In This Issue

The 11th Annual ASRA Pain Medicine Meeting and Workshops

- see page 3

Advancing the Science and Practice of Regional Anesthesia and Pain Medicine
Table of Contents

President's Message .................................................. 2
Upcoming Fall Pain Medicine Meeting in Miami .................. 3
Resident and Fellow Events at the Fall Meeting .................. 5
Can Ultrasound Guidance Be Harmful? .......................... 6
Editorial .................................................................. 8
Managing Chronic Pain During Pregnancy ........................ 9
Reconfiguration of the ASRA Board of Directors ............... 12
Rudolph H. de Jong, MD, 1928-2011 ............................. 13
How I Do It: Ultrasound-Guided Thoracic Paravertebral Blockade .................................................. 14
How I Do It: Intraclavicular Block .................................. 17
Incidence and Etiology of Neurologic Complications in Regional Anesthesia ............................................. 20

Editor
Edward R. Meriano, M.D., M.A.S.

Newsletter Committee
Steven Orebaugh, M.D. (Regional Anesthesia Lead)
David Provenzano, M.D. (Pain Medicine Lead)
Michael Barrington, M.D.
Derek Dillane, M.D.
Jeff Gadsden, M.D.
Elizabeth Huntoon, M.D.
Robert Hurley, M.D., Ph.D.
Sandra Kopp, M.D.

Resident Section
David Webb, M.D.

Foreign Corresponding
Marc Van de Velde, M.D.
Herbert C. Spencer, M.D.

Officers
President: Julia E. Pollock, M.D.
President-Elect: Joseph M. Neal, M.D.
Secretary/Treasurer: Oscar A. De Leon Casasola, M.D.
Associate Treasurer: Marc A. Huntoon, M.D.
Past President: Vincent W.S. Chan, M.D.
Executive Director: Julie Kahlfeldt, C.M.P.

Board of Directors
Honorio T. Benzon, M.D.
Asokumar Buvanendran, M.D.
Santhanam Suresh, M.D., F.A.A.P.
William F. Urmey, M.D.
Christopher L. Wu, M.D.
Eugene R. Viscusi, M.D.

Founding Fathers
L. Donald Bridenbaugh, M.D.
Harold Carron, M.D. (Deceased)
Jordan Katz, M.D.
P. Prithvi Raj, M.D.
Alon P. Winnie, M.D.
I hope you are having a wonderful summer. In addition to following up on the early and very successful ASRA Spring Meeting that took place March 15-18th at the beautiful Hilton San Diego Bayfront Hotel, I would like to update you on some other exciting things that are happening with the American Society of Regional Anesthesia and Pain Medicine including website development, E-News, and research grant recipients.

For those of you who have not visited the ASRA Website recently, you may be surprised to learn that the information found there is directly applicable to your anesthesia practice. In addition to the information about Annual meetings, intensive workshops, and research grants, there is also information specifically targeting the clinical anesthesiologist. Major tabs include a direct link to our journal Regional Anesthesia and Pain Medicine, a members only image library, practice advisories, abstracts from the 2012 Spring Meeting, and videos or recorded refresher courses lectures from the 2011 Fall Pain Meeting.

In particular, I would like to call attention to the Practice Advisories Section of the Website. Here you will find 7 different practice advisories including local anesthetic systemic toxicity, review of ultrasound guided regional anesthesia, as well as the anticoagulation, neurologic and infectious complication guidelines. There is also a downloadable checklist for the treatment of local anesthetic systemic toxicity. Most of these practice advisories are the result of consensus guideline conferences completed during our annual meetings. The information is thorough, well reviewed, concise and practical. These guidelines are the most frequent source of hits to the ASRA website by both ASRA members and non-members.

Also on the ASRA website you will find links to the ASRA E-News. Members of ASRA will receive the E-News directly to their inbox. The E-News carries succinct, pertinent information including literature reviews, updates and most recently audio interviews with two authors of abstracts from the Spring Annual Meeting. Those interviews feature Karen Boretsky discussing “Effects of a Pain Service on Pain Scores in Selected Orthopedic Patients” and John Braken discussing “Outpatient Management of Continuous Catheters Following Orthopedic Surgery.”

The E-News team has done a wonderful job enhancing communication to all the members of ASRA. That team includes Raj Gupta (Editor), Stephen Choi, Ellen King, Ed Mariano (Newsletter Editor), Steven Orebaugh, David Provenzano, Vanila Singh, and Chris Wu.

This year at the annual Spring Meeting the winner of the 2012 Carl Koller Memorial Research Grant was announced. Details of the research proposal are available on the ASRA website. The 2012 Grant winner is Caleb Ing from the Department of Anesthesiology, Division of Pediatric Anesthesiology, at Columbia University. Dr. Ing’s proposal is very timely and applicable: “Comparative peri-operative safety outcomes between regional and general anesthesia in critically ill infants.” Dr. Ing and his co-investigators are hopeful that information from this study will provide data for families and their physicians to make more informed decisions about the choice of anesthetic techniques for children undergoing anesthesia.

Finally on the website, you will find information about the upcoming 11th Annual ASRA Pain Medicine Meeting and Workshops to be held November 15-18, 2012, at the beautifully remodeled Fontainbleu Hotel in Miami, FL. Program Chair Dan Warren has worked with the Education Committee chair Terre Horlocker and the Annual Meeting Oversight Committee to plan a wonderful meeting with great speakers and outstanding workshops. Full program information as well as registration materials are available on the ASRA website. We look forward to seeing you there.

Julia E. Pollock, M.D.
It is a great honor to invite you to the 11th Annual ASRA Pain Medicine Meeting and Workshops, on behalf of the American Society of Regional Anesthesia and Pain Medicine, and 2012 Fall Program Committee. Join us at the beautiful Fontainebleau Hotel in Miami Beach, Florida, November 15th through the 18th, 2012. This year’s meeting will explore the many crossroads that we face as the practice of pain medicine continues to develop. The changes coming for medicine in general will likely have substantial impact on the field of pain medicine, and we must strive to maintain a worthy and sustainable place for our specialty in this challenging future. We encourage you to join us as we examine these issues and other hot topics in a gorgeous setting that is sure to inspire.

The meeting will open on Thursday with Refresher Course lectures that highlight the intersection of basic science and clinical applications. We will have world-renowned experts addressing core topics, including neuropathic pain, cancer pain, and the transition from acute pain to chronic states. We will also highlight the indications and implications for lumbar fusion and chronic opioid therapy.

