KJA
Korean Journal of Anesthesiology

Five-year follow-up to assess long-term sustainability of changing clinical practice regarding anesthesia and regional analgesia for lower extremity arthroplasty

Mallika Tamboli[1,2], Jody C. Leng[1,2], Oluwatobi O. Hunter[2], Alex Kou[1,2], Seshadri C. Mudumbai[1,2], Stavros G. Memtsoudis[3,4], Tessa L. Walters[1,2], Gregory Milo Lochbaum[1,2], Edward R. Mariano[1,2]

[1]Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University School of Medicine, Stanford, CA, [2]Anesthesiology and Perioperative Care Service, Veterans Affairs Palo Alto Health Care System, Palo Alto, CA, [3]Department of Anesthesiology and Public Health, Weill Cornell Medical College, [4]Department of Anesthesiology, Hospital for Special Surgery, New York, NY, USA

Clinical Research Article

Korean J Anesthesiol 2020;73(5):401-407
https://doi.org/10.4097/kja.19400
pISSN 2005-6419 • eISSN 2005-7563

Received: October 8, 2019
Revised: November 26, 2019 (1st); December 19, 2019 (2nd)
Accepted: December 19, 2019

Corresponding author:
Edward R. Mariano, M.D., M.A.S.
Anesthesiology and Perioperative Care Service, VA Palo Alto Health Care System, 3801 Miranda Avenue (112A), Palo Alto, CA 94304, USA
Tel: +1-650-849-0254
Fax: +1-650-852-3423
Email: emariano@stanford.edu
ORCID: https://orcid.org/0000-0003-2735-248X

Background: Long-term and sustainable clinical practice changes in anesthesia procedures have not previously been reported. Therefore, we performed a 5-year audit following implementation of a clinical pathway change favoring spinal anesthesia for total knee arthroplasty (TKA). We similarly evaluated a parallel cohort of patients undergoing total hip arthroplasty (THA), who did not undergo a clinical pathway change, and studied utilization rates of continuous peripheral nerve block (CPNB).

Methods: We identified all primary unilateral TKA and THA cases completed from January 2013 through December 2018, thereby including clinical pathway change data from one-year pre-implementation to 5-years post-implementation. Our primary outcome was the overall application rate of spinal anesthesia. Secondary outcomes included CPNB utilization rate, 30-day postoperative complications, and resource utilization variables such as hospital readmission, emergency department visits, and blood transfusions.

Results: The sample included 1,859 cases, consisting of 1,250 TKAs and 609 THAs. During the initial year post-implementation, 174/221 (78.7%) TKAs received spinal anesthesia compared to 23/186 (12.4%) cases the year before implementation ($P < 0.001$). During the following 4-year period, 647/843 (77.2%) TKAs received spinal anesthesia ($P = 0.532$ vs. year 1). The number of THA cases receiving spinal anesthesia the year after implementation was 78/124 (62.9%), compared to 48/116 (41.4%) pre-implementation ($P = 0.001$); however, the rate decreased over the following 4-year period to 193/369 (52.3%) ($P = 0.040$ vs. year 1). CPNB use was high in both TKA and THA patient groups, and there were no differences in 30-day postoperative complications, hospital readmission, emergency department visits, or blood transfusions between patients who underwent spinal and general anesthesia in both TKA and THA groups.

Conclusions: A clinical pathway change promoting spinal anesthesia for TKA can be effectively implemented and sustained over a 5-year period.

Keywords: Analgesia; Change implementation; Clinical pathway; Hip arthroplasty; Knee arthroplasty; Nerve block; Quality improvement; Regional anesthesia; Spinal anesthesia.

Introduction

The International Consensus on Anesthesia-Related Outcomes after Surgery group published recommendations in 2019 advocating for neuraxial anesthesia as the anesthetic technique of choice for patients undergoing total hip and knee arthroplasty [1]. Implementing these recommendations will represent a significant practice change for many anesthesiology groups, especially in the United States where nationwide database studies show that neuraxial anesthesia continues to be underutilized [2,3].

