Queen's University

41st Annual Anesthesiology Research Day

Monday November 16, 2020
****Virtual****
Kingston, Ontario

Supported by Educational Grants from:

The A. William, Austin & Amos Friend Memorial Visiting Professorship

Abbvie

Queen's University
41st Annual Anesthesiology Research Day

Scientific Program Director and Residency Research Coordinator:

Ian Gilron, MD, MSc, FRCPC

Research Day Co-organizer:

Glenio Mizubuti, MD, MSc

Queen's Scientific Adjudicators and Moderators:

Rachel Rooney
MD, FRCPC

Gregory Klar
MD, MPH, FRCPC

Guest Lecturer: **Philip Jones MD, MSc, FRCPC**

Department Head:
Ramiro Arellano, MD, MSc, FRCPC

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Institutional support:
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Held on November 16, 2020.

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VIRTUAL SCIENTIFIC PROGRAM OUTLINE

*** SESSION 1: *INTRODUCTION & GUEST LECTURE* ***

0800 – 0810 **Research Day Introduction**

– Dr. Ian Gilron

0810 – 0820 **Opening Remarks & Introduction of Guest Lecturer**

– Dr. Ramiro Arellano

0820 – 0930 ***Dr. Philip Jones***,
Professor, Departments of Anesthesia & Perioperative Medicine,
and, Department of Epidemiology & Biostatistics,
University of Western Ontario

"Openness in Research"

0930 – 0945 **Wellness break**

*** SESSION 2: *RESEARCH TRAINEE PRESENTATIONS* ***

0945 – 1100 **Oral presentations (5)**

1100 – 1115 **Wellness break**

1115 – 1215 **Oral presentations (4)**

1215 – ***Virtual lunch on your own***

EACH 10-MINUTE ORAL PRESENTATION WILL BE FOLLOWED BY A 5-MINUTE QUESTION PERIOD

The Judges will be:

Dr. Rachel Rooney, Assistant Professor, Queen's Dept of Anesthesiology & Perioperative Medicine

Dr. Gregory Klar, Assistant Professor, Queen's Dept of Anesthesiology & Perioperative Medicine

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Oral Presentations (alphabetical order)

Dana ARCHIBALD, PGY-3
Must we always wait an hour after a spinal tap for systemic heparin administration? (proposal)

Courtney BANNERMAN, BSc, PhD Candidate (Queen's Neuroscience)
The role of WNK1 in the development and maintenance of spinal cord injury pain (update)

Matthew BRUDER, PGY-5
A Pilot Study to Investigate Labor Epidural Failure Rates at Kingston Health Science Centre (update)

Daenis CAMIRÉ, PGY-4
Measurement of Movement-Evoked Pain versus Pain at Rest in Postoperative Pain Treatment Trials (update)

Carl CHAUVIN, PGY-5
The Post-Operative Waveform Evaluation Reliability (POWER) Study: Does waveform analysis predict epidural functionality in the post-operative period? (update)

Kai CHEN, PGY-3
Anticoagulation during Cardiopulmonary Bypass - Correlation between ACT and Heparin Activity measured by Anti-Xa Assay (proposal)

Emily COOK, PGY-5
Get with the Guidelines: Local implementation of preoperative biomarker screening (update)

Johnathan GODBOUT, PGY-5
A case of recurarization after sugammadex reversal in a neonate (case review)

Maia IDZIKOWSKI, MD Candidate (Queen's)
Bolus vs continuous infusion in erector spinae block: a cadaver study (proposal)

Amy JIANG, PGY-3
Surgical Sensation During Cesarean Section (proposal)

Fraser JOHNSON, PGY-4
Remembering Risk: Using Visual Risk Display of MINS to Obtain Informed Consent to Undergo Elective Surgery (update)

Noah LETOFSKY, MD Candidate (Queen's)
Magnetic Resonance Determined Spine Anatomy in Pediatrics (proposal/update)

Mohammed MOHIUDDIN, BSc (Hons), MD candidate, (Queen's)
General risks of harm with cannabinoids, cannabis, and cannabis-based medicine possibly relevant to patients receiving these for pain management: an overview of systematic reviews (update)

Rex PARK, BHSc, MD candidate, (Queen's)
Magnesium for the Management of Chronic Noncancer Pain in Adults. (update)

Julia SEGAL, PhD candidate, (Queen's DBMS)
Circadian control of pain and neuroinflammation in experimental autoimmune encephalomyelitis (update)

Craig STEWART, BSc, MD candidate (Queen's)
Can Dobutamine and Goal-Directed Fluid Therapy improve tissue oxygenation in Deep Inferior Epigastric Perforator (DIEP) flap breast reconstruction surgery? A Randomized Controlled Trial Protocol (proposal)

Emma TORBICKI, PGY-5
Leadership in the operating room (update)

Nick-Hugh WISDOM, PGY-3
Does a Standardized Operating room to ICU hand over protocol improve the perceived quality of information exchange among care providers? (proposal)

Poster Presentations (alphabetical order of first author)

Does Technology Improve Pain Reporting Compliance in Adults with Chronic Pain?
Landon Montag

Does the Speed of Sternal Retraction during Coronary Artery Bypass Graft Surgery affect Postoperative Pain Outcomes? A Randomized Controlled Trial
Craig Stewart

Systemic Heparinization after Neuraxial Anesthesia in Vascular Surgery: A Retrospective Analysis

Dana Archibald, Dr. Glenio Mizubuti, Dr. Anthony Ho

Background: The American Society of Regional Anesthesia and Pain Medicine (ASRA) released the fourth edition of evidence-based guidelines in 2018 for regional anesthesia in the patient receiving antithombotic or thrombolytic therapy. According to these guidelines, intravenous heparin should not be administered for a minimum of one hour after neuraxial anesthesia, which aims at mitigating the risk of neuraxial hematoma formation. Such risk however, may increase in the setting of traumatic (i.e., bloody) or difficult neuraxial needle placement in which case a collaborative, risk-benefit decision making with the surgical team is recommended.

This recommendation is largely based on a study with 684 patients from 1981, where 342 of the patients were given heparin after diagnostic lumbar puncture (LP) over a 10-year period in the context of acute cerebral ischemia. In the heparinized group, 7 patients had documented spinal hematomas (3 epidural, 2 subarachnoid, 2 subdural) proven by myelography, surgical laminectomy findings, or autopsy. There were no documented hematomas in the non-heparinized group. Three main risk factors of a major complication were identified: traumatic LP (76% vs 2%, $p<0.001$), anticoagulation within one hour (17.4% vs 1.5%, $p<0.001$), and treatment with aspirin therapy at the time of the LP (17% vs 2.4%, $p<0.001$). As per the ASRA guidelines, these findings have been supported with reviews of case series of hematomas, epidemiologic surveys and ASA closed-claims database from the 1990s.

However, in clinical practice, anesthesiologists may not always wait the recommended one hour or may choose to avoid neuraxial techniques if systemic heparin is likely to be required within an hour.