Friday morning, the opening session will address radiofrequency techniques in pain medicine. The afternoon plenary session will bring a lively discussion on a therapy at a crossroads, intrathecal analgesic management. We will then breakout into parallel sessions to explore topics suggested by ASRA members: pain physicians in palliative care, and special considerations for pain syndromes in women. Further parallel sessions inspired by member feedback will be held on Sunday, including headache management and applied pharmacology for the pain specialist.

A topic that brings a surprising amount of debate is the finer management points of anticoagulants and platelet modifying agents in the setting of the spectrum of interventional pain procedures. Saturday morning will bring together an expert panel to discuss important topics surrounding anticoagulant therapy in interventional pain practice including the implications for implantable devices and the management of oral anticoagulants and antiplatelet therapy in the perioperative implantation and interventional procedural time frame. Audience members will have a chance to weigh in on this topic, not only through audience questions for the panel, but also through the audience response system to survey the current practice of members participating in the session.

This year we are reaching out to physicians in primary care with a special parallel session addressing pain management in the primary care clinic, focusing on appropriate triage of pain patients. International experts in pain medicine will also address some of the most concerning issues in opioid management. We expect that pain specialists who focus on longitudinal care and medication management will want to join our primary care colleagues for this session.

Saturday afternoon heats up with “Crossroads and Controversies” as we look to experts in the field to direct us on sustainability of the specialty, notably, balancing ethical issues and financial pressures in practice management. We will also have discussions on newer interventional techniques, including minimally invasive lumbar decompression (MILD®), with focus on proper introduction of new therapies. We then will look down the road to the future of pain medicine, exploring emerging imaging techniques, and the signposts on the path through healthcare reform and its implications for pain medicine.

ASRA continues to bring outstanding hands-on workshops for participants to hone examination and procedural skills, or to be introduced to techniques that are not yet part
of one's practice. The two-hour workshops are held Thursday through Saturday and will have instruction on ultrasound- and fluoroscopic-guided techniques. We will medicine. The resident leadership will again have programming that will focus on what the residents really value—hands-on workshop instruction and small

Saturday afternoon heats up with “Crossroads and Controversies” as we look to experts in the field to direct us on sustainability of the specialty, notably, balancing ethical issues and financial pressures in practice management.

again offer three “Special Session Workshops” which will bring focused didactics together with small group hands-on training in the following topics: Ultrasound for Interventional Pain Medicine (back by popular demand), Advanced Techniques for Spinal Cord Stimulation, and Radiofrequency Techniques for Pain Medicine.

As always, we will have problem-based learning discussions during two of the lunch hours. These sessions give participants a chance to dive deep into some of the more perplexing issues in the practice of pain medicine, and not only have guidance from the expert leading the session, but also share experiences and concerns with your colleagues in a round table format.

This year’s meeting will also have a new system to support scientific abstract submissions which we expect to better meet the needs of our valued members interested in sharing their research with peers. We look forward to continued outstanding submissions of basic science and clinical research projects, as well as medically-challenging cases. There will again be recognition of the “Best of Abstracts” as well as a providing a travel award for residents and fellows with outstanding submissions. We look forward to receiving a rich array of abstracts with high scientific merit, but please note the abstract submission deadline of August 1, 2012.

The resident program always provides outstanding opportunities for those in training to interact with experts and influential pillars of the field of pain group discussion sessions. A condensed and prioritized program will allow the residents to attend the main attractions and maintain the highly valued interactive sessions. Please see Dr. David Webb’s article for further details.

The glamorous Fontainebleau hotel provides a beachside backdrop for this exciting meeting, and we will party on the beach Saturday night with hot Cuban rhythms and festive fare. Don’t forget that South Beach is just minutes away with steamy night life and endless attractions. Be sure to come ready for fun in the sun and to take in some of what this destination location has to offer. We hope that you are inspired to join hot debates during the day and let loose afterward for even hotter nights! We look forward to seeing all of you in Miami.
The 11th annual ASRA Pain Meeting and Workshops will be held November 15-18, 2012, in Miami, Florida at the Fontainebleau Hotel. On behalf of the ASRA Board of Directors, this year’s program director, Dr. Daniel Warren, and the ASRA Resident Section Committee, we welcome and encourage all residents and fellows to attend and take part in the highly regarded resident-fellow education program.

The residency-fellow program continues the next day, beginning with a morning general session consisting of such lecture topics as anatomy of the spine, basic fluoroscopy for interventional pain procedures, ultrasound-guided pain procedures, and introduction to basic surgical skills for interventional pain. During lunch, you will be able to sit in on one of three problem-based learning discussions (PBLDs): the delicate nature of signing your first contract, how to deal with complications in pain medicine, or deciding if academic or private pain medicine is right for you. Then, during the afternoon sessions, you will apply what was discussed in the morning sessions. Current staff will moderate discussions regarding fluoroscopic techniques, basic ultrasound using live models, and instruction on basic surgical skills.

Dr. Warren and the ASRA Board of Directors have planned an excellent general conference session. The resident-fellow education program has been condensed this year so that you can enjoy the resident program, general sessions, and the Miami sun. Remember to save the date, and we look forward to seeing you there.
Harmful biological effects of ultrasound in animals have been recognized for over 6 decades. To enhance image quality, ultrasound machines are being manufactured with higher acoustic outputs which increase the potential for harm. The objective of this report is to provide an overview of the biological effects of ultrasound, the implications of indices displayed in most ultrasound machines, and their clinical relevance.

Can ultrasound cause tissue damage?
Being a form of mechanical energy, ultrasound waves release thermal and non-thermal energy upon contact with tissues. Acoustic intensity is a key determinant of biological effects. Protein content of tissues, which determines ultrasound energy absorption, is directly proportional to the absorption coefficient. The absorption coefficients range from 10 dB/MHz·cm (bone), to around 1 dB/MHz·cm (skin, tendon and spinal cord). Tissue perfusion, by dissipating heat, plays a major protective role. Poorly perfused tissues like the lens and cornea are particularly susceptible to thermal effects of ultrasound exposure. Factors responsible for an increase in tissue temperature with ultrasound exposure include ultrasound frequency, focusing, pulse repetition frequency, pulse duration, absorption coefficient, and ultrasound exposure time.

