Table of Contents

Equipment & Technology
- Activated charcoal effectively removes inhaled anesthetics from modern anesthesia machines ........................................3

General
- Inspiratory oxygen fraction and postoperative complications in obese patients: a subgroup analysis of the PROXI Trial ..........6

Orthopedics
- Effect of a perioperative intra-articular injection on pain control and early range of motion following bilateral TKA ..........9

Pediatric Anesthesia
- Paediatric anaesthesia in Afghanistan: a review of the current experience .................................................................12

Pharmacology
- The effect of mixing 1.5% mepivacaine and 0.5% bupivacaine on duration of analgesia and latency of block onset in ultrasound-guided interscalene block ..................................................14

Policy, Process, Economics
- Evaluation of a mandatory quality assurance data capture in anesthesia: A secure electronic system to capture quality assurance information linked to an automated anesthesia record ............18

Regional Anesthesia
- Ultrasound guidance improves a continuous popliteal sciatic nerve block when compared with nerve stimulation .............20

Respiration and Ventilation
- A comparison of desflurane versus propofol: The effects on early postoperative lung function in overweight patients ..........24
Indicates Continuing Education Credit is available for this abstract and comment during the CE approval period. Continuing Education Credit is available to individual subscribers on the Anesthesia Abstracts web site at www.AnesthesiaAbstracts.com.

New health information becomes available constantly. While we strive to provide accurate information, factual and typographical errors may occur. The authors, editors, publisher, and Lifelong Learning, LLC is/are not responsible for any errors or omissions in the information presented. We endeavor to provide accurate information helpful in your clinical practice. Remember, though, that there is a lot of information out there and we are only presenting some of it here. Also, the comments of contributors represent their personal views, colored by their knowledge, understanding, experience, and judgment which may differ from yours. Their comments are written without knowing details of the clinical situation in which you may apply the information. In the end, your clinical decisions should be based upon your best judgment for each specific patient situation. We do not accept responsibility for clinical decisions or outcomes.
Activated charcoal effectively removes inhaled anesthetics from modern anesthesia machines

Anesth Analg 2011;112:1363-70
Birgenheir N, Stoker R, Westenskow D, Orr J

Abstract

Purpose  The purpose of this study was to determine the time needed to flush a modern anesthesia machine to < 5 parts per million (ppm) of potent inhalation anesthetic with and without an activated charcoal filter placed on the inspiratory and expiratory limbs.

Background  Malignant hyperthermia (MH) is a life-threatening complication triggered by volatile anesthetics. The mortality rate ranges from 6.5% to 16.9% despite administration of dantrolene. If a patient is identified preoperatively as being susceptible to MH the recommendation is to use a “clean” machine. Alternatively, one can flush the anesthesia machine with high fresh gas flow rates of >10 LPM for 10 to 104 minutes so that volatile anesthetic levels decrease below an acceptable level of < 5 ppm. If MH occurs during anesthesia the volatile anesthetic should be discontinued and the fresh gas flow increased to >10 LPM. The problem is that newer anesthesia machines, such as the Fabius anesthesia machine, have multiple internal elastomeric and plastic parts that capture and release volatile anesthetics. This makes it difficult to “flush” the machine in a reasonable period of time. Activated charcoal filters have recently been developed which may help decontaminate anesthesia machines quickly.

Methodology  Activated charcoal filters (Vapor-Clean, Dynasthetics LLC, Salt Lake City, UT) were placed on the inspiratory and expiratory limbs of three different Aestiva and four Apollo anesthesia machines. A different anesthesia machine was used for isoflurane, sevoflurane and desflurane. The protocols were repeated for each gas on the two machines without the charcoal filters in place. Anesthesia machines were set to deliver a minute ventilation of 6.0 L and an inspiratory to expiratory ratio of 1:2. Carbon dioxide was added at 200 mL per minute to the expiratory limb. Isoflurane was set to 1.5%, sevoflurane to 2% and desflurane at 6% for each test. Fresh gas flow rates were initially set at 10 LPM then decreased to 3 LPM after 45 minutes and the charcoal filters were removed. In the control experiments the fresh gas flow rate was set at 10 LPM then decreased to 3 LPM when the volatile anesthetic decreased below 5 ppm.

To simulate a case of MH being diagnosed after 90 minutes of anesthesia, a flask with olive oil was used to simulate a patient’s uptake and elimination of each of the volatile anesthetics. During a 90 minute “contamination” phase the oil absorbed the volatile anesthetic. When the vaporizer was turned off and the charcoal filter added the oil released the volatile anesthetic similar to that of an anesthetized patient.
Result  During the control experiments on the Aestiva anesthesia machine, the initial volatile anesthetic concentration for each agent was approximately 110 ppm. The time to achieve an inspired concentration < 5 ppm during the control and charcoal protocols on each machine are presented in Figure 1. In the control protocol, the time to achieve a concentration < 5 ppm was shortest with desflurane, followed by sevoflurane, and isoflurane with the Aestiva machine. Concentrations of isoflurane and desflurane < 5 ppm were achieved faster during the control protocol in the Aestiva machine than in the Apollo anesthesia machine (Figure 1). With charcoal filters in place it took < 2 minutes for the anesthetic concentration to decrease < 5 ppm for all volatile anesthetics. With the charcoal filters still in place, when the fresh gas flow was decreased from 10 LPM to 3 LPM at 45 minutes the volatile anesthetic concentration remained < 1 ppm. When the filters were removed after 90 minutes inhalation agent concentrations increased quickly to > 24 ppm.

With the simulated MH case using olive oil as a reservoir for volatile anesthetic, it took < 2 minutes for the charcoal filters to decrease the volatile anesthetic concentration to < 5 ppm. The concentration stayed < 5 ppm even with a reduced fresh gas flow rate of 3 LPM. The charcoal filters became saturated after at 67 minutes with isoflurane, 83 minutes with sevoflurane and 90 minutes with desflurane using the Apollo anesthesia machine.

