case. The denominator was therefore the sum of all cases with one of the specified surgical CPT codes. Next, both authors reviewed the Clinical Classifications Software (CCS) description for each surgery. All cases belonging to a CCS label that would likely not classify them as a case that could potentially receive a nerve block were removed from the final denominator value. Supplemental Digital Content 1, Table 1, http://links.lww.com/AA/C23 lists all surgical types (based on CCS label) included in the final list of outpatient cases amenable to nerve blocks. To calculate the percentage for each PNB type, this same calculation was performed only focused on the specified anatomic block location. The percentage of PNBs performed among all potential cases that could receive a block was reported for each facility type and US geographical region. Since only brachial plexus, sciatic, and femoral blocks had CPT codes designating either continuous infusion with catheter or single injection, the frequency of both continuous and single injection were reported only for these specific anatomic locations. For each of these 3 PNB categories, the top 5 surgical CPT codes reported to have used a block were identified. The percentage of these cases that received a single or continuous block was also calculated. Additionally, annual block utilization frequency was reported from 2010 to 2015. To test for statistical significance of prevalence for block utilization comparing each subsequent year versus the reference year (2010), a multivariable logistic regression was performed with presence of PNB as the dependent variable and year (categorical variable) as the independent variable. Of main interest was the difference seen during the year 2015 vs 2010. Confounders forced into the model included American Society of Anesthesiologists Physical Status (ASA PS) classification score, age, and sex. Age was treated as a categorical variable, in which age 19–49 years was the reference group. The other groups were age under 1, 1–18, 50–64, 65–79, and greater than or equal to 80 years. These covariates were included in the model due to their possible confounding with block utilization. Results of the regression analysis were reported as odds ratios (ORs), its corresponding 95% confidence interval (CI), and P value. The ORs are calculated based on the difference of PNB utilization in a subsequent year (2011, 2012, 2013, 2014, or 2015) versus the reference year (2010). Due to the large sample size of this study, only $P < .0001$ was considered statistically significant.

RESULTS

From 2010 to 2015, of the 26,568,734 cases in NACOR, 12,911,056 (48.5%) were identified as outpatient surgeries, in which 3,297,372 (25.5%) were amenable to a PNB (Table 1). Medium-sized community hospitals (25.7%) and freestanding surgery centers (22.2%) comprised the majority of outpatient cases. Cases from university hospitals comprised only 5.2%. There were a total of 1694 different facilities in this sample, in which medium-sized community hospitals (n = 299) and freestanding surgery centers (n = 504) comprised the majority. Among all outpatient cases that were amenable to a PNB, 3.3% received at least 1 type of PNB. University hospitals (3.9%), specialty hospitals (3.8%), and attached surgery centers (3.9%) had the highest frequency of PNB utilization, and the South region of the United States had the highest frequency of PNB for outpatient surgery (3.5%).

The highest frequency of PNB utilization (Table 2) was for brachial plexus nerve blocks (6.1%), followed by femoral

Table 1. Frequency of Peripheral Nerve Blocks in the Outpatient Surgery Setting Based on Facility Type and Region of the United States

	Cases	Individual Facilities	Cases Amenable to Block[a]	Blocks Performed	% Blocked of All Cases	% Blocked of Amenable Cases
Total	12,911,056	1694	3,297,372	109,808	0.85	3.33
Facility type						
University hospital	671,546	35	155,204	6054	0.90	3.90
Large community hospital	1,249,654	60	243,963	8996	0.72	3.69
Medium-sized community hospital	3,319,912	299	943,769	28,789	0.87	3.05
Small-sized community hospital	406,704	55	142,539	3865	0.95	2.71
Specialty hospital	228,833	35	58,907	2250	0.98	3.82
Attached surgery center	1,059,491	174	246,719	9513	0.90	3.86
Freestanding surgery center	2,860,296	504	781,859	25,690	0.90	3.29
Outpatient clinic	81,193	63	29,168	836	1.03	2.87
Unassigned	3,033,427	469	695,244	23,815	0.79	3.43
US region						
Northeast	1,813,248	230	519,387	16,759	0.92	3.23
Midwest	3,580,527	411	982,464	32,017	0.89	3.26
South	5,295,615	620	1,166,545	40,347	0.76	3.46
West	1,862,760	418	525,676	17,769	0.95	3.38
Unassigned	358,906	15	103,300	2916	0.81	2.82

Abbreviation: CPT, common procedural terminology.