The interaction of ultrasound waves with gas bubbles leads to rapid changes in bubble size, a phenomenon called cavitation. Ultrasound wave-induced rapid alterations in bubble size produce a rapid influx of fluid into the collapsing bubbles. The inertia of in-rushing fluid releases free radicals and produces high temperatures and mechanical injuries to cellular structures. Non-inertial cavitation follows repetitive oscillation of the bubbles producing micro-streaming. Cavitation is linearly related to pulse repetition frequency and inversely to peak rarefactional pressures. Bubble growth, and hence cavitation, does not occur with short ultrasound wavelengths (higher frequencies).

Ultrasound exposure causes alterations in various cellular elements, including ion channels and tissues, in animals. Nervous tissue, notably myelin, and bone along with adjacent tissues are very sensitive to the effects of ultrasound. Ultrasound exposure causes reversible changes in amplitude and nerve conduction.

Lung hemorrhage, from the microvasculature of visceral pleura, occurs in various animals including mice, monkeys, rabbits, and neonatal pigs following ultrasound exposure. The important determinants for lung hemorrhage are the state of deflation of the lungs (more prone with deflation), peak rarefactional pressure, and pulse repetition frequency. Lung hemorrhage is not related to age, animal species or ultrasound frequency. Of note, lung hemorrhage does not hinder animal functioning and repairs quickly.

In addition, intestinal petechial hemorrhages with apoptosis on the mucosal surface can follow exposure to ultrasound at and above diagnostic ultrasound frequencies. Intestinal hemorrhage, caused by cavitation, is frequency-dependent.

Is ultrasound exposure of concern in humans?
The majority of data about biological effects in humans are epidemiological studies of maternal ultrasound exposure on the fetus with lower intensity machines. Despite the tremendous increase in the use of obstetrical ultrasound imaging, fetal malformations have not increased in incidence. Therapeutic ultrasound, which uses higher intensities, has been reported to cause prolongation of nerve conduction in peripheral nerves. Dental hygienists, using hand held ultrasound cleaning systems, have an increased incidence of carpal tunnel syndrome. Human beings appear resistant to lung or intestinal hemorrhage for as yet unknown reasons. To date, there are no reports of actual damage secondary to diagnostic ultrasound exposure in human tissues.

What is Output Display Standard?
The Output Display Standard (ODS), was developed by the American Institute for Ultrasound in Medicine in 1983 to provide safety information. There are FDA regulations requiring the display of ODS in machines. ODS consists of 2 major indices: the Thermal index (TI) and...
the Mechanical index (MI). These indices provide conservative, in-vivo, worst-case scenario output estimates facilitating clinical decision making. Thermal index is the ratio of acoustic power of the ultrasound machine to the power required to raise tissue temperature by 1 degree Celsius (°C). Three different thermal indices were developed based on the type of tissue predominantly in the ultrasound beam path: soft tissue Thermal Index (TIS), bone thermal index (TIB), or cranial bone thermal index (TIC). Thermal indices range from 0-6 and provide an estimate of maximum temperature increase.

Mechanical Index (MI), ranging from 0-2, is a ratio of the derated peak rarefractional negative pressure and square root of center frequency, which provides an estimate of the likelihood of nonthermal effects including cavitation.

These indices are altered by changes in acoustic output, focal points, pulse repetition frequency, color Doppler flow and power Doppler.

**How can we limit potential tissue injury?**

Many international and national associations have published guidelines and consensus reports highlighting the need for concern about ultrasound-related biological effects and have recommended prudence in the use of ultrasound imaging. FDA introduced 2 tracks to accommodate manufacturers’ compliance with ODS, thereby influencing the manufacture of higher output machines for better image quality (Table 1). Track 1, applicable to machines that do not display the ODS, retain original limits. Track 3 allows higher limits for machines that display the ODS. Most of the presently available ultrasound machines provide information about acoustic intensity, pulse repetition frequency, and additional features like the power Doppler, which may be adjusted to limit the indices. Without compromising image quality, utilization of lower acoustic outputs may limit indices. Exposure time becomes critical with higher indices.

The British Medical Ultrasound Society has recommended exposure times for different indices: [http://www.bmus.org/safety_of_ultrasoundNF.htm](http://www.bmus.org/safety_of_ultrasoundNF.htm). Limiting exposure time, especially in febrile patients and with the use of power Doppler mode, may be prudent. While incorporating technological advances in the machines, paying attention to the indices may aid in limiting potential harm (Figure 1 A & B).

**Figure A & B:** Recent introduction of needle visualization technology causes a small increase in the indices. A: Ultrasound image of phantom showing the indices (boxed in red); B: Ultrasound image of phantom showing the needle with the needle visualization technology software turned on showing an increase in the mechanical index; MI: Mechanical Index, TIS: Soft tissue Thermal Index.

It has been postulated that nerve-related biological effects secondary to ultrasound exposure are not noticeable or absent because: 1) the lower temperature of coupling gel limits temperature rise, 2) the frequent use of B mode along with constant movement of the transducer during scanning prevents continuous ultrasound exposure to any particular area, 3) the needle used during interventions may conduct the heat away from the focused tissue, 4) the higher frequencies used may afford protection against mechanical effects and finally, and 5) the perfusion may lessen potential harmful effects. Although there is potential for biological effects from ultrasound exposure in animals, the risk to human tissue appears to be so subtle that it fails detection both by the patient and the practitioner. Prudence is still recommended as we continue to advance ultrasound technology and its use.

**Suggested Reading:**


**Table 1:** FDA recommendations for intensity limits based on compliance with ODS in displaying the indices. Track 3 limits are for machines displaying the indices. ISPTA.3: Spatial-peak temporal-average intensity, ISPPA.3: Spatial-peak, pulse-average intensity, MI: Mechanical Index, TI: Thermal Index, ODS: Output Display Standard (Table adapted from ref: 8).

<table>
<thead>
<tr>
<th>Use</th>
<th>ISPTA.3(mW/cm²)</th>
<th>ISPPA.3(mW/cm²)</th>
<th>MI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Track 1</td>
<td>Track 3</td>
<td>Track 1 &amp; 3</td>
</tr>
<tr>
<td>Regular</td>
<td>94</td>
<td>720</td>
<td>190</td>
</tr>
<tr>
<td>Eye</td>
<td>17</td>
<td>50 and T≤1</td>
<td>28</td>
</tr>
</tbody>
</table>
This issue of ASRA News is truly international! Dr. Michael Barrington has provided us with a fantastic overview of the incidence and etiology of neurologic complications associated with regional anesthesia. In addition, we are very fortunate to have two “How I Do It” articles by Drs. Gurkan and Conroy on ultrasound-guided infraclavicular block and thoracic paravertebral block, respectively. We appreciate these experts’ willingness to share their tips and tricks for performing procedures as well as their perspectives on the evolution of ultrasound-guided regional anesthesia.