Conclusion  Placing an activated charcoal filter on the inspiratory and expiratory limbs of Aestiva and Apollo anesthesia machines resulted in an immediate reduction of volatile anesthetic to < 5 ppm. With high fresh gas flow rates alone, it may take between 27 and 84 minutes to reduce the volatile anesthetic to an

![Figure 1. Time to Achieve Inspired Volatile Concentration Below 5 PPM](image)
acceptable level. It was recommended that charcoal filters be placed on both the inspiratory and expiratory limb of contaminated machines when a “clean” machine is needed quickly.

**Comment**

This is the first time I have heard of using activated charcoal filters to remove volatile anesthetic from the breathing circuit. The manufacturer of the Vapor-Clean has obtained FDA approval for this purpose. This study demonstrated that the Vapor-Clean effectively decontaminates to newer anesthesia machines, the Fabius and Apollo. Having a “tool” that can be used to rapidly decontaminate an anesthesia machine would be an efficient alternative to having to flush an anesthesia machine. Additionally, having a way to rapidly eliminate volatile anesthetic during a suspected MH crisis is equally important. This finding has implications for military anesthesia providers in the U.S. Navy since the Fabius anesthesia machine is replacing many of the old Narkomed M field anesthesia machines on many of the deployment platforms.

If an MH crisis does occur and an activated charcoal filter is used it is important to point out that additional filters may be required. The Vapor-Clean filter may become saturated after approximately 60 minutes with isoflurane and up to 90 minutes with desflurane.

It is important to point out that two of the three authors on this manuscript reported receiving royalties from Dynasthetics, LLC, the manufacturer of the Vapor-Clean. I don’t necessarily think this biased the results, however, it would be nice to see the experiments replicated by investigators who do not receive royalties from the company in the future.

Dennis Spence PhD, CRNA

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
General

**INSPIRATORY OXYGEN FRACTION AND POSTOPERATIVE COMPLICATIONS IN OBESE PATIENTS: A SUBGROUP ANALYSIS OF THE PROXI TRIAL**

Anesthesiology 2011;114:1313-9
Staehr AK, Meyhoff CS, Rasmussen LS, POXI Trial Group

**Abstract**

**Purpose** This study was a secondary analysis of data from a previous study to determine if high inspired oxygen decreased the incidence of surgical site infection and pulmonary complications in obese patients undergoing laparotomy procedures.

**Background** Obese patients are at increased risk for surgical site infection and pulmonary complications after laparotomy procedures. The risk is further increased in those patients with metabolic syndrome. Decreased subcutaneous oxygen tension is associated with the development of surgical site infection, especially in obese patients. Two clinical trials have found reductions in surgical site infections when patients were administered 80% compared to 30% oxygen perioperatively. However, a more recent large multi-center trial (the PROXI Trial) did not find significant reductions in the incidence of surgical site infections. The investigators of this planned secondary subgroup analysis of the PROXI Trial sought to determine if 80% oxygen would result in a reduced incidence of surgical site infections in overweight and obese patients when compared to 30% oxygen.

**Methodology** This was a planned subgroup analysis of the Danish multi-center PROXI Trial that took place between 2006 and 2008. The original study included a randomized sample of 1,400 patients who underwent urgent or elective laparotomy. Patients were randomized to receive a high fraction of inspired oxygen (80%) or low inspired concentration (30%) during the intraoperative and early postoperative period (up to 2 hours postoperatively). Patients in this subgroup analysis had a BMI ≥30 kg/m² and were age > 18. Patients were excluded if they had received chemotherapy within 3 months of surgery, had surgery within the previous 30 days, or had a preoperative SpO2 < 90%. Perioperative care was standardized and included preoperative antibiotics, absence of an oral bowel preparation, and standardized anesthetic without nitrous oxide. Blood loss was replaced 1:1 with colloids and PRBCs if blood loss was > 20 mL/kg. Patients, surgeons and staff were blinded to group assignment. Statistical analysis was appropriate. A P < 0.05 was considered significant.

**Result** A total of 102 patients were included in the 80% oxygen group and 111 in the 30% oxygen group. The average age was 63. Approximately 61% were female. Average BMI was 33.5 kg/m² (34% were morbidly obese). Baseline characteristics appeared similar [note: investigators did not present P values]. In the high oxygen group 16% had diabetes as compared to 21% in the low oxygen group. Urgent
procedures made up 18.5% of both groups.

Preoperative antibiotics were administered within 60 minutes of surgical incision in 63% of the high oxygen group and 71% of the low oxygen group. The frequency of adequate antibiotic prophylaxis was 88% in the high oxygen group and 81% in the low oxygen group. In the high oxygen group the incidence of contaminated operations was 42% and 49% in the low oxygen group. The incidence of clean operations was 35% and 32%, respectively, in the high and low oxygen groups. Estimated blood loss was lower in the low oxygen group; 290 mL (range 0-2,000 mL) compared to 418 mL (range 0-2,074) in the high oxygen group.

No significant differences were found in the incidence of surgical site infection, atelectasis, pneumonia, or respiratory failure between the high and low oxygen groups (Figure 1). The overall incidence of surgical site infection was 29%. The incidence of adverse events was similar between the two groups. The average hospital stay was 5.5 days, 9% required ICU admission, 21% required abdominal reoperation, 3.3% experienced sepsis, and there was a 1.9% 30-day mortality rate.

**Conclusion**  Administration of 80% oxygen during the perioperative period did not decrease the incidence of surgical site infection, pulmonary complications, or other adverse events in obese patients undergoing urgent or elective abdominal surgeries.

