Chapter 1 : Adrian T. Bosenberg, MB ChB

Introduction and historical perspectives / Sumner J. Yaffe and Jacob V. Aranda --Clinical pharmacokinetics in infants and children / Edmund V. Capparelli --Drug action and therapy in the infant and child / Ralph E. Kauffman --Drug metabolism and disposition in infants and children / Anders Rane --Pharmacogenetics, pharmacogenomics, and.

Abstract Background Awake regional anesthesia RA is a viable alternative to general anesthesia GA for infants undergoing lower abdominal surgery. Benefits include lower incidence of postoperative apnea and avoidance of anesthetic agents that may increase neuroapoptosis and worsen neurocognitive outcomes. Our aim was to describe success and failure rates of RA in this study and report factors associated with failure. Methods This was a nested cohort study within a prospective randomized, controlled, observer blind, equivalence trial. The data of infants, where spinal or combined spinal caudal anesthetic was attempted, was analyzed. Possible predictors of failure were assessed including: Results RA was sufficient for the completion of surgery in Spinal anesthesia was successful in Thirty four patients required conversion to GA and an additional 23 6. Conclusions The failure rate of spinal anesthesia was low. Variability in application of combined spinal caudal anesthetic limited attempts to compare the success of this technique to spinal alone. Introduction Since its initial description at the start of the twentieth century infant spinal anesthesia has occupied a significant place in the history of pediatric regional anesthesia. During the s a new role was proposed for spinal anesthesia with the recognition that this method may reduce the risk of postoperative apnea, periodic breathing and desaturation after general anesthesia in ex-premature infants. Understanding these factors could improve the success rate. The General Anesthesia compared to Spinal anesthesia GAS study is a prospective randomized controlled trial designed to compare the effect of general anesthesia to regional anesthesia in infancy on neurodevelopmental outcome. Early postoperative outcomes of regional and general anesthesia in the GAS study have been described elsewhere. The aim of this paper is to examine the infant subpopulation randomized to awake regional in the GAS study, to firstly report the failure rate in a large multinational population and secondly to identify the patient and operator characteristics associated with failure. Lastly we aim to evaluate whether addition of caudal block to spinal block increases the likelihood of successful completion of surgery. Materials and Methods Study design and participants In this multinational prospective randomized controlled equivalence trial, members from the GAS consortium Appendix 1 enrolled patients from 28 centers in Australia, the United States, the United Kingdom, Italy, the Netherlands, Canada and New Zealand between February 9, and January 31, Institutional review board or human research ethics committee approval was obtained from each site. Eligible patients included any children scheduled for unilateral or bilateral herniorrhaphy with or without circumcision. Further exclusion criteria included contraindications to general or regional anesthesia, preoperative ventilation immediately prior to surgery, congenital heart disease, known chromosomal abnormalities or other known acquired or congenital abnormalities other than prematurity which might affect development, children whose primary language was not that of the country they were recruited in, previous exposure to volatile general anesthesia or benzodiazepines as a neonate or in the third trimester in utero, or any known neurologic injury such as cystic periventricular leukomalacia or grade 3 or 4 intraventricular hemorrhage. The GAS study protocol was approved by the following: Patients were randomised with a 1: Randomization was in blocks of two or four and stratified by site and gestational age at birth: The anesthesiologist and anesthetic team were aware of group allocation and the perioperative assessments were not blinded. Parents were not informed of the group allocation but were told if they asked. Procedures Preoperative fasting was in accordance with institutional guidelines. Patient warming was in accordance with institutional practice. Spinal anesthesia was performed with a 25 or 22 gauge needle between L3 and L5 in lateral or sitting position. The dose of bupivacaine was 0. Due to unavailability of isobaric bupivacaine at some sites other agents were used in the United States, 0. Caudal anesthesia was performed with 2. In the United Kingdom 0. At the end of surgery a caudal block or an ilioinguinal block could be administered by the anesthetist to provide postoperative analgesia. Alternatively, the surgeons could perform a field block provided the total dose of bupivacaine did not exceed 2. Rescue treatments There were rescue protocols for hypoglycemia, hypotension and hypoxemia. Vasoactive drugs were given if deemed necessary by the anesthetist. Inadequate anesthesia If a spinal anesthetic was attempted and there was no evidence of effective motor block after 5 min the infant continued to vigorously spontaneously move both legs and withdraw both legs to gentle pinch of the thigh then a second attempt at a spinal anesthetic could be performed with another 1mg. If the block still appeared ineffective a general anesthetic was administered. If there was good evidence of motor block initially but the child became unsettled intraoperatively such as during spermatic cord or hernia sac traction then the first line treatment was soothing maneuvers with a pacifier. Second line treatment involved oral glucose and third line treatment involved infiltration of additional local anesthetic by the surgeon field block. If the child remained distressed for prolonged periods then sevoflurane was administered. A GA was also administered in the event of respiratory compromise or if prolonged or more extensive surgery was required. Statistical Analysis Sample size considerations The sample size for the GAS study was based on the neurodevelopmental outcome at 5 years of age. Given that this paper presents data on a secondary outcome of the study, an a-priori power calculation was not conducted for this outcome. We do not believe post-hoc power calculations are useful and instead we present our results along with confidence intervals that capture the uncertainty in our findings reflecting the sample size. Data analysis Patients were excluded from analysis if they were randomized to RA, but a regional anesthetic was never attempted, or they received only an awake caudal with no spinal block. No analysis of risk factors for failure associated with awake caudal anesthesia was attempted because of the small number of awake caudal only cases. Failure was defined as the use of any sevoflurane or sedative in infants randomized to RA, and can be categorized as either a complete failure or a partial failure. Complete failure was defined as when sevoflurane was given from before, or at the moment of knife to skin, and given continuously until the last stitch. A success was defined as a RA which required no supplementation with GA for any phase of the operation. For binary outcomes, a comparison between groups is presented as an odds ratio as estimated from a logistic regression model. For continuous outcomes, a comparison between groups is presented as a difference in means as estimated from a linear regression model. The distribution of continuous outcomes was examined for normality, and log-transformations were applied where appropriate. All outcomes were adjusted for site of randomization using the generalized estimating equation approach with robust standard errors. An exchangeable correlation structure was assumed between any two children from the same site. The following factors were identified a priori as potential risk factors for any failure partial or complete ; patient factors gestational age at birth, postmenstrual age at surgery, weight ; clinician and site factors site experience, anesthesiologists seniority ; technique factors spinal vs CSCA, drug type, drug dose, presence of bloody tap. The association between each factor and any failure was assessed separately. Site experience was defined by 1 number of blocks performed and 2 time since first randomization in study, because it was expected that there would be a significant learning curve at those centers where awake RA was not common prior to the GAS trial. The outcomes assessed for a difference between CSCA and spinal only anesthesia were failure and total anesthesia time. Results Of the cases randomized to RA, No surgery was performed in five 1. No attempt at RA was made in 10 2. Spinal anesthesia alone was attempted in The demographics of the analyzed patients are presented in table 1.