In recent years, the use of ultrasound guidance for interventional procedures has increased exponentially around the world. As anesthesiologists, our first experiences using this technology were in the context of vascular access. Now ultrasound guidance for peripheral nerve blockade has become mainstream. While we can generally agree that “big ticket” outcome benefits such as improvements in long-term functional outcomes and decreased morbidity or mortality still lack supportive data, enthusiasm for ultrasound is propelled by the desire to decrease procedural times, improve block success rates, and minimize local anesthetic dose. Early successes in applying ultrasound to regional anesthesia has sparked great interest in ultrasound for interventional pain procedures.

Program Chair, Dan Warren, M.D., and Resident Section Chair, David Webb, M.D., provide us with a teaser for the upcoming Fall Annual Meeting. This looks to be a progressive program addressing some hot topics affecting the specialty of pain medicine that shouldn’t be missed. Workshops on ultrasound-guided techniques in interventional pain medicine are back by popular demand. ASRA has been a strong proponent in this field, establishing the Special Interest Group (SIG) in Ultrasonography in Pain Medicine in 2008. To learn more about this SIG and for more information about the upcoming Fall Annual Meeting, please visit the ASRA website http://www.asra.com.

How much do we really know about ultrasound? Many of us use it every day. As ultrasound technology continues to advance with greater demand from the end-user for better image quality, we need to be aware of the potential risks. Hariharan Shankar, M.D., give us an overview of the biological effects of ultrasound that is sure to be an ongoing topic of discussion.

That’s not all. We have included even more content covering educational and informational topics to keep you up to date on your society – ASRA.

Edward R. Mariano, M.D., M.A.S.

Suggested Reading: (cont.)

A s physicians we are taught the axiom ‘primum non nocere’ “first do no harm.” This is never more important than when treating pregnant patients with pain medications because one is effectively treating two patients. The safest pregnancy-related pharmacotherapy is no therapy. However, as pain physicians we are often challenged to safely care for the pregnant pain patient who is not only on opioids but multiple adjuvants as well. This polypharmacy presents a unique challenge to the physician not only because of the variability of metabolism for each of these drugs but also because of the gestational timeline differences for fetal risk with each exposure. Specific effects of pain medications and illicit substances on the developing fetus are complex and depend on many factors including the specific type of medication, duration of use, and gestational age of the fetus when first exposed,¹² as well as maternal nutritional status and the presence of possible polysubstance use.³

To assist the clinician, the FDA developed a rating system for the teratogenic effects of drugs (Table 1). General guidelines for choosing dosages and types of drugs within each class are lacking in this population, and unfortunately the vast preponderance of medications in use today fall into the C category classification (Table 2). Maternal-fetal effects of chronic opioid use during pregnancy range from no anomalies to adverse outcomes including intrauterine growth restriction, placental insufficiency, preeclampsia, preterm rupture of membranes, premature birth, postpartum hemorrhage, perinatal mortality, prolonged QT interval, low birth weight, and hypoxic-ischemic brain injury.⁴⁵ In many cases, it is difficult if not impossible to ascribe certain cause and effect to these exposures. Intrauterine fetal withdrawal from opioids in animal models is associated with increased morbidity and mortality possible due to reduced intrauterine and placental blood flow and diminished availability of oxygen to the fetus.⁸

<table>
<thead>
<tr>
<th>Table 1: FDA Pregnancy Categories²⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category A</strong></td>
</tr>
<tr>
<td>Adequate and well-controlled studies have failed to demonstrate a risk to the fetus in the first trimester of pregnancy (and there is no evidence of risk in later trimesters).</td>
</tr>
<tr>
<td><strong>Category B</strong></td>
</tr>
<tr>
<td>Animal reproduction studies have failed to demonstrate a risk to the fetus and there are no adequate and well-controlled studies in pregnant women.</td>
</tr>
<tr>
<td><strong>Category C</strong></td>
</tr>
<tr>
<td>Animal reproduction studies have shown an adverse effect on the fetus and there are no adequate and well-controlled studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.</td>
</tr>
<tr>
<td><strong>Category D</strong></td>
</tr>
<tr>
<td>There is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience or studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks.</td>
</tr>
<tr>
<td><strong>Category X</strong></td>
</tr>
<tr>
<td>Studies in animals or humans have demonstrated fetal abnormalities and/or there is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience, and the risks involved in use of the drug in pregnant women clearly outweigh potential benefits.</td>
</tr>
</tbody>
</table>

A recently published study by Broussard et al.⁹ using data from the National Birth Defects Prevention Study 1997-2005, found children born to mothers who used opioids in the first trimester had statistically significant higher risk for congenital heart abnormalities including: 1) conoventricular septal defects, 2) atroventricular septal defects, 3) atrial septal defects, 4) hypoplastic left heart syndrome, 5) tetralogy of Fallot, and 6) pulmonary valve stenosis. The author also reported a statistically-significant association between infants who were exposed to early pregnancy opioid treatment and the occurrence of spina bifida.⁹ The authors postulated that one of the mechanisms mediating these negative effects may be the opioid’s ability to influence growth regulation during embryologic development. Exogenous opioids may act on opioid growth factor receptors during embryogenesis, resulting in delayed cell growth and migration at critical times in development thus resulting in an increased risk for certain birth defects.⁹

Adjuvant medication use is also associated with teratogenic effects. For example, in utero antiepileptic drug (AED) exposure is associated with cardiac malformations, hypospadias, and facial clefts. Treatment with certain AEDs (e.g., valproic acid and carbamazepine) was found to be associated with a
greater risk of specific malformations including neural tube defects. Exposure to certain AEDs, most notably valproic acid, may result in altered cognitive function later in life. Unfortunately there is no evidence that additional folic acid supplementation ameliorates the increased risk of congenital malformations associated with the use of AEDs.