Despite the wealth of research data generated to guide clinical care, translation of research evidence to clinical practice is often a long and tedious process [4]. The barriers to implementing change have been extensively studied, and are both intrinsic and extrinsic [5]. In December 2013, within the context of a Perioperative Surgical Home (PSH) model, we implemented a change in our clinical pathway for total knee arthroplasty (TKA), offering spinal anesthesia as the preferred intraoperative anesthetic technique [6]. We based this decision on ample evidence demonstrating positive outcomes associated with the use of this technique [7]. At the end of six months, our spinal anesthesia utilization rate increased to 63%, from a previous rate of 13% for the six months pre-implementation [6].

However, despite successful implementation of a clinical practice change, evidence suggests that most changes are not sustained [8]. For example, one-third of improvement projects are reportedly abandoned within one year in the United Kingdom's National Health Service [8]. The long-term sustainability of clinical practice changes in anesthesiology has not previously been reported. Therefore, we designed this study as a 5-year audit to examine the sustainability of a clinical pathway change at our institution favoring spinal anesthesia for TKA, hypothesizing that the rate of spinal anesthesia utilization would not differ between the first year post-implementation and the subsequent 4-year period. As a comparison, we evaluated spinal anesthesia utilization for a parallel cohort of total hip arthroplasty (THA) patients in the same time frame, since the THA clinical pathway was not changed to specify a preferred anesthetic technique. We also examined the utilization of regional analgesia in the form of continuous peripheral nerve block (CPNB), as part of the multimodal analgesic protocol and other postoperative outcomes in the PSH database for both TKA and THA.

Materials and Methods

This study was conducted with Institutional Review Board approval (28958) and waiver for informed consent (Stanford, CA, USA), and Veterans Affairs (VA) Research Committee approval (MAR0004; Palo Alto, CA, USA), at a university-affiliated tertiary care VA hospital with an active total joint replacement program, and a PSH [9,10]. The PSH program at our institution, and the TKA clinical pathway were previously described [6,11], and perioperative outcomes for inpatients are tracked using a customized PSH database [9]. The PSH database is populated by attending anesthesiologists, and is based on bedside visits on postoperative day (POD) 1, and electronic medical record reviews at POD 30.

In December 2013, at our regular departmental staff meeting, the TKA clinical pathway was changed to designate spinal as the preferred option for intraoperative anesthesia [6]. At the time, the data favoring spinal were deemed stronger for TKA compared to THA [7], so no change was made to our THA clinical pathway. The TKA clinical pathway change was endorsed by the department head and administrative champion, with unanimous agreement by all staff anesthesiologists. All anesthesiologists were provided with education and suggested language in standard work format for patient counseling, regarding anesthetic options for their knee replacement surgery. Our PSH team monitored adherence to the protocol, and provided each anesthesiologist with his or her rates of spinal anesthesia utilization, feedback on effectiveness of preoperative counseling, and re-training on the standard work as needed [6].

Study Population

We identified all primary unilateral TKA and THA cases completed from January 2013 through December 2018 to include data on the clinical pathway change from 1 year pre-implementation to 5 years post-implementation. We excluded duplicate entries and all surgeries other than primary TKA or THA (e.g., same-day bilateral surgeries, unicompartmental arthroplasty, and surgeries related to infection, reimplantation, or hardware removal plus arthroplasty). We then divided the sample into separate knee and hip replacement groups for analysis.

Outcomes

Our primary outcome was the overall spinal anesthesia usage rate in patients undergoing TKA. The initial one-year post-implementation rate was compared to the rate during the subsequent 4 years. Spinal anesthesia utilization rates one-year before, and one-year after implementation of the TKA protocol change were also evaluated. Similar comparisons were conducted in a parallel cohort of THA patients.

https://doi.org/10.4097/kja.19400

A secondary outcome was CPNB utilization rates in both the TKA and THA groups (adductor canal for TKA [12], and fascia iliaca for THA [13]). Additional outcomes included comparisons of 30-day postoperative event variables, based on anesthetic type and collected in the PSH database. Variables related to resource utilization included hospital readmission, post-discharge emergency department visits, and blood transfusions. Complications included cardiovascular events (e.g., myocardial infarction, arrhythmia, or cardiac arrest), pulmonary events (e.g., respiratory failure requiring intubation), delirium, catheterization for urinary retention, acute renal failure, ileus, surgical site infection, and death.