Objectives: The primary objective of this retrospective analysis is to determine the time intervals that anesthesiologists wait before administering systemic heparin after neuraxial anesthesia in patients undergoing vascular surgery. The secondary objective is to determine the incidence of spinal hematoma in this population.

Study Design: This is a multicenter retrospective chart review including femoral-femoral bypass, femoral-popliteal bypass, endovascular aneurysm repair and abdominal aortic aneurysm repair surgeries.

Results: 230 charts were reviewed between April 2012 to January 2020, 143 of which were femoral-femoral bypass or femoral-popliteal bypass surgeries and 87 of which were endovascular aneursysm repair (EVAR) surgeries performed by a single surgeon at Kingston General Hospital. Of the 143 bypass surgeies, 60 patients received a general anesthetic alone, 68 received a neuraxial technique, being 7 either epidural or combined spinal-epidural, and 61 subarachnoid blocks (SAB) alone of which 3 had failed with subsequent general anesthesia. In 14 cases, heparin administration occurred over one hour from neuraxial technique and 7 cases had lack of clear documentation of placement time and/or heparin administration. There were 49 cases where heparin was given before the recommended one-hour post-neuraxial technique. Of the 87 EVAR surgeries, 32 patients had general anesthesia only or no neuraxial technique and 55 had SAB. In 2 cases, heparin administration occrured over one hour from neuraxial technique, 7 cases lack clear documentation, and in 46 cases heparin was given less than one-hour post-neuraxial technique. These are preliminary results and several charts currently remain under review by a second investigator. Fifteen of the cases did not have any anesthetic records available or the case was cancelled or modified.

Control of spinal cord injury pain by γδ T cells

Courtney Bannerman[1], Jaqueline Silva[1,3], Scott Duggan[4], Nader Ghasemlou[1,2,3,4]

1. Department of Biomedical and Molecular Science, Queen's University.
2. School of Computing, Queen's University
3. Centre of Neuroscience, Queen's University
4. Anesthesiology and Perioperative Medicine, Queen's University

Chronic pain affects 60-80% of spinal cord injury (SCI) patients, making day-to-day life exceedingly more difficult. Current treatment options for those suffering from chronic SCI pain are ineffective at best. One of the reasons for the lack of treatments is that the research community is still trying to determine how chronic SCI pain starts and why it is so persistent. My doctoral work is focused on better understanding the contribution of γδ T cells to SCI pain. These immune cells are predominantly found at barrier sites, including skin and gut in both humans and mice, where they act as first-line defenders against injury and pathogens. γδ T cells secrete high levels of inflammatory mediators and help recruit circulating immune cells to sites of injury. Recent work has demonstrated that these cells are essential in locomotor recovery acutely after SCI. They are recruited as early as 24-48 hours after injury and are an early source of inflammatory cytokines. To better understand the role these cells play in chronic SCI pain, I developed an SCI mouse model that closely mimics a human SCI and shows a more severe pain phenotype by applying 60s of compression to the SCI. My preliminary data also shows that TCRδ$^{-/-}$ transgenic mice lacking these cells exhibit reduced mechanical pain after SCI. C57BL/6J mice with more severe pain also show increased numbers of γδ T cells, both acutely (7dpi) and chronically (21dpi) after injury in the spinal cord.

I am currently in the process of identifying where γδ T cells are coming from and how they are being recruited to the spinal cord. Through this work, I hope to identify new mechanisms underlying chronic SCI pain and new therapeutic options.

A Pilot Study to Investigate Labor Epidural Failure Rates at Kingston Health Science Centre

Matthew Bruder, PGY5 Anesthesia
Supervisor: Dr. Patterson

Background: Despite resident best-practices, busy labor and delivery wards and the demands of on-call residents mean that frequently laboring patients with epidurals are not closely tracked. And while entirely non-functional epidurals or complications certainly prompt anesthesiology response and follow-up, poorly functioning epidurals, or those in patients progressing through labor quickly, may fall through the cracks. Simply put, epidurals are often placed, then removed following delivery, without the physician who placed them ever being aware of exactly how effective they were. This pilot study aims to remedy this situation and collect department-wide data on the failure rates of labor epidurals at Kingston Health Science Centre (KHSC).

Clinical Need / Knowledge Gap: There is currently no local data on rates of labor epidural failures, incomplete sensory blocks, number of replaced epidurals, or common complications of labor epidurals at KHSC. Data on the *overall* failure rates of labor epidurals are widely available. However, without local data, it is difficult to identify possible areas for improvement at KHSC. This pilot study aims to collect this data, facilitating comparison to other similarly sized academic medical centers in North America.

Study Objective: To ascertain the local rate of labor epidural failures and poorly functioning epidurals at KHSC

Methods: A retrospective chart review of 6 months of labor epidurals will be undertaken. Following appropriate approvals electronic health records for all laboring patients who received lumbar epidurals will be reviewed. Data recorded will include patient age, BMI, number of epidural replacements and placement attempts, level of placement and catheter depths, epidural infusion rates and modes (bolus vs continuous), physician level of training, number of epidural boluses, sensory block level, and any complications. In keeping with similar studies, epidural failures will be defined as those requiring replacement or significant manipulation to provide an adequate sensory block. Following data collection, we will stratify epidural failure rates across several different sub-groups, including high vs low BMI, and according to physician level of training.

Hypothesis: We expect that local rates for labor epidural failures and poorly effective epidurals will fall in line with similarly sized academic centers in North America.

References

1. Arendt K, Segal S. Why epidurals do not always work. Review of Obstetrical Gynecology 2008;1(2):49-55.
2. Eappen S, Blinn A, Segal S. Incidence of epidural catheter replacement in parturients: a retrospective chart review. Int Obstet Anesth. 1998;7: 220-225.
3. J. Hermanides, M. W. Hollmann, M. F. Stevens, P. Lirk; Failed epidural: causes and management, BJA: British Journal of Anaesthesia, Volume 109, Issue 2, 1 August 2012, Pages 144–154.
4. Kinsella SM. A prospective audit of regional anaesthesia failure in 5080 caesarean sections. Anaesthesia 2008;63:822–33.
5. Pan PH, Bogard TD, Owen MD. Incidence and characteristics of failures in obstetric neuraxial analgesia and anesthesia: a retrospective analysis of 19,259 deliveries. Int J Obstet Anesth. 2004; 13:227-233.