**Comment**  This study was a planned secondary subgroup analysis of obese patients included in the multicenter PROXI trial. The PROXI trial compared the effect of perioperative administration of a high (80%) or low
oxygen concentration in 1,400 patients on surgical site infection and pulmonary complications. The PROXI trial found that a high inspired oxygen concentration did not decrease the incidence of surgical site infection or pulmonary complications. In this subgroup analysis the investigators also found no significant difference in surgical site infection or pulmonary complications between groups.

The overall incidence of Surgical Site Infection was 29%, which is higher than many other studies. The reason for this is most likely due to the high incidence of urgent surgeries in patients with significant comorbidities. Many of the patients had contaminated operative fields (e.g., perforated bowel), and many required reoperation. A more appropriate design would have been to look at only elective surgeries, because a major limitation of the study is the high incidence of urgent and contaminated operations. Because many of the procedures were urgent, adequate bowel preparation was not able to be completed, and there was a low incidence of preoperative antibiotic administration in the high and low oxygen groups (63% vs. 71%). These events help explain the higher overall incidence of Surgical Site Infection.

An important take home message I got from this investigation was the importance of administration of preoperative antibiotics, and to ensure the anesthetic plan is designed to minimize the risk of Surgical Site Infection by, for example, preventing hypothermia.

Dennis Spence PhD, CRNA

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Effect of a Perioperative Intra-articular Injection on Pain Control and Early Range of Motion Following Bilateral TKA

Orthopedics 2011;34:33-36
Fajordo M, Collins J, Landa J, Adler E, Meere P, Di Cesare PE

Abstract

Purpose  The purpose of this study was to evaluate the benefits of intra-articular analgesia for postoperative pain management in patients undergoing total knee arthroplasty (TKA).

Background  Post-operative pain control for patients undergoing TKA is an important aspect of patient care which helps early rehabilitation. There are several methods which provide for post-operative analgesia. Continuous femoral nerve block and IV infusion of narcotics are two such methods. However, nerve blocks carry risk of neurovascular injury, infection, and hematoma, while IV narcotics can cause nausea, vomiting, somnolence, respiratory depression, decreased gut motility, and urinary retention. Intra-articular injection of analgesia has been effective with arthroscopic knee surgery. It has been postulated that intra-articular injection can be similarly effective for TKA. Previous studies in this area have had mixed results, but confounding variables have limited their value. The goal of this study was to evaluate only patients undergoing bilateral TKA in order to control variables.

Methodology  This prospective, randomized study included patients less than 80 years old who were having elective bilateral TKA, and had normal cognition. Patients were excluded that had a history of stroke, rheumatoid arthritis, drug dependency, contraindications with the proposed medication regimen, or abnormal liver enzymes. No postoperative nerve blocks were performed. Each patient served as their own control and was selected to have a therapeutic intra-articular injection in one knee and a placebo injection in the other. The surgeon and patient were blinded to the random selection of which knee would receive which injection. The therapeutic medications included a combination of morphine 5 mg (7 mL), bupivacaine 0.5% with 1:200,000 epinephrine (5 µg/mL concentration, 7 mL), ketorolac 30 mg (1 mL), and normal saline (15 mL). The placebo given to the opposite knee was normal saline. The intra-articular injection was given after capsule closure and before the tourniquet was deflated. None of the medication was injected in the periarticular soft tissue.

Post-operative pain was evaluated at 4, 18, 30, 42, 54, and 72 hours using a visual analog scale (VAS) from no pain represented by a score of 0, to extreme pain represented by a score of 100. For breakthrough pain, patients were given Vicodin 5/500, Percocet 5/325, or Dilaudid 2-4 mg, as needed depending on the extent of pain. No IV narcotics were used. Pain scores and knee range of motion were compared using a
Student t test \( p<0.05 \). A power analysis determined that 30 patients were needed for the study.

**Result** Over 18 months, 30 patients meeting the study criteria were evaluated. The average age was 63.5 years and the mean patient weight was 186 pounds. The study group included 23 women and 7 men. VAS pain scores were significantly lower for the knee receiving the therapeutic injection at each evaluation interval when compared to the knee receiving the placebo. Overall, VAS pain scores were about one unit less in the therapeutic injection knee, that is, 3 vs. 4 or 4 vs. 5. The therapeutic injection knee also had significantly better range of motion on the 4th post-operative day compared to the control knee.

**Conclusion** The intra-articular injection of selected analgesia provided significantly better pain control and rehabilitation conditions than normal saline when each was used on the same patient undergoing bilateral TKA. Because this study used the same patient as a control, confounding variables were minimized. Several studies using different analgesia have shown similar results but not all studies have shown positive results. It is possible that uncontrolled variables in other studies may have contributed to the ambiguous results. This study should have limited individual variations in patient perception to pain and early functional improvement. Further investigation is necessary to determine the optimal analgesia mixture and concentrations.

**Comment**

This was a unique study design using a single patient as the test and control subject. I would agree that this helped significantly in controlling variables. It takes a very determined patient to undergo a bilateral TKA and properly rehabilitate both knees at the same time. With that in mind, it was interesting that there were more than 3 times as many females in the study as males. Does this tell us something about the determination and pain tolerance of the various sexes?

Pain control for TKA is a very challenging aspect of our anesthesia practice. This article did not stipulate what kind of anesthesia was used for the procedures. The only statement about anesthesia stated that "no postoperative regional nerve block was performed." The postoperative VAS pain scores were curiously low in the control group, suggesting to me that some type of block with prolonged analgesia affect was provided to the patient for surgical anesthesia. Regardless, the point of this study was to demonstrate that intra-articular injections can improve pain control and early range of motion. I believe it made that point.