Risks to the unborn fetus range in presentation as well as severity. In addition to the teratogenic effects of opioids and adjuvants, infants born to mothers who consume opioids chronically during pregnancy may develop neonatal abstinence syndrome (NAS). NAS is an array of signs and symptoms including central nervous system, metabolic, vasomotor, and respiratory, and GI dysfunction. NAS usually begins within 72 hours of birth and can last for several weeks depending on the half-life of the drug used. Other substances including alcohol, benzodiazepines, antidepressants, and SSRI’s, may also produce neurobehavioral dysregulation similar to that seen with NAS.

When the benefits of maintaining the pregnant patient on chronic opioid therapy outweigh the risks, there are several options available to the clinician. A complete discussion of opioid maintenance in pregnancy for both chronic pain management and opioid dependence is beyond the scope of this newsletter; however, several options are presented here.

Methadone has been used for many years as a standard for maintenance therapy and currently is the only opioid medication approved by the U.S. Food and Drug Administration (FDA) for medication-assisted treatment of opioid addiction in pregnant patients. Due to DEA restrictions, pain physicians are currently able to prescribe methadone only for pain management but not for addiction purposes. An alternative to methadone is buprenorphine which requires special DEA identification in order to prescribe for opioid addiction. Buprenorphine, a partial mu-opioid agonist, has not been extensively studied in pregnancy. Despite the lack of FDA approval for use in pregnant women in the United States, the Center for Substance Abuse Treatment (CSAT) recommends the use of buprenorphine under certain clinical circumstances.

Buprenorphine is classified as a category C drug by the FDA (i.e., one lacking adequate, well-controlled studies in pregnant women), although several studies have found it safe and effective in this group. Infants with NAS born to mothers maintained on buprenorphine required significantly less morphine (mean dose, 1.1 mg vs. 10.4 mg; P<0.0091), had a significantly shorter hospital stay (10.0 days vs. 17.5 days, P<0.0091), and shorter duration of treatment for neonatal abstinence syndrome (4.1 days vs. 9.9 days, P<0.003125) compared to methadone. A more

### Table 2: FDA Categories of commonly used drugs in chronic pain management

<table>
<thead>
<tr>
<th>Medication</th>
<th>Pregnancy Category</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propionic Acids (Ibuprofen)</td>
<td>B</td>
<td>Contraindicated in 3rd trimester of pregnancy</td>
</tr>
<tr>
<td>Salicylates-acetylated (Aspirin)</td>
<td>D</td>
<td>In the last trimester</td>
</tr>
<tr>
<td>Salicylates non-acetylated (Diflunisal)</td>
<td>C</td>
<td>Contraindicated in 3rd trimester</td>
</tr>
<tr>
<td>Oxicams (Meloxicam)</td>
<td>C</td>
<td>Prior to 30 weeks gestation</td>
</tr>
<tr>
<td>Cox-2 inhibitors (Celecoxib)</td>
<td>C</td>
<td>Contraindicated in 3rd trimester</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>B</td>
<td>IV acetaminophen category C</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Pregabalin</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Duloxetine</td>
<td>C</td>
<td>Caution in 3rd trimester</td>
</tr>
<tr>
<td>Milnacipran</td>
<td>C</td>
<td>Caution in 3rd trimester</td>
</tr>
<tr>
<td>Nor triptyline</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Amitriptyline</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Bupropion</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Cyclobenzaprine</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Carisoprodol</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Metaxalone</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Paroxetine</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Tizanidine</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Baclofen</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Capsaicin Topical</td>
<td>N/A</td>
<td>No data available</td>
</tr>
<tr>
<td>Diclofenac Epolamine Topical</td>
<td>C</td>
<td>Contraindicated in 3rd trimester</td>
</tr>
<tr>
<td>Trolamine Salicylate</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Lidocaine Patch 5%</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Methadone</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>tramadol</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Codeine/Hydrocodone</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Morphine</td>
<td>C</td>
<td>Caution in 3rd trimester</td>
</tr>
<tr>
<td>Oxycodeone</td>
<td>B</td>
<td>Contraindicated in labor and delivery; caution in 3rd trimester</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Tapentadol</td>
<td>C</td>
<td>Not recommended for use in women during and immediately prior to labor and delivery.</td>
</tr>
</tbody>
</table>
detailed discussion on buprenorphine use in the treatment and management of pregnant patients and its effects in newborns can be found in TIP 40, Clinical Guidelines for the Use of Buprenorphine in the Treatment of Opioid Addiction.

For a comprehensive review of buprenorphine use in pregnant patients and its effects on the neonate, see the article by Johnson and colleagues.

In addition to medications for controlling chronic pain during pregnancy, non-pharmacological alternatives are readily available. Physical therapy for low back pain, massage, complementary alternative medicine (acupuncture, aromatherapy), and other modalities are often effective in decreasing pain. It is also important to consider counseling and enrollment in a substance abuse program for the pregnant opioid-dependent patient.

The pregnant chronic pain patient presents a unique set of challenges to the pain physician. Avoidance of usual pain medications would be ideal, however difficult, in many circumstances. If opioids are indicated in this population, methadone or buprenorphine combined with non-pharmacologic therapies may serve as possible treatments for chronic pain management and opioid dependence during pregnancy. “Primum non nocere.”

References:
In 2010, the American Society of Regional Anesthesia and Pain Medicine (ASRA) entered into a strategic planning process. Part of that process entailed a member survey in 2011. One of the clear messages from the membership, both as reflected in the survey results and through personal conversations between individual members and directors of the Society, is that the governance structure of ASRA is often seen as less than transparent and overly exclusive. From the directors’ view, the Board’s membership structure is also problematic in that it can require up to a 16 year commitment to complete the officer track. Indeed, over the past decade some outstanding directors have had to resign from the Board because of their advancing age or expanding obligations with other professional organizations. In response to these concerns, the ASRA Board of Directors approved at their spring 2011 meeting a reconfiguration of the Board’s structure. This new configuration will affect those elected to the Board of Directors at the September 2012 interim Board meeting and will take effect at the end of the spring 2013 annual meeting. In essence, the reconfiguration involves the addition of one Director-at-Large and the elimination of the Associate Treasurer position, both of which combine to increase access to the Board by over 20% and to reduce the maximum time on the Board from 16 to 13 years.