Statistical Analysis

Statistical analysis was performed with NCSS Statistical Software (NCSS, LLC, USA), and IBM SPSS Statistics Version 23 (IBM Corp., USA). Normality of distribution was determined for all scale variables using the Kolmogorov-Smirnov test. Single comparisons of normally distributed data were performed with Student's *t* test, while the Mann-Whitney *U* test was used for continuous data in non-normal distributions. The Chi square test or Fisher's exact test ($n < 5$ in any field) was used for categorical data comparisons. A value of $P < 0.05$ was considered statistically significant.

Results

Our initial query retrieved 2,298 TKA and THA cases. After removing duplicate entries (n = 130), and all surgeries other than primary unilateral TKA or THA (n = 309), the final sample consisted of 1,859 cases, including 1,250 TKAs and 609 THAs. Nearly all patients in both groups were male. The median (10^{th}–90^{th} percentiles) age for TKA patients was 67 (56–76) years, compared to 66 (55–77) years for THA patients (P = 0.782). In both groups, the median (10^{th}–90^{th} percentiles) American Society of Anesthesiologists physical status was 3 (2–3) (P = 0.913).

Primary Outcome

During the initial year post-implementation, 174/221 (78.7%) TKA patients received spinal anesthesia, compared to 23/186 (12.4%) the year before implementation (P < 0.001). Over the subsequent 4-year period, 647/843 (77.2%) TKA patients received spinal anesthesia (P = 0.532 vs. year 1; Fig. 1). Fig. 1 further divides the spinal category into those patients who received spinal anesthesia alone, vs. combined spinal and general anesthesia. The spinal anesthesia utilization rate in patients undergoing TKA did not fall below 50% for any quarter over the 5 years after implementation (Fig. 1). The number of THA group patients receiving spinal anesthesia during the year after implementation was 78/124 (62.9%), compared to 48/116 (41.4%) during the year before implementation (P = 0.001). Over the subsequent 4-year period, the spinal anesthesia rate in THA patients decreased to 193/369 (52.3%) (P = 0.040 vs. year 1 post-implementation; P = 0.040 vs. 1-year pre- implementation; Fig. 1). Among patients who received general anesthesia alone, the failure rates for attempted spinal were 5.1% (21/406), and 3.1% (9/290) for TKA and THA, respectively.

Secondary Outcomes

The CPNB utilization rates for TKA and THA patients are shown in Fig. 2. The CPNB use rate for TKA patients did not change after implementation of the spinal protocol: 183/186 (98.4%) in the one-year pre-implementation, vs. 1049/1064 (98.6%) 5-years post-implementation (P = 0.742). The CPNB use rate increased in THA patients from 72/116 (62.1%) one-year pre-implementation to 376/493 (76.3%) 5-years post-implementation (P = 0.002).

Postoperative outcomes within 30 days are shown in Table 1. Overall, there were few complications, and there were no differences in the incidence of complications or resource utilization between spinal and general anesthesia, for either TKA or THA.

Discussion

The results of this 5-year audit show that a clinical pathway change in intraoperative anesthetic technique for patients undergoing TKA can be implemented and sustained long-term. During the same period, the rate of spinal anesthesia for THA also increased even in the absence of an explicit protocol change suggesting a secondary gain, since the same surgeons and anesthesiologists care for both TKA and THA patients. However, the long-term rate of spinal anesthesia utilization for THA was not sustained to the same degree as it was for TKA, which supports the benefit of actively maintaining the updated TKA clinical pathway.

Sustaining a clinical practice change over a long period of time requires integration of the change into an organizational routine [14]. A protocol becomes routine when it is memorized and adapted into context, reflects collective values, and conforms to rules governing decision-making [14]. Even when they become routine, clinical pathways and protocols will require ongoing maintenance, review, and reinforcement. Understanding what motivates physicians may also be helpful [15]. Taking pride in providing the best evi-