I have been using continuous femoral analgesia for several years now and I have been very happy with the results. However, because the femoral block does not address pain behind the knee, I have had to either block the sciatic nerve independently or use supplemental pain medication when there was significant pain in this area. As the article suggests, doing a nerve block can carry a significant risk as does IV pain medication. With that in mind I started
having the surgeon use the intra-articular injection described in this article to supplement the femoral analgesia. The results have been outstanding. Most patients have required little to no supplemental pain medication. I have not had to do any sciatic nerve blocks for post-operative pain after initiating the intra-articular injections, and patient’s satisfaction is excellent. I have not discontinued using the femoral nerve block because I feel it provides a level of pain management and control that the intra-articular injection cannot. I do eliminate the ketorolac from the mix when the patient’s renal function indicate diminished renal capacity.

Our efforts to provide patients with post-operative pain management will continue to evolve, but for the time being I am very pleased with this combination for patients undergoing TKA.

Steven Wooden, DNP, CRNA
Abstract

Purpose The purpose of this article was to describe the experience with pediatric trauma patients admitted to a Level 3 hospital at Camp Bastion in Helmand Province, Afghanistan.

Background Military medical forces are deployed to provide medical and surgical support to deployed personnel. Civilian casualties account for a significant portion of the patient load at some deployed medical facilities in Afghanistan. Pediatric patients account for a large proportion of the civilian casualties, and their medical treatment and evacuation can pose significant strain on deployed medical facilities.

Past reviews of US Combat Support Hospital admissions has demonstrated that pediatric admissions accounted for 10% of all admissions, but these children represented over 50% of the civilian admissions. Of those admitted with trauma, 76.3% suffered penetrating injuries, with 39% by gunshot wound and 32% from explosive injury. Less than 6% required postoperative ventilation, and mortality was 6.9%, with a majority of the causes of death being head injury and burns. Mean age of pediatric trauma patients reported in some series was 9 years (range 1 to 16), with an average length of stay of 10 days at the Combat Support Hospital.

Methodology This was a retrospective review of three months of all pediatric surgical admissions to Camp Bastion during Operation HERRICK 8b/9a (UK Facility). Data collected included age, gender, diagnosis, number of operations, admissions to ICU, and length of stay.

Result In 3 months, 31 pediatric trauma patients were admitted. Of those admissions, 58% were male and 42% were female. Average age was 6.8 years (range 6 months to 14 years), with 25% being age 2 or younger. There was an average of 2.9 admissions per week. Pediatric trauma surgery represented 10.8% of all operations, with a child requiring surgery on average every 1.9 days. Each child needed a mean of 1.6 operations (range 1 to 6).

The mechanism of injury is presented in Figure 1. The most common mechanism of injury was secondary to shrapnel (i.e. explosive), followed by gunshot wounds and burns. Pediatric patients mean length of stay was 10.5 days (range 1 to 62 days), with 35% requiring ICU admission. These pediatric patients represented 11.9% of all ICU admissions. Of those admitted to the ICU, 82% required laparotomy,
36% had injury to the liver; spleen; or pancreas, and 27% required thoracotomy. One child died after a penetrating explosive injury to the chest and abdomen.

**Conclusion**  
Anesthesia providers deployed to Afghanistan must be prepared to administer anesthesia to pediatric trauma patients.

**Comment**  
Readers are probably wondering why I chose to review an article on pediatric trauma patients in Afghanistan. I felt it was important to review this topic because many of our readers are military anesthesia providers, and I suspect some of our readers have had to care for pediatric trauma patients while deployed to Afghanistan and Iraq. A former student of the USUHS Nurse Anesthesia Program and current Navy CRNA served at this facility alongside British anesthetists. I suspect he may have cared for some of these children, so I believe it is important to thank him for his service and describe the potential number and types of pediatric trauma cases an anesthesia provider may experience while on deployment to Afghanistan.

The results of this study are consistent with other reports from Afghanistan. A majority of the injuries (> 70%) will be due to penetrating injuries secondary to improvised explosive devices and gunshot wounds. Age ranges will run the gamut from 6 months to 17 years, and many may require massive blood transfusion, ICU care, and multiple operations. Some may present with burns, specifically secondary to injuries due to kerosene lamps used for lighting.

The most important take home message from this study is that anesthesia providers who are on active duty or in the reserves need to maintain their competence in pediatric and trauma anesthesia. If involved in ordering or reviewing supplies prior to deployment I would recommend verifying that pediatric equipment and supplies are included.

Dennis Spence PhD, CRNA

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Pharmacology

THE EFFECT OF MIXING 1.5% MEPIVACAINE AND 0.5% BUPIVACAINE ON DURATION OF ANALGESIA AND LATENCY OF BLOCK ONSET IN ULTRASOUND-GUIDED INTERSCALENE BLOCK

Anesth Analg 2011;112:471-6

Abstract

Purpose The purpose was to compare the block onset, duration of motor block, and duration of analgesia between:

- mepivacaine 1.5%
- mepivacaine 0.75% + 0.25% bupivacaine
- bupivacaine 0.5%

used for ultrasound-guided interscalene nerve block.

Background Short and long-acting local anesthetics are typically combined to achieve a faster onset time with prolonged duration of analgesia. However, there is limited research on these outcomes when combinations of local anesthetics are administered for ultrasound-guided interscalene nerve block.

Methodology This was a prospective, randomized, double-blind investigation of 69 subjects (23 per group) undergoing elective, outpatient shoulder arthroscopy with ultrasound-guided interscalene nerve block. Subjects were randomized to receive an interscalene nerve block with 30 mL of one of the following solutions:

- 15 mL of 1.5% mepivacaine + 15 mL 0.5% bupivacaine (Group MB)
- 30 mL of 1.5% mepivacaine (Group M)
- 30 mL of 0.5% bupivacaine (Group B)

Sedation and the block procedure were standardized. An in-plane interscalene nerve block was performed using a 38 mm linear ultrasound transducer, a 50 mm long 22 gauge stimulating needle, and inline pressure monitor to keep injection pressure ≤ 15 psi. After confirmation of a deltoid or upper-extremity motor response at between > 0.2 mA and < 0.7 mA a total of 30 mL of the local anesthetic solution was injected in 5 mL aliquots at the superior trunk with intermittent aspiration. Blocks were considered successful if the surgery could be completed without general anesthesia, defined as >50 mcg/kg/min propofol or any use of nitrous oxide or volatile anesthesia.