The essential elements of the Board of Directors reconfiguration are:

- The number of officers is reduced from 5 to 4 by eliminating the Associate Treasurer position, which decreases time spent as an officer from 10 to 8 years. Officers will continue to serve 2-year terms. The Treasurer is elected by vote of the Board of Directors and will automatically ascend through the ranks of President-Elect, President, and Immediate Past President. Current or past Board members who have not served the Society as President are eligible for election to the office of Treasurer.

- Currently ASRA has 6 Directors-at-Large who are elected for 2-year terms and may enter the officer track or serve a maximum of 6 years before moving off the Board. The new configuration includes 7 Directors-at-Large – 6 of these positions are for two years and 1 is for one year. Directors may now serve a maximum of 5 years unless they ascend onto the officer track.

- These combined changes – a reduction of 1 officer, an increase of 1 director, and a shorter term as director - will afford more members the opportunity of being elected to the Board of Directors.

- The final change involves member nomination for directors. Prior to each election, ASRA members will be asked by the Nominations Committee to submit names of individuals who they believe should be considered for an open director position. The Committee will consider these nominations when they present a slate of candidates to the sitting Board of Directors. However, election of new directors, re-election of existing directors (up to the 5-year limit), and election of the treasurer will remain the duty of the Board of Directors, as stipulated by the Society’s Bylaws.

The ASRA Board of Directors believes that the new configuration will both address membership concerns related to access to Director-at-Large positions and will make the potential time commitment for board service more palatable to those who are elected. For the new configuration to become possible, a current officer of the Society will step down and not become President. Some of the current Directors-at-Large will see their terms reduced from 6 to 5 years, and will less likely ascend to the officer track.

If you have any questions regarding these changes, please feel free to address them to Joe Neal (anejmn@vmmc.org).
Rudolph H. de Jong—scholar par excellence—passed away May 27, 2011. “Rudy,” as he was known by friends and colleagues, was a quiet, unassuming man with a passionate quest for knowledge. His contributions to anesthesiology include publications of original research in peer-reviewed journals, regular scientific and refresher course presentations at ASA, IARS and ASRA meetings, book chapters, letters-to-the-editor and 3 monographs. He served on the FDA Committee that had oversight of anesthetic drugs and various committees of professional societies. He challenged himself and those he mentored to present scientific information in a form easily understood by clinical anesthesiologists. He embraced and encouraged collaborative research both among anesthesiologists as well as between basic scientists and anesthesiologists. Perhaps best known for his studies of local anesthetic toxicity, Rudy also contributed to knowledge about neuromuscular blocking drugs, various aspects of regional anesthesia and pain, as well as mechanisms of action of general anesthetics.

Born in Amsterdam, the Netherlands he immigrated with his family to the United States when he was 17 yo. He earned his B.A. and his M.D. degree at Stanford University School of Medicine and obtained training in regional anesthesia at the Virginia Mason Hospital under the tutelage of Dr. Daniel Moore.

His first of many major contributions to the anesthesia literature was an article published in Anesthesiology in 1961 entitled “Axillary Block of the Brachial Plexus.” In this landmark article, Rudy reported the importance of the anatomy of the axillary sheath. He applied the measurements he obtained from careful cadaver dissections to the formula for the volume of a cylinder and concluded 42 ml should be sufficient to completely bathe all branches of the brachial plexus distal to the cords.

A review article entitled “Physiological Mechanisms of Peripheral Nerve Block by Local Anesthetics” was perhaps Rudy’s most important single publication. This publication ultimately affected the clinical practice of many hundreds if not thousands of anesthesiologists. This article published in 1963 with his friend and mentor Irv Wagman formed the basis for Rudy’s textbook Physiology and Pharmacology of Local Anesthesia.

In 1965, Rudy moved to Seattle, where he spent the next decade doing research at the University of Washington involving neuropharmacology and particularly local anesthetic toxicity. Rudy seized on the fact that local anesthetics selectively stimulate amygdala and demonstrated conclusively that diazepam, which specifically suppresses the electrical activity of the amygdaloid, provides improved and much more specific local anesthetic seizure prophylaxis and management than that provided by the then used barbiturates.

Later Rudy served as a senior editor of the Journal of the American Medical Association and corresponding editor of Archives of Surgery, during which time he was research professor of anesthesiology at the University of Illinois Medical Center. Other appointments included Eleanor Brooks Saltosall Professor for Research in Anesthesiology and the Control of Pain at Tufts University School of Medicine in Boston and at the University of Cincinnati in the Pain Control Center with Dr. Raj. He served as director of the Interdisciplinary Pain Management Center at the Medical College of Georgia, then director of the Jefferson Pain Institute Thomas Jefferson University in Philadelphia. He next became director of the Carolina Pain Center at the University of South Carolina School of Medicine He retired from this position in 1998.

It is rare that an individual can make major contributions in all three aspects of academic anesthesia, namely, teaching, research, and patient care. Rudy has provided us with the classic textbook on the pharmacology of local anesthetics, with much of the information obtained from his own laboratory; he gave us an entirely new therapeutic approach to the management of systemic reactions to local anesthetics; and directed a pain service at several major universities, and in so doing he not only provided patients with his expertise in pain management but also provided his residents and fellows with invaluable teaching in this rapidly expanding subspecialty of anesthesiology.

*Much of the material for this was extracted from Dr Alon Winnie’s introduction of Dr. de Jong as the Gaston Labat Lecturer at the 1995 ASRA annual meeting.

Written by: James E Heavner, DVM, PhD, DACVA Fellow of Interventional Pain Management (HON) Professor Emeritus, Anesthesiology and Cell Physiology and Molecular Biophysics Clinical Professor of Anesthesiology, TTUHSC Lubbock, TX
Paravertebral block involves the use of local anaesthetic lateral to the vertebral column to produce ipsilateral anaesthesia and analgesia by blockade of the thoracic segmental nerves. The key advantages over intercostal blocks are broader coverage (can cover multiple dermatomes and include blockade of the posterior primary ramus) and the ability to insert a catheter.

Single-level injection with catheter insertion constitutes my usual approach for analgesia as part of a multimodal regimen for unilateral incisions in thoracic dermatomes, such as thoracotomy and nephrectomy. I have found it particularly useful for management of analgesia for fractured ribs in difficult cases. A bolus dose of 15 ml 0.5% bupivacaine can cover a mean of 4 (1-11) thoracic dermatomes. Single-injection blocks performed at multiple spinal levels has been described as an anaesthetic technique for breast surgery. There are case reports and prospective studies of bilateral paravertebral blocks being used for obstetric analgesia, and even as an alternative to general anaesthesia for abdominal surgery.