Systematic review of movement-evoked pain versus pain at rest in postsurgical clinical trials and meta-analyses: A follow-up review

Daenis Camire, Amanda-Ross White, Tim Brennan, Henrik Kehlet, Jason Erb, and Ian Gilron

Background: Postoperative pain is one of the most prevalent and disabling complications of surgery that is associated with personal suffering, delayed functional recovery, prolonged hospital stay and chronic postsurgical pain. Previous studies have distinguished between pain at rest (PAR) and movement-evoked pain (MEP) after surgery. In most studies including both measures, MEP has been shown to be substantially more severe in intensity than PAR. Furthermore, since MEP is commonly experienced during normal activities (e.g. breathing, coughing, walking etc.), it has a greater adverse functional impact than does PAR. In 2011, a previous systematic review by Srikandarajah and Gilron, showed that only 39% of reviewed trials included MEP as a trial outcome and 52% failed to identify the pain outcome as either PAR or MEP. Consequently, an editorial in 2011 by Kehlet and Dahl confirmed that there has been no progress in the quality of assessment, despite the need to include movement-associated pain in perioperative analgesic trials was emphasised almost 20 years ago.

Study Question: In postsurgical pain treatment trials: 1) what is the frequency of use of pain at rest (PAR) versus movement-evoked pain (MEP) as a trial outcome, and 2) what methods are used to assess MEP?

Purpose of Study: Main data to be extracted will be:
1. Designation of movement-evoked pain as the trial primary outcome
2. Designation of pain at rest as the trial primary outcome
3. Distinction between movement-evoked pain and pain at rest in assessing pain
4. Method of evoking pain for the assessment of movement-evoked pain

Study Design: We will search the following electronic bibliographic databases: MEDLINE, EMBASE, The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Methodology Register). As a convenience sample of 2014-2019 postsurgical pain treatment trials, this review will be limited to thoracotomy, knee arthroplasty and hysterectomy surgical procedures involving humans and will focus on randomized controlled clinical trials and meta-analyses that report pain as a trial outcome. Articles will be excluded if they: are not randomized controlled trials, include a mix of surgeries, do not deal with outcomes following surgery, do not report pain scores, or report pain only after 1 week postoperatively. No analysis of subgroups is planned at this time.

Progress: A suggested timeline of this study is 12-24 months. Approximately 900 articles will be reviewed with around an estimated 30-40% of these results meeting inclusion criteria will be included in the analysis (N=300-360). Currently, the PROSPERO Review Protocol registration is complete. The Review Protocol has been published in JMIR Research Protocols. An update will be presented of the 251 articles reviewed for Thoracotomy patients, including protocols for ongoing studies and how they've addressed this problem.

Limitations: Given that the focus of this review is on pain outcome measurement only, reviewed trials will not be evaluated with respect to trial quality or risk of bias. As the expected time in adopting recommendations from the previous 2011 systematic review is indeterminate, there may be potential for misrepresentation of earlier articles in bolstering analgesic trial methodology.

References:

Kehlet, H., and Dahl, J. B. (2011). Assessment of postoperative pain-need for action! *Pain*, *152*(8):1699-700. doi: 10.1016/j.pain.2011.03.013

Srikandarajah S, Gilron I. (2011). Systematic review of movement-evoked pain versus pain at rest in postsurgical clinical trials and meta-analyses: A fundamental distinction requiring standardized measurement. *Pain*, *152*(8): 1743-1739. doi:10.1016/j.Pain.2011.02.008.

Post-Operative Waveform Analysis Reliability (POWAR) Study: Does waveform analysis predict thoracic epidural functionality in the post-operative period?

Carl Chauvin PGY5, Gregory Klar FRCPC, Glen Mizubuti FRCPC, Mike McMullen FRCPC

Background: Administration of analgesic drugs via epidural catheters is an important analgesic option in the perioperative setting. However, the failure rate of thoracic epidurals is consistently estimated between 15-30% using conventional placement techniques.[1,2] Establishing more reliable means of placing well-functioning thoracic epidurals and assessing their continued functional status with confidence remains an important and elusive goal.

Epidural waveform analysis (EWA) has been shown to be a useful clinical adjunct for confirming proper placement of an epidural catheter.[1,2,3] To date, however, no study has previously demonstrated the continued utility of EWA in assessing epidural catheters in the post-operative period. We seek to show that for suspected failed or equivocally functioning epidurals, EWA is an efficient, non-invasive, reliable adjunct to determining the functional status of the epidural.

Study Design: The study is a prospective control pilot study. Patients were identified pre-operatively and consented to participate in the clinical study. Thoracic epidural was conventionally placed pre-operatively using a loss-of-resistance (LOR) technique. After catheter insertion and positioning, a test dose of 4cc of lidocaine 2% was administered, followed by a 5cc normal saline flush.[4] The catheter will then be transduced via EWA. Presence or absence of a pulsatile waveform was recorded, as was the presence or absence of a block to ice after 15 minutes.

Post-operatively, epidural catheters were flushed in PACU with 5cc normal saline, and again transduced for EWA. Patients were assessed for the continued presence of a block to ice. Epidurals producing a bilateral block of 2+ levels were categorized as *functional*; those producing no block, a unilateral block, or a block of only 1 level will be categorized as *equivocal*. Participants with the latter result will then have a bolus of 4cc lidocaine 2% administered through the epidural. After 15 minutes, the block will again be assessed with ice. *Equivocal* epidurals that developed a bilateral 2+ level block in response to this bolus were also categorized as *functional*; those that did not develop a bilateral block even after this bolus were categorized as *failed*.

Each EWA recording was independently reviewed by three separate raters. Post-operative EWA result was compared with block to ice following epidural lidocaine for each, to establish the reliability of epidural catheter waveform analysis at predicting whether an epidural is functional in the post-operative period.

Hypothesis: EWA as measured through an epidural catheter will reliably distinguish between *functional* (i.e. lidocaine bolus produces bilateral 2+ dermatome block) vs. *non-function* (i.e. lidocaine bolus has negative result) in the post-operative period.

Progress: Patient enrollment and data collection has been completed. 84 patients were enrolled in the study. Four patients were excluded prior to EWA post-op testing; of the remaining 80, 73 patients had functional epidurals and 7 had non-functional epidurals (as adjudicated by block-to-ice test post-operatively). EWA video recordings were evaluated independently by three raters. EWA analysis yielded a **sensitivity of 89%**, a **specificity of 86%**, a **positive predictive value of 98%**, and a **negative predictive value of 43%**. Interrater reliability (Kappa coefficient) analysis is in progress.

References:

1) Leurcharusmee P et al. Reliability of waveform analysis as an adjunct to loss of resistance for thoracic epidural blocks. *Reg Anes Pain Med*. 2016;40:693-697.
2) Arnuntasupakul V et al. *A randomized comparison between conventional and waveform-confirmed loss of resistance for thoracic epidural blocks*. *Reg Anes Acute Pain*. 2016;41:368-373.
3) de Médicis E et al. *Technical report: optimal quantity of saline for epidural pressure waveform analysis*. Can J Anaesth. 2007;54:818–821.
4) Lennox PH et al. *A pulsatile pressure waveform is a sensitive marker for confirming the location of the thoracic epidural space*. J Cardiothorac Vasc Anesth. 2006;20:659–663.