Block onset time was determined by a blinded observer starting from injection of the local anesthetic and every 5 minutes until 20 minutes after injection.

Motor strength was evaluated with a 3-point scale:

- 0 = no visible or palpable contraction
- 1 = weak movement
- 2 = able to move against resistance

Successful motor block was defined as inability to abduct the arm from a neutral position against minimal resistance (blockade of superior trunk). A paper clip was used to evaluate sensory block in territory of the axillary, musculocutaneous, radial, median, medial antebrachial cutaneous, and ulnar nerves. Sensory

ANESTHESIA ABSTRACTS is A PUBLICATION OF LIFELONG LEARNING, LLC © COPYRIGHT 2011
ISSN Number: 1938-7172
PAGE 14
block was assessed with pinprick and assigned a score of:

- 2 = normal sensation
- 1 = dull sensation
- 0 = no sensation

A successful sensory block was defined as absence of sensation over the sensory distribution of the axillary nerve. Sensory block evaluation was repeated upon arrival in the PACU and at 1 and 2 hours after surgery. Pain scores were evaluated with an 11-point verbal numeric rating scale.

Subjects were contacted by a blinded research staff member at 24 and 48 hours. Duration of motor block was defined as the time from block placement to the time a subject could flex their elbow. Duration of postoperative analgesia was defined as the time when pain was first perceived by the patient. This definition was used as a surrogate marker of return of sensory function. At 24 hours pain scores were recorded. Descriptive and inferential statistics were used to analyze the results. A P < 0.05 was considered significant.

**Result** Data from 64 subjects were analyzed. No significant differences were noted between the three groups with regards to demographic data, duration of surgical procedure, or amount of sedation required. No subject required general anesthesia. Subjects were approximately 55 ± 13 years old, with 71% being men with a BMI of 29 ± 6. A significantly larger proportion of subjects in the Group M had a sensory block of the inferior trunk (ulnar nerve) at 20 minutes and 1 hour postoperatively when compared to the other two groups (P = 0.03). In the PACU pain scores ranged from 0 to 3, however no subject required pain medications.

There were significant differences in the duration of motor block between the three groups. Subjects in Group B had the longest duration and subjects in Group M had the shortest duration of motor block, respectively (P < 0.001; Figure 1). Similarly, analgesic duration was longest in the Group B and shortest in Group M (P < 0.001; Figure 1). No significant differences in pain intensity at 24 hours were found between the three groups (P = NS). No adverse events were reported.

<table>
<thead>
<tr>
<th>Table 1. Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Sensory block onset time (min)</td>
</tr>
<tr>
<td>Motor block onset time (min)</td>
</tr>
<tr>
<td>Sensory block inferior trunk @ 20 min.</td>
</tr>
<tr>
<td>Sensory block inferior trunk @ 1 h post-op</td>
</tr>
<tr>
<td>Pain intensity @ 24 hours post-op</td>
</tr>
</tbody>
</table>

Note: * mepivacaine vs. bupivacaine and combination group.
Conclusion

There was no significant difference in sensory or motor block onset time between 0.5% bupivacaine, 1.5% mepivacaine or a combination of 1.5% mepivacaine + 0.5% bupivacaine. The duration of analgesia and motor block was the longest with 0.5% bupivacaine, followed by the combination solution, and shortest with 1.5% mepivacaine. Duration of analgesia is probably a more important criterion for selecting a local anesthetic solution rather than block onset time.

Comment

Many providers mix fast (i.e., mepivacaine) and long (bupivacaine) acting local anesthetics to obtain a more rapid onset and prolonged duration of analgesia. This study showed that the onset times were not significantly different between the plain bupivacaine, mepivacaine, or combination of the two. The onset time was approximately two minutes longer with 0.75% mepivacaine + 0.25% bupivacaine compared to either local anesthetic alone. While not statistically or clinically significant, this difference is most likely related to the higher concentration of the latter two agents and use of ultrasound-guidance. A recent
systematic review by Lui et al\(^1\) found that ultrasound-guidance results in a faster onset time of peripheral nerve blocks. This is most likely due to the closer proximity and direct visualization of the needle tip to the nerve trunks.

The duration of analgesia and motor block was longest with 0.5% bupivacaine and shortest with plain 1.5% mepivacaine. The combination mixture duration was shorter than 0.5% bupivacaine, however this difference was not statistically significant. The study was probably underpowered to detect a difference between these two agents. These differences, however, are clinically relevant since patients in the 0.5% bupivacaine group had almost 4 hours longer postoperative analgesia when compared to the combination mixture. The finding of a longer duration of motor block in comparison to sensory block is counterintuitive. Traditional teaching is that motor blockade recovers before sensory block does.

The investigators postulate this was caused by the somatotrophic organization of nerve fibers within the fascicles, with the outermost being motor and innermost being sensory fibers, respectively. This anatomical difference may result in prolonged motor block in comparison to sensory block. Another possible reason is that the investigators relied on subject self-report and used return of pain as a surrogate marker of duration of sensory block, and ability to bend the elbow as a surrogate marker of duration of motor block. Subjects may have underestimated the duration of either outcome. Additionally, these surrogate markers may not be an accurate reflection of sensory or motor block duration.