Block failure occurs in approximately 12% cases, and various patterns of spread have been observed in contrast studies. It is plausible that the use of ultrasound to accurately locate the paravertebral space and observe patterns of spread in real time may reduce the failure rate and improve local anaesthetic coverage.

Problems associated with epidural blockade, such as lower limb motor blockade, urinary retention, hypotension, and concerns about neuraxial nerve damage related to haematoma or abscess formation may explain the resurgence in use of the paravertebral block. Recent reports suggest improved long term outcomes, with reduced chronic pain and cancer recurrence after breast surgery, which is now the subject of prospective study.

Anatomy
The thoracic paravertebral space is a wedge-shaped potential space. Medially it is bound by the vertebral body, intervertebral disc, and intervertebral foramen. Its anterolateral border is the parietal pleura, and it communicates with the intercostal space laterally beyond the tip of the transverse process. The posterior border is formed by the transverse process and the superior costotransverse ligament, which forms the most important structure to be traversed by the needle. This ligament joins the inferior aspect of the transverse process above with the superior aspect of the neck of the rib below and may be appreciated by a ‘click’ (loss of resistance) on advancement of the needle. The contents include fat and extrapleural fascia, the segmental nerve branching into anterior and posterior primary rami, the sympathetic chain and rami communicantes, and radicular vessels. The nerve at this point may consist of rootlets, devoid of a sheath, allowing good local anaesthetic penetration. The nerve should lie deep to the transverse process, protecting it from the needle. The endothoracic fascia, the deep fascia of the thorax, is a fibroelastic structure dividing the paravertebral space into anterior and posterior compartments. It is closely applied to the anterior vertebral body; laterally it contains the sympathetic chain anterior to it and the segmental nerve posterior to it. Catheter placement relative to this layer may determine the different patterns of spread observed with this block.

![Anatomy of paravertebral space](image)
Surface anatomy
In the thoracic spine, the superior aspect of the spinous process relates laterally to the transverse process of the vertebra below it, due to its steep downwards angulation. The tip of the transverse process is located ~2.5 cm from the spinous process. This is the insertion point for the traditional approach to paravertebral blockade.

Sonoanatomy
I usually start imaging with a high-frequency linear probe and change to a low-frequency curvilinear probe if imaging is difficult. The curved probe provides a wider field of view which can help identify the midline and pleura during transverse scanning but at lower resolution. The transverse process projects posteriorly, and the costotransverse articulation is on its anterior aspect, forming a step in bony depth and angle to allow identification of the transverse process tip with ultrasound. With a transverse probe orientation, the acoustic shadow of these bony margins becomes deeper at the point where the transverse process joins the rib (Fig. 2). It is important to distinguish the pleura from the acoustic shadow of bone – pleura moves with inspiration, and some penetration of ultrasound occurs. The pleura can be distinguished from bone more easily in the sagittal plane – it is the deeper hyperechoic structure (Fig. 3). Local anaesthetic injected into the paravertebral space should increase the depth between transverse process and parietal pleura. Identification of the radicular vessels using colour flow Doppler while scanning the paravertebral space is difficult because of the depth and size of the vessels, and the presence of acoustic shadow.

Ultrasound-guided techniques
A number of US-guided approaches to the paravertebral space have been advocated, and no particular approach has been proven superior. Proximity to the neuraxis and lung require a good orientation to the anatomy, and steep angles of insertion may make needle visibility difficult. Orientation to the transverse and spinous processes during needle insertion is greatly helped by creating surface markings during your survey scan.

For novice sonographers, in obese patients, or if there is subcutaneous emphysema making imaging difficult, I recommend an “ultrasound-assisted” approach. A survey scan defines the location and depth of the transverse process tip for marking and the depth to lung. When measuring distance, only light probe pressure should be used. Proceed with paravertebral blockade in the traditional way, ensuring the angle of needle insertion matches the angle of the ultrasound beam during the survey. The non-ultrasound technique has a good success rate and low risk of complications.

Transverse in-plane approach. Identification of the key landmarks is as described above. When performing a survey scan, mark the tip of the transverse process and spinous process. It is usually possible to visualize the transverse process and pleura without the rib obscuring it. Position the tip of the transverse process in the middle of the image and then rotate the probe slightly. The heel of the hand holding the probe should be resting firmly against the patient to hold this position. The needle insertion point should be at least 2 cm lateral to the tip of the transverse process to allow an insertion angle suitable for needle visualization. The needle is directed in between the transverse process and pleura, and injection is...
performed under vision (by an assistant with extension tubing) to observe pleural displacement and confirm correct position. Care should be taken not to advance the needle more than 1 cm once it is in the acoustic shadow of the transverse process, as it is pointing in the direction of the intervertebral foramen. It is also possible the catheter fed beyond the needle may enter the neuraxis, although this has not been reported in the published case series.³

**Sagittal in-plane approach.** Positioning the probe in a sagittal orientation 2–3 cm lateral to the midline to obtain an image as in Figure 3 clearly distinguishes bone and pleura. Angulating the probe slightly laterally may improve visibility of the pleura which reflects anteriorly toward the mediastinum at this site (Fig 1). Between the transverse processes are the superior costotransverse and intertransverse ligaments and, deep to these, the paravertebral space. The difficulty I find with this approach is that the angle of insertion becomes relatively steep to map a course between the bony landmarks and finish close to pleura, making needle visibility difficult (Fig 5). This may be helped by flexing the patient as much as possible, making the target slightly more shallow and the bones further apart, and/or using a more echogenic needle. Potential advantages include observation of spread in the adjacent acoustic windows and catheter insertion is not pointing toward the neuraxis.

**Conclusion**
Paravertebral blockade is experiencing a resurgence in interest and use. As regional anaesthetists become more experienced with the use of ultrasound, its application to guide routine paravertebral insertion is inevitable. Although this is challenging, it can be achieved. Further study is required to define the optimal approach and demonstrate improved outcomes with ultrasound guidance.

**References**
6. Exadaktylos AK, Buggy DJ, Moriarty DC, Mascha E, Sessler DI: Can anesthetic technique for primary breast cancer surgery affect recurrence or metastasis? Anesthesiology 2006; 105: 660-4
Infraclavicular block (ICB) is an upper extremity block that provides complete anesthesia below the shoulder. Refinement in techniques and ultrasound (US) guidance have increased the interest in ICB, and it is probably one of the most commonly-performed upper extremity blocks today.