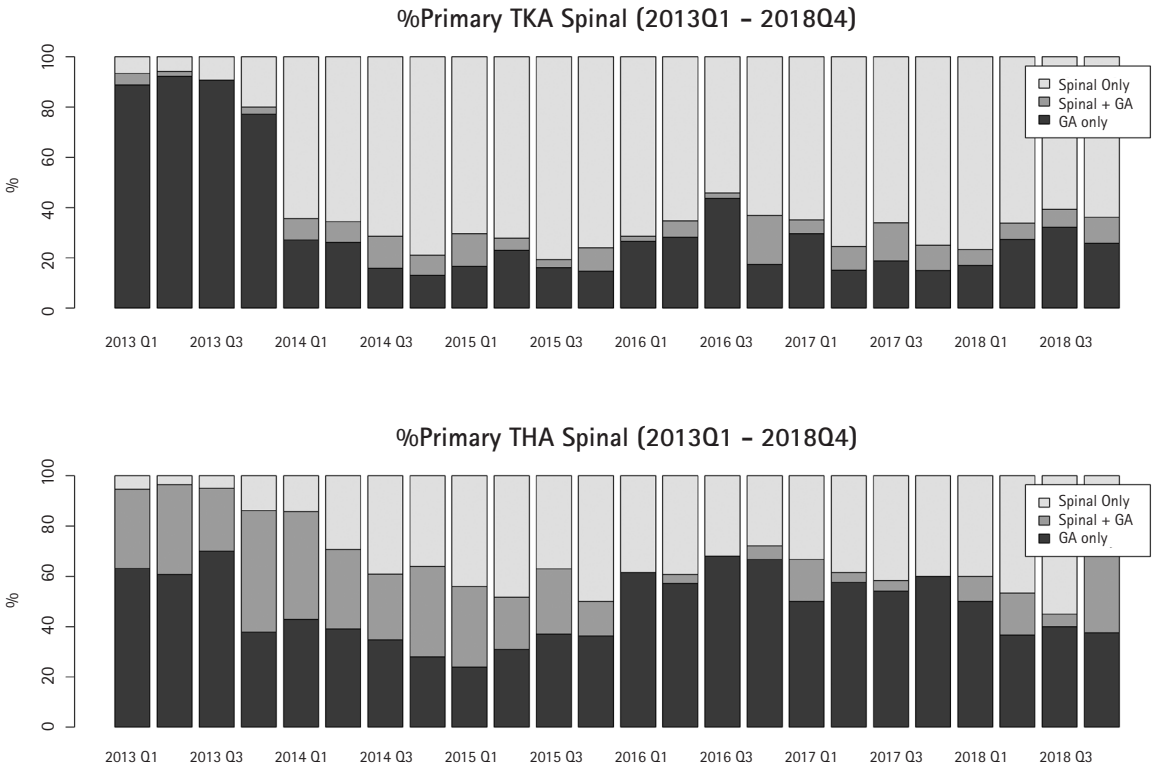

Fig. 1. Intraoperative anesthetic technique rates from January 2013 through December 2018 by quarter. For illustration purposes only, the spinal anesthesia category has been further divided into spinal anesthesia alone ("Spinal Only"), and spinal and general anesthesia combined ("Spinal+ GA"). TKA: total knee arthroplasty, THA: total hip arthroplasty, GA: general anesthesia, Q1: January through March, Q3: July through September.