[a]Total cases that could receive a block were determined by identifying all surgical CPT codes that received at least one block. The total is then defined by the number of all cases with one of these surgical CPT codes.

Table 2. Frequency of Peripheral Nerve Blocks in the Outpatient Surgery Setting Classified by Type of Nerve Block

	Cases	Cases Amenable to a Block[a]	% Blocked of All Cases	% Blocked of Amenable Cases
All cases	12,911,056			
All cases that received a block	109,808	3,297,372	0.850	3.330
Cervical plexus blocks	5302	1,023,615	0.062	0.582
Brachial plexus				
All	141,994	2,345,171	1.100	6.055
Single shot	130,201	2,345,171	1.008	5.552
Continuous	11,848	2,345,171	0.092	0.505
Axillary	6384	1,708,076	0.049	0.374
Suprascapular	2144	818,735	0.017	0.270
Intercostal	444	998,091	0.003	0.044
Ilioinguinal, iliohypogastric	434	422,303	0.003	0.103
Sciatic				
All	31,105	2,077,785	0.241	1.497
Single shot	26,848	2,077,785	0.208	1.292
Continuous	4280	2,077,785	0.033	0.206
Femoral				
All	41,629	2,167,934	0.322	1.920
Single shot	37,304	2,167,934	0.289	1.721
Continuous	4372	2,167,934	0.034	0.202
Lumbar plexus	58	437,161	0.000	0.014
Other peripheral nerve or branch	26,393	3,047,621	0.204	0.866

Abbreviation: CPT, common procedural terminology.

[a]Total cases that could receive a block were determined by identifying all surgical CPT codes that received at least one block. The total is then defined by the number of all cases with one of these surgical CPT codes.

nerve blocks (1.9%), and sciatic nerve blocks (1.5%). The nerve block with lowest frequency was the lumbar plexus block (0.01%). The surgical procedure that had the highest proportion of cases that received a nerve block was shoulder arthroscopy with decompression of the subacromial space with partial acromioplasty with a block frequency of 41%. This was followed by anterior cruciate ligament reconstruction, which had a block frequency of 32% (Table 3).

A multivariable logistic regression was performed to assess association of year with performance of blocks, while controlling for ASA PS classification score, age, and sex (Supplemental Digital Content 2 and 3, Tables 2 and 3, http://links.lww.com/AA/C24, http://links.lww.com/AA/C25). When comparing prevalence of blocks in 2015 vs 2010 (Figure 1), the frequency of all (single-injection or continuous) brachial plexus blocks increased from 3.2% to 8.9% (OR, 2.8; 95% CI, 2.7–2.9; $P < .0001$), sciatic nerve blocks increased from 0.6% to 2.1% (OR, 3.9; 95% CI, 3.6–4.2; $P < .0001$), and femoral nerve blocks more than 3-fold from 0.8% to 3.2% (OR, 4.6; 95% CI, 4.3–4.8; $P < .0001$). Likewise (Figure 2A), there was a significant increased prevalence for single-injection blocks of the brachial plexus (OR, 2.8; 95% CI, 2.7–2.9; $P < .0001$), sciatic nerve (OR, 4.4; 95% CI, 4.1–4.8; $P < .0001$), and femoral nerve (OR, 5.0; 95% CI, 4.7–5.3; $P < .0001$). Also

Table 3. Top 5 Surgical CPT Codes Associated With Brachial Plexus, Sciatic, and Femoral Nerve Blocks

Surgical Procedure(s)	CPT Code	Total Cases	Single and Continuous Blocks	% Blocked of Possible Cases	Continuous Blocks	% Continuous of All Blocked Cases
Brachial plexus block (single injection and continuous)						
Arthroscopy, shoulder surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament release, when performed	29827	107,094	43,520	41	4215	10
Arthroscopy, shoulder, surgical; debridement, extensive	29822	22,501	9218	41	831	9
Arthroscopy, surgical; repair of a superior labrum anterior/posterior lesion	29807	22,517	8533	38	828	10
Arthroscopy, shoulder, surgical, distal claviculectomy	29824	19,177	7866	41	526	7
Arthroscopy, shoulder surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament release, when performed	29826	28,939	7272	25	413	6
Sciatic nerve block (single injection and continuous)						
Open treatment of bimalleolar ankle fracture, with or without internal or external fixation	27814	16,067	2753	17	356	13
Achilles tendon repair	27650	13,897	2213	16	238	11
Anterior cruciate ligament reconstruction	29888	53,182	2147	4	19	1
Open treatment of distal fibular fracture (lateral malleolus), includes internal fixation, when performed	27792	9588	1387	14	149	11
Hallux valgus correction	28296	27,096	712	3	276	39
Femoral nerve block (single injection and continuous)						
Anterior cruciate ligament reconstruction	29888	53,182	17,193	32	1386	8
Total knee arthroplasty	27447	18,369	3479	19	1144	33
Knee arthroscopy and chondroplasty	29881	230,578	1510	1	150	10
Ligamentous reconstruction (augmentation), knee; intraarticular (open)	27428	5862	1374	23	114	9
Manipulation of knee joint	27570	11,241	1080	10	105	10