CORRELATION BETWEEN ACTIVATED CLOTTING TIME AND ANTI-XA ACTIVITY IN PATIENTS UNDERGOING CARDIAC SURGERY REQUIRING CARDIOPULMONARY BYPASS

Authors: Kai Chen, Tarit Saha, Rob Tanzola, Graeme Quest, David Good, Maggie Savelberg, Wilma Hopman, Anne Vincent

Objective: Anticoagulation for cardiopulmonary bypass (CPB) has historically involved the use of heparin as the anticoagulant of choice. Activated clotting time (ACT) is considered the gold standard for determining adequate level of anticoagulation before and during CPB. Recent guidelines suggest ACT > 480 seconds during CPB; however, initial validation studies were done on much older generations of bypass circuits in animal models and results have not been replicated in more recent clinical studies. ACT is also a measure of whole blood clotting, which varies in value depending on how the instrument determines clotting, and does not necessarily reflect degree of heparin activity.[1] Newer studies have shown poor correlation between ACT and anti-Xa activity levels, the latter considered the gold standard for monitoring heparin activity.[2] We sought to quantify the correlation between two point-of-care ACT instruments (Hemochron and i-STAT) with the laboratory based anti-Xa activity assay for patients undergoing cardiac surgery requiring CPB at various time points during surgery.

Design and Method: 50 patients undergoing cardiac surgery requiring CPB were consented and enrolled. Blood samples were taken from each patient to examine the correlation between two ACT point-of-care instruments, Hemochron and i-STAT, and that of anti-Xa activity at various points during surgery.

These timepoints were at 1) baseline, 2) after initial heparin bolus prior to initiating bypass, 3) several time points during CPB, and 4) after protamine reversal of heparin. Pearson's (r) and Spearman's (rho) correlations were calculated for each set of comparisons.

Results and Conclusions: We obtained a total of 542 comparisons between ACT values and anti-Xa activity. There was poor correlation between both ACT instruments and anti-Xa activity after the initial bolus of heparin prior to bypass, with correlations worsening on bypass. I-STAT generally correlated better with anti-Xa activity and the two ACT instruments generally correlated well with each other, except while on CPB. There was greater than 16-fold difference seen in heparin activity between patient samples when ACT > 400, with anti-Xa activity ranging from 0.78 to 16.10 U/mL. Furthermore, the average ACT (i-STAT) after protamine reversal was 22 seconds lower than baseline; however, average post-protamine anti-Xa activity was 0.77 U/mL.

Discussion: Our results suggest a wide range of level of anticoagulation in patients during CPB. There is inadequate reversal of heparin post-bypass, reaching therapeutic anticoagulation levels based on anti-Xa criteria, despite ACT values normalizing. Using ACT alone as a point-of-care tool may be inadequate in determining the optimal level of anticoagulation and reversal in patients undergoing cardiac surgery requiring CPB.

References:

1. Shore-Lesserson L et al. Clinical Practice Guidelines-Anticoagulation During CardioPulmonary Bypass. The Annals of Thoracic Surgery. 2018 Feb 1;105(2):650-62.
2. Carroll R et al. The Future of Activated Clotting Time. Anesth Analg. 2018 Aug;127(2):e25-e26.

Get with the Guidelines: Two PDSA cycles of local implementation of preoperative biomarker screening

Dr. E Cook, Dr. J Dion, Dr. C Nickel, Dr. K Marosi, R Phelan and Dr. M McMullen

Background: In 2017 the Canadian Cardiovascular Society (CCS) recommended that cardiac biomarkers (BNP or NT-proBNP) should be routinely measured before elective noncardiac surgery to optimize perioperative cardiac risk stratification[1]. The new screening initiative targeted patients 65 years or older, patients 45-64 years of age with significant cardiovascular disease and, patients with a Revised Cardiac Risk Index score ≥1. The CCS guidelines also recommend postoperative monitoring with daily troponins in patients with elevated BNP or NT-proBNP levels, as an elevated postoperative troponin is known to be the strongest predictor of 30-day mortality[2].

Preoperative measurement of BNP/NT-proBNP levels was implemented as part of the presurgical screening process at Kingston Health Sciences Center (KHSC) in December 2016. A protocol for the management and follow-up of patients with positive results was developed but effective implementation requires collaboration with multiple stakeholders (surgeons, anesthesiologists, internal medicine, postgraduate trainees, nursing staff and laboratory medicine teams). Despite system wide implementation, the adherence to the CCS guidelines at KHSC remained unknown. The aim of this quality improvement project was to utilize a Plan-Do-Study-Act (PDSA) cycle approach to both define and increase the rate of appropriate postoperative monitoring for myocardial injury at KHSC.

Methods: The study was designed as a prospective quality assurance PDSA cycle with three distinct phases:

1. Chart review of patients with a positive preoperative NT-proBNP to determine if patients received appropriate follow-up and examine 30-day morbidity and mortality (July – December 2018)
2. Implement interventions (alert stickers, targeted education sessions with individual services and redesign of order sets) aimed to improve compliance with the guidelines (January – July 2019)
3. Chart review of patients with a positive preoperative BNP after the interventions are implemented (July – December 2019)

Results: Data from the initial PDSA cycle revealed that at baseline only 36% of patients with an elevated NT-proBNP level received complete postoperative follow-up. This improved to 49% after the targeted interventions were implemented. For patients that had only partial follow-up as per the CCS Guidelines, the most common element missing was the postoperative troponin screening.

Conclusions: The initial phase of this PDSA study revealed that after implementing a BNP screening program at KHSC, there was suboptimal postoperative monitoring for MINS. Several targeted interventions were successfully implemented within local perioperative care and increased rates of complete follow-up by 13%. Given the significant impact myocardial injury has on postoperative morbidity and mortality there is need for further efforts to increase both the detection and subsequent management of MINS at KHSC. This is one of the goals of the new Perioperative Medicine Consult Service and subsequent PDSA cycles will be helpful to analyze the impact of this service.

[1]Duceppe E, Parlow J, Macdonald P, et al. Can J Cardiol 2017; 33: 17-32.
[2]Devereaux PJ, Chan MT, Alonso-Coello P, et al. JAMA 2012; 203: 2295-304.

A Case of Recurarization After Sugammadex Reversal In A Neonate

Johnathan Godbout PGY-5
Anesthesiology staff supervisor Dr Heather O'Reilly, CHEO

Sugammadex is a reversal agent that rapidly encapsulates the steroidal neuromuscular blocking agents, rocuronium and vecuronium, and terminates their effect. Although recurarization, defined as an increase in neuromuscular block after a variable period of recovery, is possible after administration of Sugammadex, there have only been case reports documenting the phenomenon. Furthermore, studies reporting the use of Sugammadex specifically in the neonatal population are lacking in the literature.