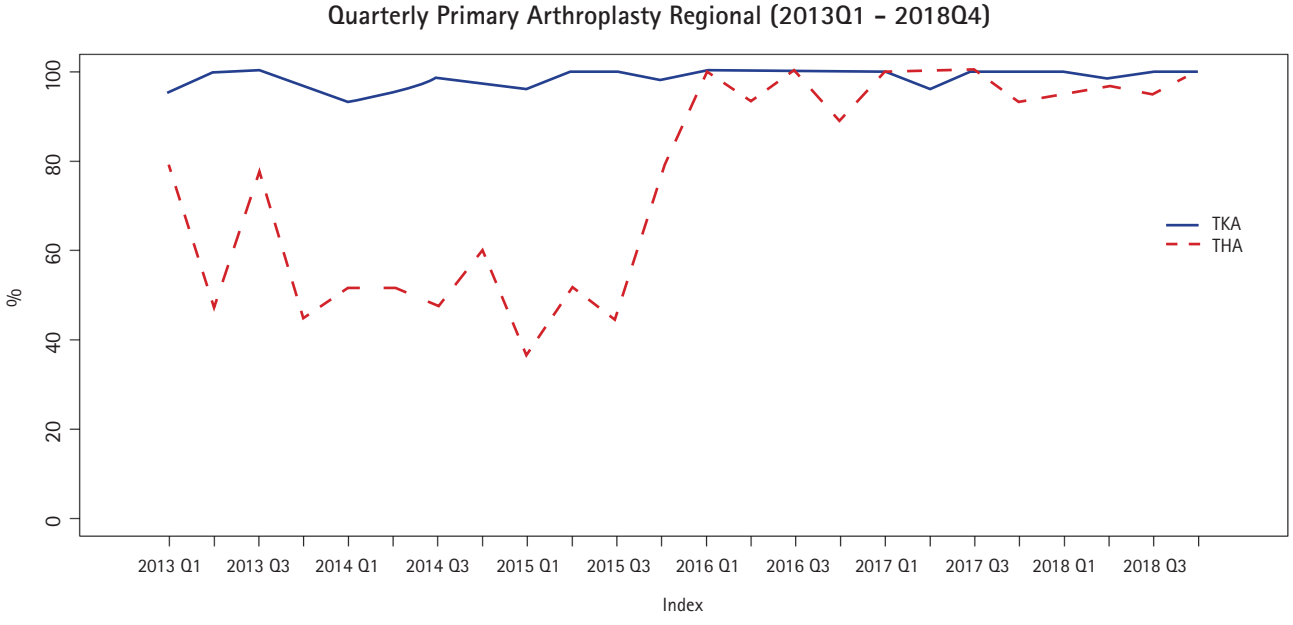

Fig. 2. Rate of CPNB utilization from January 2013 through December 2018 by quarter. CPNB: continuous peripheral nerve block, TKA: total knee arthroplasty, THA: total hip arthroplasty, Q1: January through March, Q3: July through September.

https://doi.org/10.4097/kja.19400

Table 1. Thirty-day Postoperative Outcomes Based on Anesthetic Technique

	Knee Replacement (n = 1,250)			Hip Replacement (n = 609)		
	General (n = 406)	Spinal (n = 844)	P value	General (n = 290)	Spinal (n = 319)	P value
Readmission to the hospital	5 (1.2)	6 (0.7)	0.350	3 (1.0)	0 (0)	0.107
Emergency department visit	15 (3.7)	19 (2.2)	0.142	4 (1.4)	6 (1.9)	0.755
Blood transfusion	0 (0)	2 (0.2)	0.561	2 (0.7)	0 (0)	0.226
Cardiovascular	2 (0.5)	2 (0.2)	0.600	1 (0.3)	0 (0)	0.476
Pulmonary	0 (0)	0 (0)	> 0.999	0 (0)	0 (0)	> 0.999
Delirium	0 (0)	1 (0.1)	> 0.999	1 (0.3)	0 (0)	0.476
Catheterization for urinary retention	1 (0.2)	2 (0.2)	> 0.999	3 (1.0)	0 (0)	0.107
Acute renal failure	0 (0)	0 (0)	> 0.999	0 (0)	0 (0)	> 0.999
Ileus	0 (0)	1 (0.1)	> 0.999	0 (0)	1 (0.3)	> 0.999
Surgical site infection	2 (0.5)	1 (0.1)	0.248	2 (0.7)	1 (0.3)	0.607
Death	0 (0)	0 (0)	> 0.999	0 (0)	0 (0)	> 0.999

Values are presented as number (%).

dence-based care or following international recommendations [1] is an example of an intrinsic motivation [15]. Extrinsic motivations may relate to payment, and there is now a national quality measure in the United States related to utilization of regional anesthesia for TKA [16].

When we made the deliberate change in the TKA clinical pathway to initially offer patients spinal anesthesia [6], the intent was not to achieve 100% adherence. Patients may not receive spinal anesthesia for a variety of reasons (e.g., anticoagulation or patient refusal). However, we believe that patients who have no contraindications should be offered the option, and provided with supportive evidence when it exists [1,7]. The Regional Anesthesiology and Acute Pain Medicine (RAAPM) Service reinforces the clinical pathways at our institution. The RAAPM team co-manages all orthopedic surgery patients from admission until discharge, and is solely responsible for analgesic medications and interventions [11]. On a daily basis, a RAAPM team member sends an email to the anesthesiology attending physicians and residents assigned to the intraoperative care of joint replacement patients the next day to notify them of the multimodal analgesic plan (e.g., preoperative oral non-opioid analgesics and nerve block), and provide the intraoperative protocol suggesting spinal anesthesia as the preferred technique for knee replacement patients [6,11]. These clinical pathway protocols are also located in a shared drive on the veterans affairs workgroup server for anesthesiology.