Chapter 2 : Charles Cote | Harvard Catalyst Profiles | Harvard Catalyst

Santhanam Suresh, Charles J. CotÃ©, in A Practice of Anesthesia for Infants and Children (Sixth Edition), Selection of a Local Anesthetic. Local anesthetics commonly used for peripheral blocks in children include lidocaine, mepivacaine, bupivacaine, and, more recently, levobupivacaine and ropivacaine. 72,74, Longer-acting agents have a greater role in peripheral blocks than shorter.

This article has been cited by other articles in PMC. Abstract The interscalene brachial plexus block is not commonly used in pediatric regional anesthesia. The increasing popularity of ultrasound has allowed more anesthesiologists to perform regional anesthesia with high success rates in pediatric patients with the direct visualization of the target nerve and spread of local anesthetics. We present a case of interscalene brachial plexus block under ultrasound guidance in a month-old child with acute drug-induced hepatitis who required fixation of a fracture of the lateral humeral condyle. Brachial plexus, Pediatrics, Regional anesthesia, Ultrasonography Regional anesthesia in pediatric patients is always challenging [1]. The recent introduction of ultrasound in pediatric regional anesthesia has made it more popular by enabling the direct visualization of target nerves and surrounding structures [2]. Although several ultrasound-guided regional techniques in children have been introduced, only a few articles had been published about ultrasound-guided interscalene brachial plexus block US-ISB in pediatric patients [3 , 4]. The efficacy of US-ISB for anesthesia and analgesia after orthopedic surgery has been established in adults, but not in children. We present a case of US-ISB in a child with acute drug-induced hepatitis undergoing surgery for correction of a lateral humeral condyle fracture. Case Report A month-old boy weighing 14 kg was diagnosed with a fracture of the right lateral humeral condyle and scheduled for open reduction and internal fixation with a kwire. He had suffered from an upper respiratory infection for the previous 3 weeks and drug-induced hepatitis developed as a result of his medication. Other laboratory exams were normal, except for mild anemia Hb 8. A pediatrician recommended delaying the surgery for about 4 weeks, but early intervention is needed for fractures of the lateral condyle of the humerus in pediatric patients. We decided to proceed with the surgery under an interscalene brachial plexus block without supplementary general anesthesia. Under mask-assisted ventilation, the patient was placed in the supine position with the neck rotated slightly to the left. The skin was prepared in typical sterile fashion. A transverse scan was performed at the level of the interscalene groove with the long axis of the probe parallel to the clavicle. Then, the transducer was moved slightly in the caudal direction until the brachial plexus roots were identified between the anterior and middle scalene muscles. Braun Medical, Bethlehem, PA was advanced using the inplane technique. Once the needle reached the brachial plexus, the nerve stimulator Maxistim; Life-Tech, Stafford, TX was turned on, starting from 1. After confirming needle placement, 1. Successful blockade was determined by the absence of a withdrawal response and hemodynamic changes in response to surgical stimuli, such as the skin incision.

Chapter 3 : Patient-controlled epidural analgesia in children: Can they do it? â€” Northwestern Scholars

polaner d, suresh s, cote cj: pediatric regional anesthesia, a practice of anesthesia for infants and children, 3 edition. EDITED BY COTE C, TODRES ID, RYAN JF, GOUDSOUZIAN NG. PHILADELPHIA, WB SAUNDERS COMPANY, , PP