Abbreviation: CPT, current procedural terminology.

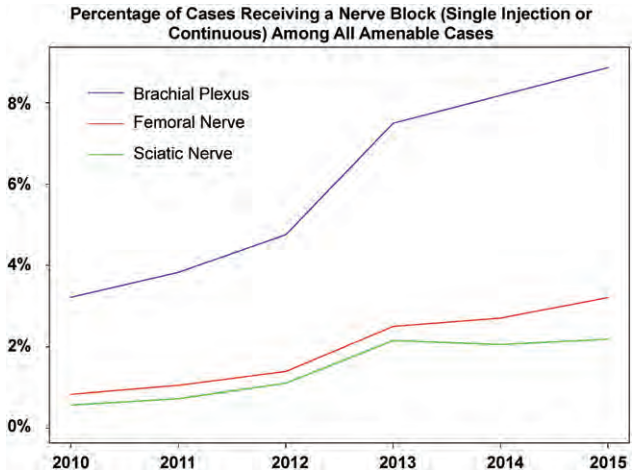

Figure 1. Percentage of cases receiving a single-injection or continuous nerve block via catheter of any type of peripheral nerve block among all cases amenable to a nerve bock among outpatient surgeries from 2010 to 2015. A multivariable logistic regression was performed (controlling for American Society of Anesthesiologists Physical Status score, age, and sex) comparing prevalence of each subsequent year to reference year of 2010. Each subsequent year had a statistically significance odds ratio ($P < .0001$) for each block type.

comparing 2015 to 2010, there was an increase in prevalence for continuous PNBs (Figure 2B) involving the brachial plexus (OR, 2.7; 95% CI, 2.4–3.0; $P < .0001$), sciatic nerve (OR, 1.5; 95% CI, 1.2–1.9; $P < .0001$), and femoral nerve (OR, 2.1; 95% CI, 1.8–2.5; $P < .0001$). Among all cases that had a PNB (single-injection and/or continuous infusion), there was no significant difference in prevalence for single injections among brachial plexus blocks when comparing 2015 to 2010 (OR, 1.0; 95% CI, 0.9–1.1; $P = .94$); however, there was a difference for both the sciatic (OR, 2.4; 95% CI, 1.9–3.0; $P < .0001$) and femoral (OR, 2.4; 95% CI, 2.0–2.9; $P < .0001$) nerves in the outpatient setting (Figure 3).

DISCUSSION

In this retrospective analysis, we report the frequency of utilization of various regional anesthesia techniques for ambulatory surgery using data from the nationwide database, NACOR. To our knowledge, this is the first large-scale study describing the frequency of PNB in the outpatient population. University hospitals comprised only a minority of the facilities, while the majority were community hospitals and freestanding surgery centers. Overall, the rates of PNB among all cases that were amenable to a PNB are low, at about 3%. Among the different types of PNB, nerves blocks of the brachial plexus, femoral nerve, and sciatic nerve had the highest frequency. Orthopedic surgeries comprised the majority of outpatient surgeries amenable to PNBs. Importantly, the frequency of regional anesthesia has dramatically increased from 2010 to 2015. However, while the total number of continuous PNBs is increasing, the proportion of continuous PNBs to that of single injections is not increasing. These findings are important to better define practice patterns, trends, and disparities in health care.