In 2019, we changed our THA protocol to also favor spinal anesthesia as the first choice, based on new recommendations [1]. Although there are specific differences between THA and TKA with regard to intraoperative management (e.g., patient positioning, use of a tourniquet, blood loss), evidence suggests that neuraxial anesthesia is associated with benefits, even when combined with general anesthesia [1]. The rate of CPNB utilization is consistently high for all joint replacement patients at our institution. We attribute this to our PSH model in which the RAAPM team directly co-manages orthopedic surgery patients, and is primarily responsible for all aspects of pain management. The increase in THA patient CPNB utilization triggered in 2015 was secondary to the hiring of a new orthopedic surgeon who was particularly supportive of peripheral regional analgesia. Our CPNB data demonstrate our system's ability to adapt and efficiently implement practice changes that quickly become 'hard-wired', and can be sustained over time. Within one quarter, nearly all THA patients were receiving CPNB, and this rate has not wavered since implementation.

There were several limitations to our study. First, the study was retrospective in nature. Second, the reported data are dependent on complete and accurate documentation in the electronic medical record, and integration of clinical information into the PSH database. Outcomes that are not routinely included in the PSH database (e.g., quality of recovery, patient satisfaction) are not available for analysis. Third, this study is clearly underpowered to detect differences in major postoperative complications due to the extreme rarity of these events. Larger database studies are more appropriate for studying these outcomes [17]. Finally, this study was conducted at a single, tertiary-care, university-affiliated VA hospital with a male-dominated patient population and other unique characteristics [18,19]; therefore, the clinical results may not be generalizable to other clinical settings and populations. However, we have identified some of the factors within our practice that may have made it possible to sustain long-term change, and these may be applicable to other practice settings.

In summary, a major clinical pathway change in intraoperative anesthetic technique for TKA patients can be effectively implemented and sustained over a 5-year period in the context of a PSH. In addition, our experience shows an increase in spinal anesthesia usage

for THA patients in the same timeframe, suggesting a collateral benefit from the TKA clinical pathway change.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This material is the result of work supported with resources and the use of facilities at the Veterans Affairs (VA) Palo Alto Health Care System (Palo Alto, CA, USA). The contents do not represent the views of the Department of Veterans Affairs or the United States Government.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Mallika Tamboli (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Software; Visualization; Writing – original draft; Writing – review & editing)
Jody C. Leng (Conceptualization; Investigation; Methodology; Resources; Supervision; Writing – original draft; Writing – review & editing
Oluwatobi O. Hunter (Conceptualization; Investigation; Writing – review & editing)
Alex Kou (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Software; Visualization; Writing – original draft; Writing – review & editing)
Seshadri C. Mudumbai (Conceptualization; Investigation; Methodology; Resources; Supervision; Validation; Writing – review & editing)
Stavros G. Memtsoudis (Conceptualization; Methodology; Validation; Writing – review & editing)
Tessa L. Walters (Conceptualization; Resources; Software; Writing – review & editing)
Gregory Milo Lochbaum (Conceptualization; Methodology; Supervision; Writing – review & editing)
Edward R. Mariano (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing)

ORCID

Mallika Tamboli, https://orcid.org/0000-0002-4011-2205
Jody C. Leng, https://orcid.org/0000-0002-7768-5285
Oluwatobi O. Hunter, https://orcid.org/0000-0002-1502-9522
Alex Kou, https://orcid.org/0000-0003-1807-1176
Seshadri C. Mudumbai, https://orcid.org/0000-0001-8486-9966
Stavros G. Memtsoudis, https://orcid.org/0000-0001-9093-0030
Tessa L. Walters, https://orcid.org/0000-0001-9245-5819
Gregory Milo Lochbaum, https://orcid.org/0000-0003-1064-7249
Edward R. Mariano, https://orcid.org/0000-0003-2735-248X