Cardiac surgery Anatomy Understanding of the anatomic differences between adults and infants are crucial in order to safely, and in a technically proficient fashion administer spinal anesthesia in children. Anatomic differences in Spinal canal Conus medullaris ends at L2-L3 compared to L1 in adults Small pelvis with sacrum that starts more cephalad Dural sac ends more caudad The spinal cord terminates at a much more caudad level in neonates and in infants compared to adults, Figure 1. The conus medullaris ends at approximately L1 in adults and at the L2 or L3 level in neonates and infants. In order to avoid potential injury to the spinal cord, dural puncture should be performed below the level of the spinal cord, i. However, neonates and infants have a proportionately smaller pelvis than adults and the sacrum is located more cephalad relative to the iliac crests. The more caudad termination of the dural sac makes it more likely to have an inadvertent dural puncture during performance of a single-shot caudal block if the caudal needle is advanced too far into the caudal epidural space. The spinal cord terminates at a much more caudad level in neonates and in infants compared to adults. This may, in part, account for the higher local anesthetic dose requirements and shorter duration of action of spinal anesthesia in this population. The operating room should be warmed prior bringing the patient into the room. Warm blankets and radiant heating lamps will help to diminish heat loss in infants. With older children, the room should be quiet and if possible, surgical instruments should be covered so as to minimize patient anxiety. Newer operating rooms may be equipped with stereo or video equipment which may be used to distract older children if the block is performed while the child is awake or sedated. Standard monitoring devices blood pressure cuff, pulse oxymeter, electrocardiogram leads should be applied prior to performing the block. A plan should be made regarding the concomitant use of intravenous sedation or general anesthesia. The approach should be dictated by the medical condition and age of the patient, the comfort level of the anesthesia provider and the nature and anticipated length of the surgical procedure. In former preterm infants undergoing lower abdominal procedures of less than 90 minutes duration, it is common practice to perform spinal anesthesia without adjuvant sedation and to conduct the anesthetic without supplemental intravenous or general anesthesia. In fact it has been shown that the use of concomitant sedation may predispose these infants to apnea and bradycardia. In some cases, spinal anesthesia may be combined with caudal or epidural anesthesia. Hypobaric solutions are not commonly utilized in infants. If the sitting position is preferred, special attention must be paid in infants to insure that the neck is not flexed which may result in airway obstruction FIGURE 3. Neck flexion is not necessary as it does not facilitate performance of the block. It is essential to monitor the oxygen saturation of the infant while performing the spinal to ensure the adequacy and patency of the airway. Spinal anesthesia in the neonate; shown is the lateral position. Spinal anesthesia in the neonate in the sitting position; head flexion must be avoided to prevent respiratory obstruction. Technique In infants, the L or L5-S1 interspace should be identified; the L interspace may be used in older children. The area should be cleared and draped in a sterile fashion. The desired dose of local anesthetic should be calculated and be prepared in a syringe prior to dural puncture to insure that the correct dose is administered. A short or gauge spinal needle is often used. A midline approach is usually recommended over a paramedian approach. Once clear CSF is seen exiting the needle, drug s should be injected slowly. The barbotage method is not recommended as this may result in unacceptable high levels of motor blockade and potential for a total spinal blockade. The caudal end of the patient should not be elevated for placement of the electro-cautery return electrode as a total spinal can result from spread of local anesthetic solution to a higher spinal level. One of the techniques we have resorted to in our teaching institution to prolong the duration of surgical analgesia is the use of spinal anesthesia using 0. We turn the patient to the side that has the largest hernia at the time of performance of the block. This prolongs the duration of anesthesia and analgesia. Alternatively, hypobaric solution of local anesthetic can be injected in the lateral position with the operative side up, Figure 5 and Figure 6. Equipment for spinal anesthesia in the neonate. Shown are the disinfectant, hypodermic needle for local infiltration and the spinal needle. Spinal anesthesia in the neonate; needle insertion. Spinal anesthesia in the neonate; injection of the local anesthetic. Assessing the block Assessing the level of blockade may prove difficult in infants and young children, particularly