In closing, I think this is an important study. Anesthesia providers can use these numbers as rough estimates when counseling patients on block duration. If epinephrine is added (i.e., 1:400,000) then expect the block duration to last slightly longer. Given the reported pain scores at 24 hours were moderate to severe (6-7 out of 10), I would recommend a multimodal analgesic regimen be prescribed postoperatively. Patients should be instructed to start taking pain medications before the block wears off.

Dennis Spence, PhD, CRNA


The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Policy, Process, Economics

**Evaluation of a mandatory quality assurance data capture in anesthesia: A secure electronic system to capture quality assurance information linked to an automated anesthesia record**

Anesth Analg 2011:112:1218-1225

**Abstract**

**Purpose**  The purpose of this article was to report on the implementation of a clinical event recording system in conjunction with a pre-existing automated anesthesia record.

**Background**  A significant part of quality assurance (QA) in hospitals is the collection of information about adverse events in order to monitor the safety of clinical care. Anesthesia providers may be asked to voluntarily report the occurrence of near misses and adverse events, but this reporting is often inconsistent. Mandatory checklists may increase the consistency, but also make the routine of patient care documentation more labor intensive. Electronic systems that actively survey patient records can be designed to detect specific types of entries and flag them as an adverse event. Hand conducted surveillance is more flexible but is associated with a higher workload. Alternative data collection exploiting existing automated anesthesia information systems (AIMs) might offer some advantages compared to conventional methods.

**Methodology**  The anesthesia department of Massachusetts General Hospital had used an AIM for five years previous to this study. During this project, the anesthesia department developed a QA database for monitoring adverse events and near misses. The database received patient information from the AIMs but was a stand-alone application, separate from the patient record, in order to preserve peer review protection during potential litigation. After handing over patient care, the anesthesiologist, resident, or nurse anesthetist, was directed to QA data entry before being allowed to complete the patient care record. QA data entry consisted of a checklist of potential events, including the option to mark “no event.” Items on the checklist were derived from institutional experience and elements expected by external agencies. Examples of checklist items include medication error, airway event, dental injury, and case cancellation. Providers were also able to enter information at a later time in order to capture events that were detected after patient care transfer.

**Result**  During the 12 months following the implementation of the new electronic database, 471 events were reported out of 55,382 total cases performed. The rate of reported events was 0.85%, which was a 92% increase compared to the previous year. Sixty-seven percent of the 471 reports came through the AIM linked database. In addition to adverse events and near misses, many providers
reported on the occurrence of additional minor clinical problems, such as equipment malfunction or intravenous catheter dislodgment.

**Conclusion** Implementation of a clinical event reporting system in conjunction with a pre-existing AIM resulted in a sustained capture of more adverse and near miss events.

**Comment**
This article described the experience of the Massachusetts General anesthesia department with the addition of a QA database to their existing automated anesthesia record. More events were reported using the automated QA database than with the previously used conventional reporting system. The additional data collected reflected information that went undetected under the old system, leaving some clinical problems unrecognized. Since it isn’t possible to solve problems that are unrecognized, this system change should be a beneficial step toward improved quality of patient care.

An obvious question is how likely this experience is to be duplicated in other anesthesia departments. Massachusetts General is a large academic center in a major metropolitan area, with an anesthesia department that may well be different from many others in the country. The members of the study’s anesthesia department are self described as young and accustomed to technology. Their 5 year history with using an AIMS is undoubtedly longer than a great number of other anesthesia departments. Despite increasing national discussion promoting the adoption of electronic health records, only 8% of US hospitals have electronic records in at least one clinical unit'. The anesthesia providers in this study were ahead of the curve, have gained confidence with automated recording, and were ready to step up to the next level of increased efficiency that technology can facilitate. Through their willingness to report even minor events, these providers seem to consider QA a tool that can be used to improve many aspects of anesthetic care, not just the life and death components.

It is likely that the experience described in this report seems light years away from the daily routine of many anesthesia providers. But even slow adopters will be forced into automatic recording soon, since it is practically being mandated by health policy makers. So this experience of how automatic records can be used to improve our practice quality could be a look into the future for all of us.

Cassandra Taylor DNP, DMP, CRNA, CNE

Regional Anesthesia

Ultrasound guidance improves a continuous popliteal sciatic nerve block when compared with nerve stimulation

Reg Anesth Pain Med 2011;36:181-4
Bendtsen TF, Nielsen TD, Rohde CV, Kibak K, Linde F

Abstract

Purpose The purpose of this study was to compare sensory block success rates during the first 48 hours after continuous popliteal sciatic nerve block with catheter when the catheter was placed with ultrasound guidance vs. nerve stimulation.

Background Continuous popliteal sciatic nerve block decreases pain, nausea, and length of stay after foot and ankle surgery. Use of a nerve stimulator (blind technique) to assist placement of a continuous posterior popliteal nerve catheter ranges from 60% to 75%. Recent reports suggest ultrasound guidance may improve success of nerve catheter placement, however further research is needed to support this practice.

Methodology One hundred patients scheduled for elective major foot and ankle surgery were randomized into either a nerve stimulator or ultrasound group. Sedation and anesthetic regimens were standardized in both groups (TIVA with propofol and remifentanil infusions and LMA). Four anesthesiologists experienced with both techniques placed all popliteal catheters. Independent observers recorded block data. Postoperative data was collected by blinded independent observers.