We report a case where a 7-week-old neonate (post conceptual age of 40 weeks) that received rocuronium during a general anesthetic was thought to be fully reversed with Sugammadex, but subsequently developed respiratory failure necessitating non-invasive positive pressure ventilation. An additional dose of Sugammadex was required, which effectively restored muscle function and the patient recovered well. Multiple confounding factors were considered and ultimately recurarization was believed to have caused the episode.

This case re-enforces the importance of using acceleromyography or electromyography monitoring to guide reversal with Sugammadex. It also highlights the importance of sound clinical judgement and continuous assessment in all cases with or without the use of such monitors. Finally, anesthesia providers should maintain an index of suspicion for recurarization in the face of muscle weakness & respiratory failure even when Sugammadex was used for NMBA reversal.

Bolus vs continuous infusion in erector spinae block: a cadaver study

Maia Idzikowski, Anthony Ho

The erector spinae plane (ESP) block is a form of regional anesthesia/analgesia used mainly in thoracic trauma, rib fracture, thoracic and abdominal surgery, and chronic pain. A major benefit to providing regional anesthesia is superior analgesia with concomitant reduction in opioid consumption and associated side effects (sedation, respiratory depression, long term opioid dependency, etc). The ESP block is a superficial fascial block. Local anesthetic injected into the ESP needs to reach the paravertebral space to numb the thoracic and abdominal nerves emerging from the spinal cord. It must therefore be administered in relatively large volumes to penetrate the fenestrated intercostal muscles and paraspinal ligaments to arrive at the target. It is not clear whether a large bolus or a continuous trickle of the same volume will have the same spread of the injectate at the paravertebral region. Our study analyzes the spread of injectate dye in response to the administration of an erector spinae plane (ESP) block in cadavers. The development of a standardized dosage and method of administration has yet to be established, and our research aims to address this gap in the literature. We hypothesize that administering a 20-mL bolus of dye over 30 sec in an ESP block would be different from 20 mL administered over 4 hours.

Surgical Sensation During Caesarean Section Under Regional Anesthesia

Amy Jiang, Lindsey Patterson

Question: What surgical sensation do Caesarean section patients perceive under regional anesthesia?

Background:

Caesarean section is a major abdominal surgery performed on a young and usually healthy population. It represents a significant and highly emotional milestone. Patients undergoing C-section receive minimal if any sedation. Providing patient education and counselling is an important component of relieving maternal anxiety and avoiding a general anesthetic. Preoperative and intraoperative education has been found to have a significant effect on perioperative anxiety and pain control, as well as maternal satisfaction during C-section. There is currently minimal qualitative literature addressing the surgical sensation that patients perceive during C-section. This study aims to provide a descriptive assessment of subjective surgical experience during C-section under regional anesthesia. This will enhance our current understanding and allow us to better alleviate patient anxiety through informed counselling.

Study Method:

Qualitative descriptive study. Patients will be contacted by phone after discharge home from hospital. English speaking women undergoing C-section at KGH with neuraxial anesthesia can be included. An interview will be conducted and recorded within 2 weeks of their surgery. Thematic reviews will subsequently be performed to identify major themes in descriptions of surgical sensation.

Proposed Semi-Structured Interview Questions:

Information on patient, surgical, and anesthetic factors will be collected for each study participant. Patient information will include age, past medical history, past anesthetic history, and obstetric history. Surgical information will include the indication, case urgency, and whether the uterus was exteriorized. Anesthetic information will include the type of regional anesthesia and any medications administered perioperatively. Proposed interview questions include: What were your concerns prior to your surgery? Did you receive any education or counselling about what to expect? Did you experience pain during your surgery, after your spinal/epidural? Please describe. Did you experience any other sensation during your surgery? Please describe. What would you tell another patient about the same procedure, with the same anesthetic? What would you want to hear from your anesthesiologist before and during surgery?

References

Alahuta S, Kangas-Saarela T, Hollmen AI, Edstrom HH. Visceral pain during caesarean section under spinal and epidural anesthesia with bupivacaine. Acta Anaesthesiologica Scandinavica 1990; 34: 95 – 98.

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Remembering Risk: Using Visual Risk Display of MINS to Obtain Informed Consent

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Background: Informed consent is an important aspect of the patient-physician relationship. Prior to agreeing to undergo treatment patients must have risks and benefits disclosed to a "reasonable patient" standard.[1] The 2016 Canadian Cardiovascular Society Guidelines on Perioperative Cardiac Risk Assessment strongly recommend the communication of perioperative cardiac risk to patients.[2] Myocardial injury is the most common post-operative complications and have significant impacts on patient outcomes.[2] Very few studies have examined the communication of risk to patients, particularly when communicating perioperative cardiac risk. One study looked at the variability of physician's subjective definitions of risk (low, medium, and high) when communicating perioperative cardiac risk and found great variability between clinicians.[3] When communicating with patients about "evidence" there are studies that have looked at various communication methods; event rate, natural frequencies, bar graphs, and have found improvements with respect to patient understanding and recall when aids are utilized.[4] The aim of this prospective cohort study is a 2-stage research project to address current practice in perioperative cardiac risk communication and examine opportunity to improve communication and patient education.

Study Design: The study will consist of two phases. Phase One will assess the current practices with respect to cardiac risk discussion and assess the need for quality improvement. Phase One will be a quality assessment by way of a survey. The survey will be offered after the PSS consultation to patients $\geq$ 45 years old, seen in consult prior to elective orthopedic surgery requiring an overnight admission to KHSC. The survey will assess current risk discussion practices by asking about patient satisfaction with cardiac risk discussion, patient estimation of risk (minimal to very high, 5 point scale), ability to recall cardiac risk (__/100) , likelihood to recommend discussion technique, and general feedback. A subset of consenting patients will complete a second survey following surgery will again assess patient estimation of cardiac risk, recall of cardiac risk (__/100), and sources of information used to understand cardiac risk.
Phase Two will look further in the cardiac risk discussion and assess the effectiveness of incorporating the use of structured, scripted risk discussion with and without the use of a visual aid.
In Phase Two, patients will receive the same surveys utilized in Phase One. The first survey will be immediately following their PSS visit and the second, for consenting patients, will take place in hospital following their surgery.
A reworking of Phase 2 is in progress as a result of the COVID-19 pandemic.

Hypothesis: The use of visual representation of perioperative risk of Myocardial Injury after Non-Cardiac Surgery during the pre-anesthetic assessment will improve the patients' satisfaction with cardiac risk discussion and their understanding and retention of the risk in the post-operative period.

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Magnetic Resonance Determined Spine Anatomy in Pediatrics

Authors: **Letofsky, N.; Archibald, D.; Haghighat, A.; Ho, A. M. H.***

Background:
Epidurals are used commonly in pediatric populations for intraoperative and postoperative pain management. While epidural placement has been shown to confer only a small rate of complications, potential complications such as iatrogenic neurological sequelae warrant consideration. Previous publications have theorized that knowledge of the range of depths of the epidural space and spinal cord may improve safety of the procedure. We therefore sought to determine the margin of safety from the posterior of the epidural space to the spinal cord and the dura to the spinal cord in pediatric patients.