if the patients have received sedation or those in whom the block is being performed under general anesthesia. In infants, pin prick or their response to cold stimuli e. In children older than 2 years we use the Bromage scale. In the event of a rapidly rising level of blockade, the patient may be placed in reverse Trendelenburg. Clinical pearls Evaluation of spinal anesthesia: These include hypotension, bradycardia, postdural puncture and transient radicular symptoms. Puncah et al recently reported their experience with consecutive spinal anesthetics. All spinal blocks were performed with sedation. Hypotension was rarely reported. Large series have been reported after frequent lumbar punctures for spinal tap in children with lower incidence of postdural puncture headaches. The use of different types of needles for spinal tap has been studied. They were divided into two groups either using a Quincke needle or a pencil point Whitacre needle. Transient radicular symptoms have been reported in children following spinal anesthesia with no long term adverse effects. An epinephrine-wash rather than a standard dose of epinephrine for the syringe is preferred in our practice. Hyperbaric solution with glucose or eubaric solution result in the similar quality and duration of the spinal block in children. Adjuvants to spinal solution have recently been reported. Relative Contraindications Contraindications to the use of spinal anesthesia in children are similar to those in the adult population. The use of spinal anesthesia in children with neuromuscular diseases particularly central core disease or congenital neuromuscular disease is controversial. Other contradications to spinal anesthesia may include anatomic deformities, infection at the puncture site, presence of an underlying coagulopathy, hemodynamic instability, presence of a ventriculo-peritoneal or other ventricular shunt and poorly controlled seizures. We avoid spinal anesthesia in neonates and children who may have increased intracranial pressures. Special consideration should be given to the child with a known difficult airway when considering a spinal anesthetic. While spinal anesthesia may be a reasonable choice in these patients, the first consideration should be the ability of the practitioner to manage the airway. Obviously the nature of the surgical procedure will dictate the use of regional techniques. Spinal anesthesia has been used for myelomeningocele repair, exploratory laparotomy and other invasive abdominal procedures in infants. The surgical site, anticipated length of the procedure and the surgical position supine, lateral, prone are important factors. A third consideration is the age of the child. Spinal anesthesia can be administered in infants while awake but preschool and school-age children may require intravenous sedation which poses its own set of risks in pediatric patients with a difficult airway. Clinical Uses Apnea and former preterm infants The most common indication for spinal anesthesia in pediatric patients is its use in former preterm infants undergoing bilateral inguinal hernia repairs. Apnea can occur in former preterm patients following a general anesthetic. Lack of uniformity in study design, small patient population sizes and variations in methodology probably account for the differences. Overall, the risk of apnea was independently related to both gestational age and conceptual age. Additional risk factors for postoperative apnea were a hematocrit The use of regional anesthesia may decrease but not eliminate the incidence of postoperative apnea. The concomitant use of ketamine may increase the incidence of postoperative apnea above that reported in control patients17;29 Unfortunately, very little information is available regarding the potential benefits of spinal anesthesia over general anesthesia in this particular population. A small randomized study of former preterm infants who received spinal anesthesia showed a decrease in the incidence of postoperative desaturation and bradycardia compared with those who received general anesthesia for inguinal herniorraphy. An observational study of over former preterm infants found a 4. The early report by Abajian et al. Interestingly, the study population included infants with medical conditions the authors felt increased the risk of general anesthesia. Spinal Anesthesia for cardiac surgery Regional techniques have been used in cardiac surgery to facilitate early extubation. Clinical pearls Special considerations for infants and children undergoing spinal anesthesia. Choose of patients who are not likely to have a significant decrease in systemic vascular resistance after spinal anesthesia. Ability to perform atraumatic spinal anesthesia especially since these patients will be heparanized in the postoperative period. Spinal anesthesia can also be used effectively in children for postoperative pain relief especially if opioids are used. Finally, in some clinical settings, spinal anesthesia may be may be the only anesthetic option available.