For the popliteal sciatic block the needle insertion was the midpoint between the biceps femoris tendon laterally and semimembranosus and semitendinosus muscle medially 7 cm proximal to the popliteal crease. In the nerve stimulator group an 18 g x 55 mm B-bevel stimulator needle was advanced in the sagittal plane cephalad and at a 45 degree angle to the skin to elicit dorsiflexion or plantarflexion of the toes and foot with stimulation. The target current was 0.5 mA or less. In the ultrasound group an out-of-plane technique was used using a 6 to 13-Mhz linear transducer probe to identify the popliteal neurovascular structures in the short axis. The needle tip was advanced out-of-plane just proximal to the sciatic bifurcation. After appropriate placement of the needle tip, a catheter was advanced 3 cm into the nerve sheath in both groups. Thirty mL of 0.75% ropivacaine was injected in 5 mL aliquots. At the end of the surgery a superficial saphenous nerve block was performed with 15 mL of bupivacaine 0.5% just proximal to the medial ankle.

Postoperative pain in the PACU was managed with fentanyl 50 to 100 µg and acetaminophen 1 g orally 4 times a day. Three hours after the initial bolus of local anesthetic, 15 mL of 0.25% bupivacaine was injected through the catheter and an infusion was started with the same solution at 8 mL/hr. Breakthrough pain was...
managed with an additional bolus of 15 mL of 0.25% bupivacaine (max 4 per 24 hours) and the rate increased to 10 mL/hr. If the bolus did not relieve the pain, IV morphine 0.05 to 0.1 mg/kg was administered to achieve a pain score of < 3 out of 10. Postoperative nausea was treated with ondansetron 2 mg, max 4 mg per 24 hours.

The primary outcome was success rate of continuous popliteal sciatic nerve block, defined as sensory block of both the common peroneal and tibial nerves at all time points (1, 6, 24 and 48 hours postoperatively). Sensory block was evaluated with ice, with 0 = no cold sensation, 1 = reduced cold sensation, and 2 = normal cold sensation. Successful sensory block was defined as a score of 0 or 1.

Secondary outcomes included postoperative pain, pain location (territory of worst pain), opioid consumption, nausea scores, total ondansetron administered, number of needle passes, patient satisfaction, and complications. Power analysis and statistical analysis was appropriate.

**Result** Ninety-eight subjects completed the study (ultrasound group n = 50; nerve stimulator group n = 48). No significant differences were noted in baseline demographics between the two groups. The median number of needle passes was significantly higher in the nerve stimulator group (2, range 1-10) when compared to the ultrasound group (1, range 1-6; P = 0.0005). Median patient satisfaction scores after catheter insertion were higher in the ultrasound group (9, range 5-10) compared to the nerve stimulator.

<table>
<thead>
<tr>
<th>Table 1. Block Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Surgical procedures</strong></td>
</tr>
<tr>
<td>Calcaneal osteotomy</td>
</tr>
<tr>
<td>Subtalar osteotomy</td>
</tr>
<tr>
<td>Total ankle replacement</td>
</tr>
<tr>
<td>Ankle arthrodesis</td>
</tr>
<tr>
<td><strong>Pain scores median (range)</strong></td>
</tr>
<tr>
<td>1 hr postop</td>
</tr>
<tr>
<td>6 hrs postop</td>
</tr>
<tr>
<td>24 hrs postop</td>
</tr>
<tr>
<td>48 hrs postop</td>
</tr>
<tr>
<td><strong>Territory of worst pain 48 hrs postop</strong></td>
</tr>
<tr>
<td>Saphenous</td>
</tr>
<tr>
<td>Sciatic (tibial, peroneal, sural)</td>
</tr>
<tr>
<td><strong>Ondansetron mg 0-48 hrs, median (range)</strong></td>
</tr>
<tr>
<td><strong>Morphine mg total 0-48 hrs, median (range)</strong></td>
</tr>
</tbody>
</table>
group (B, range 3-10; P = 0.0006). However, patient satisfaction scores at 1, 6, 24 and 48 hours were similar between the two groups (median 10 at all time points; P = NS). Pain scores, fentanyl administered in the PACU, nausea scores, and total bupivacaine administered were similar between the two groups (P = NS; Table 1). Success rates for continuous sensory blockade of the popliteal sciatic nerve were significantly higher in the ultrasound group (P = 0.03; Figure 1). Likewise, total morphine administered during the first 48 hours was significantly lower in the ultrasound group (Table 1; P = 0.02).

**Conclusion** Ultrasound guided placement of a continuous popliteal sciatic nerve catheter using an out-of-plane technique increases the success rate of sensory block postoperatively when compared to a nerve stimulator technique. Ultrasound guidance also decreases the number of needle passes, improves patient satisfaction with initial block placement, and decreases opioid consumption.

**Comment**

This was a well designed study that demonstrates use of ultrasound guidance improves the success of a popliteal sciatic nerve block as defined as complete sensory blockade in the peroneal and tibial nerve distributions. It is important to point out that the investigators used an out-of-plane technique rather than an in-plane technique for ultrasound guided placement of the popliteal nerve catheters. Many anesthesia providers utilize an in-plane technique for placement of a single shot or continuous popliteal sciatic nerve block. Therefore, these results may not apply when an in-plane technique is used.

One of the major advantages of ultrasound guidance is the ability to see the location of the needle tip and spread of the local anesthetic. There is variability in the division of the sciatic nerve into the popliteal and tibial nerves. This can explain why 44% of patients in the nerve stimulator group had the worst pain in the sciatic nerve distribution (tibial, peroneal, sural) whereas only 16% in the ultrasound group had pain in the sciatic nerve distribution to the foot and ankle.

What is interesting is that patients in the ultrasound group had significantly more pain in...
the saphenous nerve distribution when compared to
the nerve stimulator group at 48 hours
postoperatively. All patients received a superficial
saphenous block at the level of the ankle at the end of
the surgery. However, this block would be worn off at
48 hours. While there was no statistical difference in
type of surgical procedures performed in each group,
9% more patients in the ultrasound group had an ankle
arthrodesis procedure. This could explain why more
patients in the ultrasound group had pain in the
saphenous nerve distribution. Since the block was less
effective in the nerve stimulator group this could also
explain the differences since patients were asked to
describe the area with the worst pain.