Methods:
This was a retrospective study of 42 T2 weighted sagittal MRI spine images of children without spinal pathology ranging from 0-12 years old, in the supine position. These were obtained from the Kingston Health Sciences Centre database, and the study was approved by the hospital ethics committee. Three investigators independently measured distances from the anterior border of the ligamentum flavum to the spinal cord, and anterior edge of the dura to the spinal cord. This was measured both perpendicular to skin and parallel to the angle of spinous process of inferior vertebra.

Results:
Scans identified for inclusion included 25 females and 22 males. The patients were of the following ages: 7 aged less than one year of age, 5 aged one or two years, 7 ages three or four years, 4 aged five or six years, 8 aged seven or eight years, 7 aged nine or ten years, and 4 aged eleven or twelve years. The conus medullaris was identified superior to the L1 vertebrae in some patients, necessitating their exclusion from the L1/L2 measurements. This included 4 patients aged one or two years, 2 patients aged three or four years, 3 patients aged seven or eight years, 1 patient aged nine or ten years, and 1 patient aged eleven or twelve years.
The greatest perpendicular depth measured at all ages studied was 4.86 mm dura to cord, and 7.40 mm ligamentum flavum to cord. This was identified at the level of T5/T6. The greatest depth along the angle of the inferior spinal vertebrae, also at T5/T6, was 9.65 mm dura to cord, and 15.10 mm ligamentum flavum to cord.
The depth was greater when measured along the angle of the spinous process at T5/T6 and T9/T10 ($P<0.01$ for both sites when comparing dura-spine and ligamentum flavum to spine distances), but not L1/L2 ($P=0.53$, $P=0.97$).

Conclusion:
The margin of safety when performing an epidural, as defined by both ligamentum flavum to spinal cord distance and dura to spinal cord distance, may be greatest in the mid thoracic spine.

General risks of harm with cannabinoids, cannabis, and cannabis-based medicine possibly relevant to patients receiving these for pain management: an overview of systematic reviews

Mohammed Mohiuddin, Fiona M Blyth, Louisa, Degenhardt, Maria Di Forti, Christopher Eccleston, Simon Haroutounian, Andrew Moore, Andrew S.C. Rice, Mark Wallace, Rex Park, Ian Gilron

Abstract

The growing demand for improved pain treatments together with expanding legalization of, and access to, cannabinoids, cannabis, and cannabis-based medicines has intensified the focus on risk-benefit considerations in pain management. Given limited harms data from analgesic clinical trials, we conducted an overview of systematic reviews focused on all harms possibly relevant to patients receiving cannabinoids for pain management.

This PROSPERO-registered, PRISMA-compliant systematic overview identified 79 reviews, encompassing over 2200 individual reports about psychiatric and psychosocial harms, cognitive/behavioral effects, motor vehicle accidents, cardiovascular, respiratory, cancer-related, maternal/fetal, and general harms. Reviews, and their included studies, were of variable quality.

Available evidence suggests variable associations between cannabis exposure (ranging from monthly to daily use based largely on self-report) and psychosis, motor vehicle accidents, respiratory problems, and other harms. Most evidence comes from settings other than that of pain management (eg, nonmedicinal and experimental) but does signal a need for caution and more robust harms evaluation in future studies.

Given partial overlap between patients receiving cannabinoids for pain management and individuals using cannabinoids for other reasons, lessons from the crisis of oversupply and overuse of opioids in some parts of the world emphasize the need to broadly consider harms evidence from real-world settings. The advancement of research on cannabinoid harms will serve to guide optimal approaches to the use of cannabinoids for pain management. In the meantime, this evidence should be carefully examined when making risk-benefit considerations about the use of cannabinoids, cannabis, and cannabis-based medicine for chronic pain.

Efficacy and Safety of Magnesium for the Management of Chronic Pain in Adults: A Systematic Review

Authors: Rex Park, Anthony M-H Ho, Gisèle Pickering, Lars Arendt-Nielsen, Mohammed Mohiuddin, Ian Gilron

Introduction
Chronic pain is a highly prevalent and complex health problem that is associated with a heavy symptom burden, substantial economic and social impact, and also, very few highly effective treatments. This review examines evidence for the efficacy and safety of magnesium in chronic pain.

Methods
We searched MEDLINE, EMBASE, CENTRAL, and clinical trial databases from inception to September 2018, to identify randomized controlled trials (RCTs) that evaluated the efficacy of magnesium (at any dose, frequency, or route of administration) compared to placebo in chronic pain. Primary outcomes included any participant-reported measures of pain intensity or pain relief that have been previous validated. Secondary outcomes included participants experiencing any adverse event.

Results
Our search identified 1062 citations. A total of 9 RCTs containing 418 participants were included. Three studies examined neuropathic pain (62 participants), 3 examined migraines (190 participants), 2 examined complex regional pain syndrome (86 participants), and 1 examined low back pain with a neuropathic component (80 participants). Heterogeneity of included studies precluded any meta-analyses. No judgement could be made about safety because adverse events were inconsistently reported in the included studies. Evidence of analgesic efficacy from included studies was equivocal. However, reported efficacy signals in some of the included trials provide a rationale for more definitive studies.

Discussion
For the purposes of routine patient care, there is insufficient evidence to support or refute the hypothesis that magnesium is efficacious and safe in chronic pain. Larger sized trials with good assay sensitivity and better safety assessment and reporting will serve to better define the role of magnesium in the management of chronic pain. Additionally, due to differing bioavailabilities of various magnesium compounds[1-3], without measuring magnesium levels, it is difficult to determine whether lack of efficacy is due to inadequate dosing or because magnesium is indeed not efficacious. Therefore, these future trials would ideally be stratified by baseline body magnesium levels and magnesium formulations.

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Circadian disruption of pain and neuroinflammation in experimental autoimmune encephalomyelitis

Julia Segal, Mitra Knezic, Ian Gilron, Nader Ghasemlou

Circadian rhythms are 24-hour rhythms that regulate many biological functions, including pain, inflammation and nociceptive activity. Over half of multiple sclerosis (MS) patients experience chronic pain, with many reporting higher pain intensity at night. We therefore sought to identify whether pain and neuroimmune interactions exhibit a circadian rhythm in experimental autoimmune encephalomyelitis (EAE), a mouse model of MS. Mechanical and cold sensitivity were measured in EAE mice at multiple times per day over 28 days post-immunization. It was found that mechanical sensitivity, assessed with the von Frey assay, was increased at ZT8 (where ZT0=lights on) compared to ZT2, 14, and 20, suggesting that this pain modality may be under circadian control. There were no significant differences in cold sensitivity between times of day, indicating that this circadian effect is specific to mechanical sensitivity. To assess whether immune cell infiltration to nervous tissue is under circadian control, lumbar spinal cord and dorsal root ganglia tissues were isolated for flow cytometry from sham and EAE mice at ZT2, 8, and 14 at 14- and 28-days post-immunization. This analysis revealed a disrupted rhythm in several immune cell subsets. These findings suggest a potential role for circadian disruption in the pathology of EAE as well as its accompanying symptoms. Further studies may indicate whether EAE mice have disrupted sleep/wake cycles, and whether manipulating environmental conditions to induce circadian disruption can exacerbate EAE. We hope that this work will identify novel mechanisms underlying the onset and progression of EAE pain, give new insight into the neuroimmune control of disease outcomes, and lead to the identification of new therapeutic targets.