Chapter 4 : Regional Anesthesia | Clinical Gate

Charles J. CotÃ©, in A Practice of Anesthesia for Infants and Children (Fourth Edition), Ropivacaine Like levobupivacaine, it is an l -enantiomer that has reduced risks of cardiac and neurologic toxicities compared with bupivacaine.

Specifics of local anesthetics when used in pediatric regional anesthesia Bupivacaine: Bupivacaine is the most commonly used local anesthetic solution in infants and children in North America. The pharmacokinetics and pharmacodynamics of bupivacaine have been well documented in literature. The preferred concentration for children is a 0. Older children can tolerate a higher dose of local anesthetic solution 0. The incidence of cardiac toxicity is greater than neurotoxicity in children. This is due to the concomitant use of general anesthesia which masks the neurotoxicity and hence cardiac toxicity is first seen with overdosing of local anesthetic or intravascular placement. It is always judicious to use intermittent and slow bolus injections of bupivacaine to detect intravascular injection. A test dose with epinephrine containing solution is often used. This facilitates detection of intravascular placement. Besides the use of the usual cardiovascular signs including increase in heart rate and blood pressure, increasing amplitude of T-waves is suggestive of intravascular placement. This is a newer amide local anesthetic that is being used more frequently in pediatric surgery. It is a levo-enatiomer with less cardiovascular and central nervous system side effects compared to bupivacaine. The lethal dose of ropivacaine in rats is higher than bupivacaine. Pharmacokinetic data is available in children on the use of ropivacaine in continuous infusions as well as for single shot injections. Alpha-1 acid glycoprotein is an acute phase reactant that increases in the phase of injury such as surgery. In neonates and infants, this response is not surmountable due to the decreased amount of alpha- 1 acid glycoprotein. This facilitates the metabolism of local anesthetic solution. As a result, the free fraction of the local anesthetic is increased in the plasma. Levobupivacaine is a newer levo-enatiomer that has fewer adverse effects than bupivacaine. Pharmacokinetic data is available in children and the dosage interval is not very different than bupivacaine. Levobupivacaine has been shown to be less toxic in the animal model compared to bupivacaine. Animal experiments have shown that levobupivacaine has less myocardial depression and a decreased incidence of inducing fatal dysrhythmias compared to bupivacaine. The presence of plasma cholinesterase also limits the duration of activity of these drugs leading to shortened activity of these drugs. The most common ester local anesthetics used in infants and children are chloroprocaine and tetracaine. These drugs however, are not commonly used in children except as an adjuvant to spinal anesthesia in former premature infants undergoing spinal anesthesia or as the sole anesthetic solution for caudal analgesia. The most common preparations include lidocaine, tetracaine, benzocaine and prilocaine. The topical anesthetic solution permeates through the skin to provide analgesia. Both drugs have undergone extensive trials and have been used in children for repeated painful procedures. Adequate education of the anesthesiology trainees on the use of regional anesthesia, its advantages and its side effects is of paramount importantance for its successful and safe application in pediatric population. Analgesia in children by spinal injection with a report of a new method of sterilization of the injection fluid. Med Rec ; Randomised trial of fentanyl anaesthesia in preterm babies undergoing surgery: Effect of neonatal circumcision on pain response during subsequent routine vaccination [see comments]. Caudal analgesia in children and infants. J Urol ; Ultrasound guidance for infraclavicular brachial plexus anaesthesia in children. Practical pediatric regional anesthesia. The safety of epidurals placed during general anesthesia. Epidemiology and morbidity of regional anesthesia in children: Principles of drug biodisposition in the neonate. A critical evaluation of the pharmacokinetic-pharmacodynamic interface Part I. A critical evaluation of the pharmacokinetic-pharmacodynamic interface Part II. Drug metabolism in the human fetus and newborn infant. Pharmacokinetics of fetal and neonatal exposure to drugs. Bupivacaine for intercostal nerve blocks in children: Bupivacaine pharmacokinetics during epidural anaesthesia in children. Pharmacokinetics of bupivacaine following caudal anesthesia in infants. Toxicity of local anesthetics in infants and children. Continuous caudal anesthesia for inguinal hernia repair in former preterm infants. Spinal anesthesia for preterm infants undergoing inguinal hernia repair. Sciatic nerve blockade in infant, adolescent, and adult rats: Pharmacokinetics and cardiovascular effects of bupivacaine during epidural anesthesia in children with Duchenne muscular dystrophy. The cardiotoxicity of local anesthetics: Neurologic complications of consecutive continuous axillary catheters. Convulsions associated with pediatric regional anesthesia [editorial; comment] [see comments]. Eur J Anaesthesiol Mar;5 2: The comparative toxicity of ropivacaine and bupivacaine at equipotent doses in rats. Caudal anaesthesia with 0. A comparison of 0. Tachycardia and convulsions induced by accidental intravascular ropivacaine injection during sciatic block. Ropivacaine in paediatric surgery: Paediatr Anaesth ; 8: Ropivacaine for central blocks in children. Pharmacokinetics of local anaesthetics in infants and children. A comparison of three different concentrations of levobupivacaine for caudal block in children. Efficacy, safety, and pharmacokinetics of levobupivacaine with and without fentanyl after continuous epidural infusion in children: Systemic and regional pharmacokinetics of levobupivacaine and bupivacaine enantiomers in sheep. Chloroprocaine for epidural anesthesia in infants and children. Kinetics of local anesthetic esters and the effects of adjuvant drugs on 2-chloroprocaine hydrolysis. Continuous caudal anaesthesia with chloroprocaine as an adjunct to general anaesthesia in neonates. Intensive Care ; A prolonged chloroprocaine epidural block in a postpartum patient with abnormal pseudocholinesterase. High epidural block with chloroprocaine in a parturient with low pseudocholinesterase activity. Plasma levels of 2-chloroprocaine in obstetric patients and their neonates after epidural anesthesia. Postoperative apnea, bradycardia, and oxygen desaturation in formerly premature infants: Randomised controlled trial of eutectic mixture of local anaesthetics cream for venepuncture in healthy preterm infants. Child Fetal Neonatal Ed ; Topical anesthesia during circumcision in newborn infants. Use of EMLA cream in a department of neonatology. A randomized controlled trial to evaluate S-Caine patch for reducing pain associated with vascular access in children.