Few studies describing the overall use of regional anesthesia in the outpatient setting have been published, as most have involved very specific/narrow populations and/or

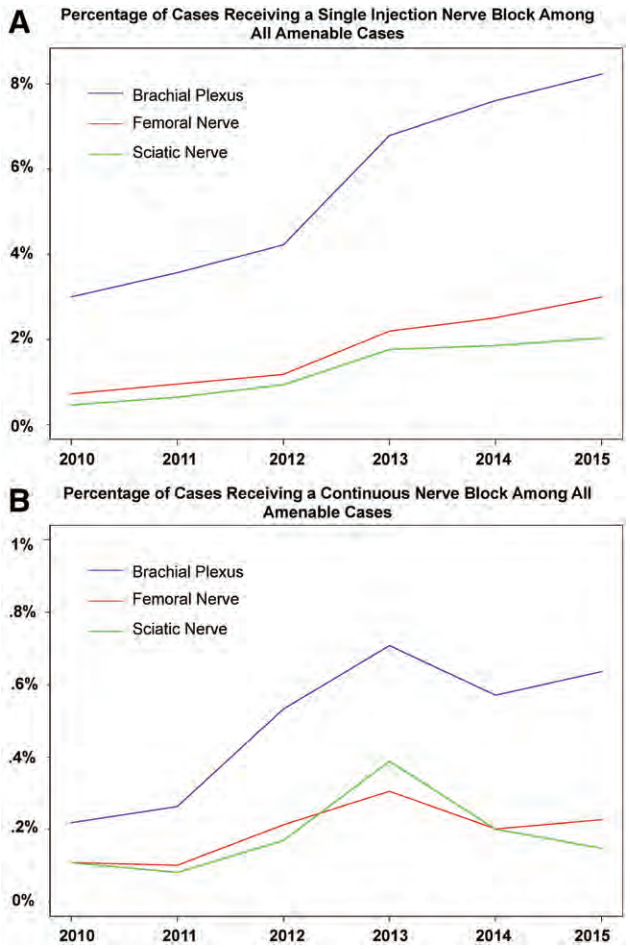

Figure 2. Percentage of cases receiving a (A) single injection or (B) continuous block via catheter among all cases amenable to a nerve block among outpatient surgeries from 2010 to 2015. A multivariable logistic regression was performed (controlling for American Society of Anesthesiologists Physical Status score, age, and sex) comparing prevalence of each subsequent year to reference year of 2010. Among single injections, each subsequent year for each block had a statistically significance odds ratio ($P < .0001$). Among continuous blocks, each subsequent year for each block type had a statistically significant odds ratio, except for 2011 vs 2010 for all block types.

anatomic locations such as specific for rotator cuff repair,[7,8] knee and shoulder surgery,[10] or upper extremity fracture repair.[9] The lack of nationwide, all-encompassing investigations is probably due to the historic lack of large national databases containing anesthesia-related procedure data. However, the emergence of databases such as the National Survey of Ambulatory Surgery, Premier Perspective, Inc, and NACOR make much-needed analysis more possible.[12]

The use of regional anesthesia in the outpatient setting offers significant potential improvements in perioperative outcomes, including superior postoperative analgesia, reduced risk for postoperative complications such as nausea/vomiting, improved recovery profile, diminished use of resources, and reduced time to discharge.[2,4,5] With an overall penetration rate of 3%, PNBs—single-injection or continuous—are currently being applied to a small minority of surgical procedures amenable to regional anesthesia and analgesia. The reasons for the discrepancy remain unknown and deserve further study with quantification of the issue.

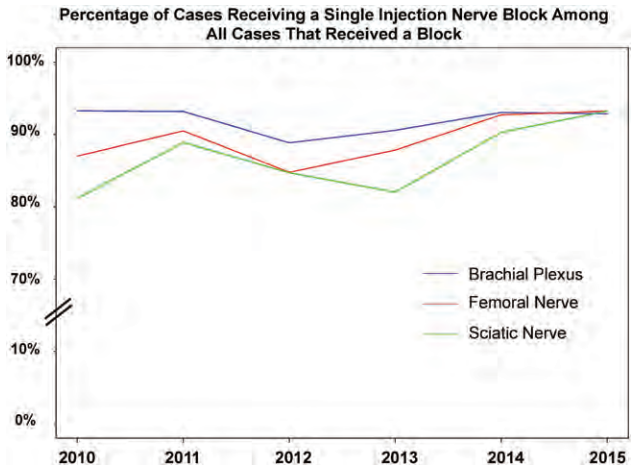

Figure 3. Percentage of cases receiving a single-injection nerve block among all cases that received a nerve block (single-injection or continuous infusion via catheter) among outpatient surgeries from 2010 to 2015. A multivariable logistic regression was performed (controlling for American Society of Anesthesiologists Physical Status score, age, and sex) comparing prevalence of each subsequent year to reference year of 2010. For brachial plexus blocks, only years 2012 and 2013 had a statistically significant odds ratio ($P < .0001$) for block utilization compared to year 2010. For sciatic nerve blocks, only years 2011, 2014, and 2015 had statistically significant odds ratios for block utilization. For femoral nerve blocks, only years 2014 and 2015 had odds ratios that were $P < .0001$.