References

1. Memtsoudis SG, Cozowicz C, Bekeris J, Bekere D, Liu J, Soffin EM, et al. Anaesthetic care of patients undergoing primary hip and knee arthroplasty: consensus recommendations from the International Consensus on Anaesthesia-Related Outcomes after Surgery group (ICAROS) based on a systematic review and meta-analysis. Br J Anaesth 2019; 123: 269-87.
2. Cozowicz C, Poeran J, Zubizarreta N, Mazumdar M, Memtsoudis SG. Trends in the use of regional anesthesia: neuraxial and peripheral nerve blocks. Reg Anesth Pain Med 2016; 41: 43-9.
3. Liu J, Wilson L, Poeran J, Fiasconaro M, Kim DH, Yang E, et al. Trends in total knee and hip arthroplasty recipients: a retrospective cohort study. Reg Anesth Pain Med 2019. Advance Access published on Jul 11, 2020. doi: 10.1136/rapm-2019-100678.
4. Morris ZS, Wooding S, Grant J. The answer is 17 years, what is the question: understanding time lags in translational research. J R Soc Med 2011; 104: 510-20.
5. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999; 282: 1458-65.
6. Mudumbai SC, Walters TL, Howard SK, Kim TE, Lochbaum GM, Memtsoudis SG, et al. The Perioperative Surgical Home model facilitates change implementation in anesthetic technique within a clinical pathway for total knee arthroplasty. Healthc (Amst) 2016; 4: 334-9.
7. Memtsoudis SG, Sun X, Chiu YL, Stundner O, Liu SS, Banerjee S, et al. Perioperative comparative effectiveness of anesthetic technique in orthopedic patients. Anesthesiology 2013; 118: 1046-58.
8. Silver SA, McQuillan R, Harel Z, Weizman AV, Thomas A, Nesrallah G, et al. How to sustain change and support continuous quality improvement. Clin J Am Soc Nephrol 2016; 11: 916-24.
9. Walters TL, Howard SK, Kou A, Bertaccini EJ, Harrison TK,

https://doi.org/10.4097/kja.19400

Kim TE, et al. Design and implementation of a perioperative surgical home at a Veterans Affairs Hospital. Semin Cardiothorac Vasc Anesth 2016; 20: 133-40.
10. Mariano ER, Walters TL, Kim TE, Kain ZN. Why the perioperative surgical home makes sense for Veterans Affairs Health Care. Anesth Analg 2015; 120: 1163-6.
11. Steckelberg RC, Funck N, Kim TE, Walters TL, Lochbaum GM, Memtsoudis SG, et al. Adherence to a multimodal analgesic clinical pathway: a within-group comparison of staged bilateral knee arthroplasty patients. Reg Anesth Pain Med 2017; 42: 368-71.
12. Mariano ER, Kim TE, Wagner MJ, Funck N, Harrison TK, Walters T, et al. A randomized comparison of proximal and distal ultrasound-guided adductor canal catheter insertion sites for knee arthroplasty. J Ultrasound Med 2014; 33: 1653-62.
13. Mudumbai SC, Kim TE, Howard SK, Giori NJ, Woolson S, Ganaway T, et al. An ultrasound-guided fascia iliaca catheter technique does not impair ambulatory ability within a clinical pathway for total hip arthroplasty. Korean J Anesthesiol 2016; 69: 368-75.
14. Pluye P, Potvin L, Denis JL, Pelletier J. Program sustainability: focus on organizational routines. Health Promot Int 2004; 19: 489-500.
15. Lubarsky DA, French MT, Gitlow HS, Rosen LF, Ullmann SG. Why money alone can't (always) "nudge" physicians: the role of behavioral economics in the design of physician incentives. Anesthesiology 2019; 130: 154-70.
16. American Society of Regional Anesthesia and Pain Medicine. Four new quality pain measures approved for 2018 [Internet]. Pittsburgh (PA): ASRA; 2018 Jan 13 [cited 2019 Aug 16]. Available from https://www.asra.com/news/185/four-new-quality-painmeasures-approved.
17. Elkassabany NM, Memtsoudis SG, Mariano ER. What can regional anesthesiology and acute pain medicine learn from "big data"? Anesthesiol Clin 2018; 36: 467-78.
18. Trivedi RB, Post EP, Sun H, Pomerantz A, Saxon AJ, Piette JD, et al. Prevalence, comorbidity, and prognosis of mental health among US veterans. Am J Public Health 2015; 105: 2564-9.
19. Olenick M, Flowers M, Diaz VJ. US veterans and their unique issues: enhancing health care professional awareness. Adv Med Educ Pract 2015; 6: 635-9.