Can Dobutamine and Goal-Directed Fluid Therapy improve tissue oxygenation in Deep Inferior Epigastric Perforator (DIEP) flap breast reconstruction surgery? A Randomized Controlled Trial Protocol

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Introduction: Breast reconstruction is an integral part of breast cancer care. The deep inferior epigastric perforator (DIEP) flap remains the gold standard in autologous breast reconstruction.[1,2] Postoperative complications are relatively common and often result from poor flap perfusion/oxygenation including fat necrosis (incidence 13%), and partial (2.5%) or total flap loss (0.5%).[3] Hence, optimal perioperative fluid management and hemodynamic control, and adequate use of inotropes/vasopressors may play a major role in preventing such complications. Maintaining normovolemia is particularly important as hypovolemia leads to tissue hypoperfusion, whereas hypervolemia to tissue edema, both of which can potentially affect flap oxygenation. Yet, in current clinical practice, perioperative fluid therapy is commonly prescribed subjectively, leading to wide variations in total volume administered. Conversely, cardiac output (CO)-guided fluid therapy has been shown to modify inflammatory pathways and improve tissue perfusion/oxygenation in various settings.[4,5] Additionally, inotropes (e.g., dobutamine), may be beneficial in enhancing flap oxygenation through increased CO and peripheral vasodilation. The **purpose** of this trial is to evaluate the effects of perioperative hemodynamic therapy guided by CO monitoring on tissue oxygenation during (and after) DIEP flap. We **hypothesize** that a low-dose, perioperative dobutamine infusion combined with goal-directed fluid therapy will improve flap perfusion/oxygenation in patients undergoing DIEP surgery.

Methods: This study is a prospective, randomized controlled trial. Based on similar studies, a sample size of 22 patients (11 per group) would provide an 80% power at a 2-sided α of 0.05. We, however, will randomly assign 40 patients undergoing elective DIEP flap surgery to either the intervention or control group. Perioperative management and hemodynamic goals (including MAP≥65mmHg) will be identical in both groups, except for fluid administration, which will be guided by CO monitoring in the intervention group vs. traditional means (pulse rate, urine output, etc.) in the control group; and a low-dose (2.5µg/kg/min) fixed-rate dobutamine infusion which will be started *only* in the intervention group once fluid optimization is achieved intraoperatively, and maintained until 4h postoperatively. All surgical procedures will be performed by the same surgeon. Tissue oxygenation will be assessed at specific time-points (intra- and postoperatively) by near-infrared spectroscopy (NIRS).

Results: Our **primary outcome** is perioperative DIEP flap tissue oxygenation. **Secondary outcomes** include: (1) postoperative complications from flap malperfusion; (2) need for surgical re-intervention for flap-related issues; (3) amount of intraoperative intravenous fluids/blood products administered; and (4) hospital length of stay.

Conclusion: The current investigation is underway, with 9 patients having been randomized and conducted through our protocol to date.

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Does leadership style employed by anesthesiologists affect operating room team performance?

Emma Torbicki, Rene Allard, Darren Beiko, Julian Barling

Related area of Clinical "Need": The OR is a high stakes environment requiring cooperation between interdisciplinary teams to ensure a successful patient outcome. Knowledge regarding the effects of leadership style on OR team performance may result in more cohesion and improved responses to crises. Results of this research may help guide development of leadership training programs for medical personnel. Leadership has been well researched in psychology and business for many years. There are many well-defined leadership styles described in the literature which have been applied to the current study.

Current knowledge gaps in this area: While there is increasing literature examining the impact of team performance on clinical outcomes, the impact of leadership styles on team dynamics remains poorly understood.

Hypothesis to be tested: Abusive and over-controlling leadership styles are associated with poor operating room team performance.

Proposed study design: This is a prospective observational study. Teams of two trained assessors gathered information surrounding 150 operations performed at a tertiary care hospital in Canada between June and August 2014. Randomization was done by assigning numbers to each case list and using a random number generator to select cases. If the patient or healthcare personnel in that room declined to participate another number was drawn at random.

The data collected included: case complexity, preoperative patient health status, emergent or elective surgery, type of procedure, length of stay in hospital, adverse events within thirty days of surgery, and styles of leadership (abusive, over-controlling, laissez-faire, or transformational). The OR personnel involved in each case were asked to fill out validated questionnaires assessing boredom, psychological safety and team dynamics.

Possible pitfalls, feasibility and expected project timeline: The data for this project was collected in the summer of 2014 and is therefore already available for analysis. It should be feasible to finish data analysis by June 2018. Due to the limitations of the study design and the nature of the question it will be difficult to make definitive comments regarding causality. It would be very difficult to randomize anesthesiologists to a particular leadership style for the duration of a case. As such, an observational study such as this one is better suited to study such behaviours.

There is also a potential for bias should certain personnel be more frequently assigned to certain lists compared to others. This would occur most commonly with surgery on young infants and cardiac surgery at our centre. The randomization strategy implemented for this study aims to mitigate this effect.

Additionally, emergent operations occurring overnight (after 2300) were not included in the sample, which may introduce a bias towards certain kinds of leadership.

PROJECT TITLE: ***Does a Standardized Operating room to ICU hand over protocol improve the perceived quality of information exchange among care providers?***

PRINCIPAL INVESTIGATORS: Name: Nick-Hugh Wisdom
Name: Dr Christopher Haley (Staff Supervisor)

ABSTRACT

Transfer of patients form the operating room to the ICU confers a transitionary period in care that is rife with danger. Separate from the issues related to the physical transfer of invasive lines and liberation of the airway from the hands of the anesthesiology personnel to the mechanical ventilator the lack of a clear and structured handover process poses a significant threat. In this study we will evaluate the current handover practices at KHSC prior to and after the implementation of structured handover checklist. The surrogate measures will be the perceived quality of the handover, the completeness as well as the duration. It is the hypothesis of the study authors that, such as been demonstrated in other studies, the quality of information exchange will be significantly improved post intervention with no significant difference in the duration of the handover. We expect that with improved, and accurate, dissemination of relevant perioperative care of the surgical patient that lapse and mistakes in care will be mitigate and outcomes improved.