I suspect we will continue seeing more studies
demonstrating efficacy of ultrasound guided nerve
blocks. Regional anesthesia has seen resurgence in
recent years. If anesthesia providers want to expand
their repertoire of clinical skills I recommend that
they become proficient with ultrasound guided nerve
blocks.

Dennis Spence, PhD, CRNA

Reimbursement information for ultrasound
guided peripheral nerve blocks at this link:
http://www.gehealthcare.com/usen/community/
reimbursement/docs/reimbursement_anesthesiology_2.25.09.pdf

The views expressed in this article are those of the author
and do not reflect official policy or position of the
Department of the Navy, the Department of Defense, the

Uniformed Services University of the Health Sciences, or
the United States Government.
Respiration and Ventilation

**A comparison of desflurane versus propofol: The effects on early postoperative lung function in overweight patients**

Anesth Analg 2011;113:63-9
Zoremba M, Dette F, Hunecke T, Eberhart L, Braunecker S, Wulf H

**Abstract**

**Purpose** The aim of this study was to compare the effects of maintenance anesthesia with desflurane versus propofol on postoperative pulmonary function in overweight and mildly obese patients undergoing minor surgery.

**Background** Both desflurane and propofol have relatively rapid elimination profiles in the obese population. Return to consciousness and immediate recovery profiles are faster in the obese population with these agents compared to older anesthetics. However, the obese suffer a higher rate of postoperative pulmonary complications than lean patients, so if there are differential effects between desflurane or propofol on the development of postoperative pulmonary dysfunction, this information could guide anesthetic choices.

**Methodology** In this prospective study, 134 healthy, overweight to mildly obese patients (BMI 25 to 35 kg/m²) were randomized to receive either desflurane or propofol as maintenance anesthesia during minor peripheral surgery (mean duration 80 ± 20 minutes). Induction and intubating doses were standardized for both groups. End-tidal desflurane and propofol TIVA doses were titrated to maintain BIS values from 40 to 60. Baseline pulmonary spirometry and oxygen saturation (SpO₂) were measured during a preoperative visit and at 0.5, 2, and 24 hours after PACU admission.

**Result** The propofol group had a lower average SpO₂ than the desflurane group immediately after surgery and at all postoperative measurements except at 24 hours (p < 0.005). The propofol group had lower spirometric measures (FVC, FEV₁₀, PEF, MMEF, FIVC, and PIF [defined in notes at end]) than the desflurane group immediately after surgery and across all measurement times (p < 0.01) except for FVC at 24 hours (p = 0.05). Increasing BMI was associated with prolonged reductions in some spirometric values in the early postoperative period in the propofol group.

**Conclusion** In a sample of overweight and mildly obese patients, propofol for maintenance of anesthesia is associated with decreased pulmonary function in the first 24 hours postoperatively compared to desflurane anesthesia.

**Comment** A couple of problems here. First, the data on pulse oximetry is not useful. In general, pulse oximeters have an accuracy ± 3% in the range of 70% to 100%. The minimal, but statistically significant, differences in SpO₂ are well within most instrument limitations (the authors did not denote the instrument type and model used in the study). The difference between...
93.8% and 94.6% obtained by averaging pulse oximeter values is trivial. A more precise methodology to measure oxygenation would include arterial oxygen tension (PaO₂) and the fractional oxygen saturation (SaO₂), measurements that require an arterial blood sample, a Clark electrode and a co-oximeter. This is definitely a case in which statistical significance is not equivalent to clinical significance!

Second, there is a potential flaw in part of the spirometry analysis. The baseline values were taken in the preoperative interview; the implication is that the testing occurred in the standard sitting position. But the postoperative data were acquired in a 30° Fowler’s position. Research has shown that the 30° Fowler’s position is not equivalent to the sitting position in the overweight and obese population (BMI 25 to 39.9 kg/m²) during the measurement of lung volumes.1 In this study, moving from supine to 30° Fowler’s did not improve the FRC (1.65 ± 0.43 versus 1.69 ± 0.45 L). Both were significantly lower than the sitting FRC (2.13 ± 0.56 L). Because lung volumes influence airway caliber, comparing spirometry values obtained from different positions to assess a drug effect is not appropriate. The data presented in Figures 1 through 5 of the original article illustrate differences in data ”from preoperative baseline values” thereby presenting a faulty comparison since this may represent both a drug effect and the effect of position. However, Table 3 in the original article illustrates a comparison of only the postoperative data between groups and these analyses are methodologically valid.

These patients would have benefitted from an alveolar recruitment maneuver (inflation to 40 cm H₂O for 10 to 20 seconds) after induction with 100% oxygen. Anesthesia-induced atelectasis will develop and more atelectasis develops that takes longer to resolve in obese patients. The use of PEEP in the absence of alveolar recruitment does not reinflate collapsed alveoli. In this study, the subjects likely emerged from anesthesia with atelectasis and those with higher BMI have more atelectasis that takes longer to resolve. So along with increased BMI, the effects of atelectasis contribute to low lung volumes in these subjects and therefore impact the author's interpretation of the results.

It is possible that that propofol is associated with more atelectasis than desflurane, but due to the flaws in the research design, this study does not unequivocally prove it.

Penelope S Benedik PhD, CRNA, RRT


FVC Forced Vital Capacity
FEV₁.₀ Forced Expiratory Volume in 1 second
PEF Peak Expiratory Flow
MMEF Maximal Mid-Expiratory Flow
FIVC Forced Inspiratory Vital Capacity
PIF Peak Inspiratory Flow

Editor’s Note: The citation from Respiratory Care at the end of the comment is Dr. Benedik's own research. This is not an attempt at self promotion; the research goes directly to the potential problems with this particular study. If the investigators had read this citation, the study might have been designed differently.