We did, however, identify a significant upward trend between 2010 and 2015 for the overall application of both single-injection and continuous PNBs for outpatients. We can only speculate on reasons for this increase, but it might possibly be due to (1) the emerging evidence of superior perioperative outcomes in these patients receiving regional anesthesia and (2) the ongoing efforts in improving training among residents and fellows in ultrasound-guided techniques.[13] In contrast, the proportion of continuous PNBs to single injections has not been increasing. There have been a multitude of studies demonstrating the benefit of ambulatory continuous infusions; however, the required resources to manage these infusions in the outpatient setting may be a barrier to more widespread use.[2]

Despite this low frequency of overall PNB utilization, when looking specifically at certain orthopedic surgeries, we found a much higher prevalence of regional anesthesia use; for example, 40% of some shoulder arthroscopies and 32% of anterior cruciate ligament reconstruction receiving regional anesthesia. However, in these surgeries, the use of continuous PNB only comprised around 10% of those cases that received a nerve block. Future research and efforts may focus on identifying the barriers to increasing utilization of continuous PNBs for certain outpatient orthopedic procedures.

There are several significant limitations of this study. The first is due to possible sampling bias: health care facilities volunteer their data to NACOR, and therefore, this is not a random or comprehensive sample of anesthesia care in the United States. A related limitation concerns the hospital mix of this study sample: the predominant reporting facilities were medium-sized community hospitals and freestanding surgery centers, with less participation from academic institutions. Despite the potential limitations due to sampling bias, NACOR is the largest available anesthesia database in the United States, comprising more than 10 million outpatient cases, providing the best general estimate of the frequency of regional anesthesia available at this time. Additional limitations are related to the possibility of missing data points, coding bias, or invalid data input into this large database. However, there is no evidence of a systematic error that may have skewed the results. In addition, there are potentially other confounders for PNB use not included in the NACOR database; however, we were able to adjust for age, sex, and ASA PS classification score. Finally, due to the limitations of CPT coding, we are unable to differentiate between different variations of brachial plexus blocks (eg, interscalene, supraclavicular, or infraclavicular), femoral nerve blocks (eg, adductor canal), or sciatic nerve blocks (eg, subgluteal, popliteal fossa).

In conclusion, we report the frequency of overall regional anesthesia use among all candidate cases in the outpatient setting. While the overall frequency is low—approximately 3%—there is a significant upward trend over the study period. Regional anesthesia offers significant positive impact for perioperative outcomes and hospital efficiency metrics, and it remains unclear what factors limit wider use. Future studies may identify barriers and disparities in care to implement methods to increase regional anesthesia volume, where beneficial and appropriate.

DISCLOSURES

Name: Rodney A. Gabriel, MD.
Contribution: This author helped design the study, conduct the study, collect the data, analyze the data, and prepare the manuscript.
Conflicts of Interest: Rodney A. Gabriel's institution has received funding and/or product for his research from Epimed, a manufacturer of cryoneurolysis devices; infusion pump manufacturers Infutronics and Smiths Medical; perineural catheter manufacturers, Ferrosan Medical and Teleflex Medical; and a manufacturer of a peripheral nerve stimulation device, SPR Therapeutics.
Name: Brian M. Ilfeld, MD, MS (Clinical Investigation)
Contribution: This author helped design the study, conduct the study, analyze the data, and prepare the manuscript.
Conflicts of Interest: Brian M. Ilfeld's institution has received funding and/or product for his research from Myoscience and Epimed, manufacturers of cryoneurolysis devices; infusion pump manufacturers Infutronics, Baxter Healthcare, Smiths Medical, and Summit Medical; perineural catheter manufacturers, Ferrosan Medical and Teleflex Medical; a manufacturer of a peripheral nerve stimulation device, SPR Therapeutics; and 2 manufacturers of long-acting liposome bupivacaine formulation, Pacira Pharmaceuticals and Heron Pharmaceuticals.
This manuscript was handled by: Richard Brull, MD, FRCPC

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