BACKGROUND

The transfer of patients from the operating room to the intensive care unit is a critical period where there is potential for morbidity and mortality[1]. Communication failure is touted as one of the most common causes of preventable medical error. The joint commission has thus identified improvement of communication effectiveness as one it's national patient safety goals in 2002[2].Higher rates of preventable errors have been reported by studies, to occur in the critical care setting of the OR and the ICU as compared to other areas in the hospital[3]. This observation is not surprising as these patients tend to be the sickest patients with multiple dimensions to care. Information exchange, during handovers, involves many different people, each of whom has different perspectives and priorities which can lead to ineffective communication. This is problematic as patients are typically transferred from the OR with invasive lines, monitors and airway all of which can switch team focus from the information exchange process[4]. To highlight the extent of the problem; the Joint Commission has identified, in 2004, communication as one of the top contributors to medical error, with handover contributing to approximately 80% of serious preventable AEs and also for 20% of all malpractice claims in the United States.

Ineffective communication during clinical handover can have immediate and long-term consequences for the delivery of safe patient care. Immediate consequences include loss of information and technical errors, delay in medical diagnosis, wrong treatment and higher incidences of life -threatening events. Delayed consequences could include increased patient complaints, increased hospital length of stay, and healthcare costs.[5] Standardized protocols are a means of standardizing handovers and thereby improving the quality of the information exchange as well as the efficiency. Previous studies have demonstrated that communication is improved by 25%, without significant increase in the duration of handover. One study found that there was a reduction in complications and a increase in early extubations with improved quality of data transfer.[6]

Critical Appraisal Essay – Sergiy Shatenko, PGY 1, Anesthesiology and Perioperative Medicine

Publication title: "***Paradox of age: older patients receive higher age-adjusted minimum alveolar concentration fractions of volatile anesthetics yet display higher bispectrality index values"***

Authors: Katherine Ni, Mary Cooter, Dhanesh K. Gupta, Jake Thomas, Thomas J. Hopkins, Timothy E. Miller, Michael L. James, Miklos D. Kertai and Miles Berger. Study took place at Duke University Medical Centre in NC, USA.

British Journal of Anaesthesia, 123 (3): 288e297 (2019)

Introduction

This article was chosen for a critical appraisal because it addresses an important clinical question regarding depth of anesthesia in the elderly. In the introduction, the authors pointed out that the common teaching is that both MAC and MAC-awake decrease by 6-7% per decade and that excessive administration of volatile can lead to undesired side effects, which they briefly stated: nausea, vomiting, delirium and cognitive dysfunction.(1) In addition, they discussed the fact that BIS does not have a linear relationship with MAC. They hypothesized that older patients would receive a higher MAC in clinical practice than predicted and as a result would have lower BIS values reflecting the relative overdose. The introduction of this paper may have understated the importance of the clinical question. Having a reliable way to monitor the depth of anesthesia in older patients and avoiding overdosing them is incredibly important for a number of outcomes. In a time of ERAS protocols, and health system financial constraints complications such as PONV and delirium can increase hospital length of stay, have adverse effects on surgical outcomes and patient satisfaction. The hypothesis chosen was an appropriate one since their institution, similar to ours, does not display age-adjusted MAC fractions and it would be easy to overdose an older person if paying attention to the unadjusted MAC on the anesthetic machine. It would then follow that given this relative overdose, we would see lower BIS values in older patients. Testing this hypothesis would make anesthesiologists more aware of the fact that we tend to overdose older patients and hopefully adjust our practice in a way that results in less side-effects as a result.

Methods

This study design was a retrospective, observational study in 4699 human subjects undergoing general anesthesia at Duke University Medical Centre. The subjects were aged >30 years, receiving general anesthesia lasting >1h with an inhalational agent used for >80% of surgery. Patients were excluded if they received more than one inhalational anesthetic, continuous infusions of propofol, ketamine or dexmedetomidine or received boluses of propofol or ketamine totaling more the three times the weight-based induction doses. Patients were also excluded if their temperature dropped to <34 degrees Celsius. These exclusion criteria were reasonable and were chosen because they have an effect on depth of anesthesia and BIS. This study was ethically sound and as it was a retrospective chart review, no informed consent was required by the Duke University Medical Centre Institutional Review Board. Data collection and analysis was done automatically through Epic. Statistical analysis was used to examine the relationship between age and end-tidal delivered MAC fraction using local polynomial regression analysis (LOESS) as well as the relationship between age-adjusted MAC and BIS values using both LOESS and Spearman's correlation.

Results

The main results are that in clinical practice at this centre, the trend is to reduce ET MAC by 3.41%, compared to the 6-7% quoted in the literature. In addition, the BIS values in older patients are 3.4 points higher in older patients compared to younger patients, although they do no specifically define what the age groups. The results are clearly laid out in graph and in text form and are easy to follow. The authors also included a subgroup analysis of BIS with age in patients based who received different doses of narcotics, ketamine and nitrous oxide, as well as those who received regional anesthesia, as these are known variables that can affect BIS.

Conclusion

The main conclusion of the study is that in clinical practice at this institution the end-tidal MAC declines by 3.41% per decade compared to the 6-7% value quoted in the literature. In addition, despite this apparent overdose, the BIS values were higher in older patients. This trend held, even when adjusting for fentanyl dose, ketamine, nitrous oxide and regional anesthesia. The results seem to support their conclusions. This is clinically significant as it shows a trend of failing to appropriately reduce ET MAC to adjust for the age-related decline in MAC requirements and that BIS monitoring may be falsely elevated and may not be as accurate as we would like especially in the older population. Despite the statistical relevance of the increase in BIS, the 3.4 point absolute increase in BIS may not be clinically relevant due to the large minute to minute and second to second variability in BIS that we see daily.

Critique

There are several ways that this study could improve, starting with the study design. Clearly, a prospective study with BIS monitoring in all participants and randomization in regard to whether the anesthesiologist could see the BIS would provide more robust results. In addition, study design should include neuromuscular monitoring in all patients, and perhaps a subgroup analysis where patients are fully paralyzed. This is important as EMG activity is known to interfere with BIS monitoring(2). Furthermore, there is a known tendency to reduce the dose of paralytic give to older patients due to a decline in metabolic function which could, at least partially, explain the results seen in this study(3). I also believe that to answer the clinical question, there would need to be tighter exclusion criteria. In particular, the dose of ketamine, an agent known to have an impact on the accuracy of the BIS, should be more restricted(4). Current exclusion criteria for ketamine use to less than three times the weight-based induction dose seem insufficient as that is still a very generous amount if given over the duration of an average case. The same goes for propofol and dexmedetomidine, albeit to a lesser extent. Finally, as this is a single center study the applicability of the results are somewhat limited.

As a result of this paper, I will be more mindful of the fact that we tend to overdose older patients, especially since our machines do not calculate age adjusted MAC. This will be less relevant when we transition to the updated machines that do have that function. I will continue to use BIS as a tool, keeping in mind it's limitations. I believe further work need to be done in the form of a randomized controlled trial looking at this issue in more detail.

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