Chapter 5 : Publications Authored by Santhanam Suresh | PubFacts

Santhanam Suresh. Professor, Feb 16 , A Practice of Anesthesia for Infants and Children and pain medicine recommendations on local anesthetics and.

Chapter 6 : Santhanam Suresh â€” Northwestern Scholars

Ester local anesthetics differ from amide local anesthetics in that they are metabolized by plasma cholinesterases As a result, metabolism of ester local anesthetics depends on plasma cholinesterase levels Hence in populations which have decreased plasma cholinesterase levels, like in neonates and infants, the plasma level of these.

Chapter 7 : SPINAL ANESTHESIA IN CHILDREN

8 Justin Long, Amod Sawardekar, Santhanam Suresh, Neuraxial anaesthesia in paediatrics, Anaesthesia & Intensive Care Medicine, , 17, 6, CrossRef 9 Chang Amber Liu, Jinghu Sui, Charles J. CotÃ©, Thomas A. Anderson, The Use of Epinephrine in Caudal Anesthesia Increases Stroke Volume and Cardiac Output in Children, Regional Anesthesia.

Chapter 8 : REGIONAL ANESTHESIA FOR PEDIATRIC PATIENTS: GENERAL CONCEPTS

From the Departments of Anesthesiology (B.J.W.) Biostatistics and Medical Informatics (J.B.), University of Wisconsin School of Medicine and Public Health, American Family Children's Hospital, Madison, Wisconsin the Department of Anesthesiology, Emory University School of Medicine, Children's Healthcare of Atlanta at Egleston Children's.