**Anatomy**

This block is performed below the clavicle at the cord level of brachial plexus. The axillary (subclavian) artery is surrounded by three cords. The axillary vein lies adjacent to the artery and is positioned caudally. These three cords - lateral, posterior and medial - are named according to their relative position to the artery. The anatomy of the plexus varies widely among individuals. The MRI study of Sauter revealed that the cords are found within 2 cm from the center of the artery, approximately within 2/3 of a circle. With reference to a clock face with the axillary artery at the center, the cords are distributed between 3 and 11 o’clock. Considering all volunteers, an average point with shortest distances to all cords was found at 8 o’clock, close to the artery, in the cranioposterior quadrant.

**History**

ICB was first described by Bazy in 1914. Although the technique has a long history, Raj modified the technique and reported a high success rate using a nerve stimulator in 1973. Failure to obtain similar success rates reported by Raj has led to a search for an approach that has consistently-high success rates in different hands. Since that time, many approaches, which differ in the site of needle entry and/or needle direction, have been described. Following MRI studies, Klaastad has suggested that ICB can be accomplished by the ‘lateral sagittal route’ [lateral sagittal infraclavicular block (LSIB)] with ease and low risk of complications, such as pneumothorax or vascular puncture. LSIB is the infraclavicular approach used in our clinic. With this technique, it is easy to palpate the bony landmarks -clavicle and coracoid process- even in obese patients. Using LSIB, the single injection technique is well-accepted by patients with fewer adverse effects than an axillary block by multiple-injection technique and more complete anesthesia with a block onset time of 20 minutes. Large-scale studies have reported similar success rates that range between 89.5% and 91%. This dependably-high success rate seems to be a major advantage of the LSIB technique.

**Ultrasound-Guided LSIB Technique**

Although LSIB was first performed using nerve stimulation (NS), it is a technique very suitable for US guidance. Important sonoanatomic structures include the axillary artery and three cords of the brachial plexus posterior to the pectoralis minor muscle. Using a linear probe, the prominent pulsatile axillary artery can be easily identified. Brachial plexus cords that surround the artery look hyperechoic and can be identified with high resolution US machines. Yet, sometimes difficulty can be encountered seeing the posterior cord, which lies behind the artery and can be confused with the acoustic enhancement beyond the blood vessel (Fig. 1). Comparative studies have revealed that US guidance further increases the block success rate up to 95%. Currently in our clinic, where more than 1000 US guided LSIB has been performed during recent years, our success rate is over 95% (unpublished data). US guidance has also reduced...
vascular puncture incidence from 20% to almost nil. In addition to high success rates, improved patient safety, and comfort, US guidance has provided certain advantages that allow the technique to be used in many instances where it would not be clinically feasible with NS alone.

The patient is placed in supine position with relaxed shoulders. Typically the arm to be blocked is adducted and the hand is on the abdomen but special arm positioning is not necessary, which is an advantage, especially in the case of painful, traumatized extremities. However, abduction of the arm will further bring cords to a more superficial position, which may be an advantage during deep blocks. The head is rotated slightly to the opposite direction. The anesthesiologist works from behind the shoulder. The point of needle insertion is at the intersection between the clavicle and the coracoid process. The US probe is placed just below the clavicle, in para-sagittal orientation, about 0.5–1 cm inferior to the site of needle entry (Fig. 2). Any US machine with a variable frequency linear probe can be used for performing the block. In very obese patients, convex or microconvex probes should be considered. A 22 gauge, 80 mm block needle is used during block performance. The needle is directed in-plane with the US probe, and aimed towards the cranioposterior part of the axillary artery. The needle tip is positioned close to the recognizable cords around the 8 o’clock position based on a previous-published MRI study. The visualized local anesthetic (LA) distribution should be considered sufficient when it reaches all identified cords or surrounds the artery in a U shape covering 3–11 o’clock of the clock face. If spread is judged insufficient, the needle should be redirected to provide a U-shaped LA distribution around the axillary artery. In adult patients, we typically administer 30 ml of LA mixture (20 ml of levobupivacaine 0.5% and 10 ml of lidocaine 2%). If bilateral block is planned, we administer only 20 ml of LA for each side.

**Single- versus Dual-Control during US-Guided ICB**

Some clinicians choose to use both localization modalities, NS and US guidance, simultaneously for the performance of this block. However, avoidance of NS may result in a greater degree of patient comfort, especially in trauma cases, where motor stimulation may be quite painful. In a randomized study, it was shown that during LSIB performance, US guidance alone produces a block success rate identical to the combination of both US and NS guidance, yet provides a shorter block performance time. Block onset time was similar in both groups. The axillary artery is a large, pulsatile landmark that can be easily identified during US scanning (Fig. 1). For these reasons, we recommend using US guidance alone.

**ICB in Children**

LSIB is easy to perform in children due to distinct anatomical landmarks. Using NS in our study that
included 80 children, all patients received 0.5 ml/kg of bupivacaine 0.25% with adrenaline 5 mcg/ml. All of the patients were pain-free at awakening from general anesthesia with a mean duration of analgesia of 13 ± 8 h and a mean duration of motor block of 6 ± 2 h. Vascular puncture was detected in six patients. Currently in our clinic, all ICB blocks in children are performed using US guidance alone and 0.25% levobupivacaine 0.5 ml/kg.

Possible complications

Vascular puncture with or without inadvertent LA toxicity is the most frequent complication described, although US guidance has dramatically reduced the incidence of this occurrence. Because ICB block is a relatively deep block in a noncompressible area, coagulopathy can be considered as a relative contraindication. Pneumothorax is probably the most feared complication; attention should be paid to stay strictly lateral and sagittal to avoid meeting the pleura.

Catheter Technique

The infraclavicular area is the best site of the brachial plexus for catheter placement. Pectoral muscles keep the catheter in place, and therefore catheter dislodgment is not a major problem. Catheters are most useful for repeated surgery, daily debridement and painful complex surgeries like elbow surgery. During catheter placement we administer 20 ml of LA as described before. The needle tip is placed around 8 o’clock, and the catheter is further threaded about 2-3 cm beyond the tip of the needle. Different regimens (LA administration on demand, and/or continuous infusion via patient-controlled analgesia pumps) using dilute LA concentration can be used for pain treatment. We typically administer levobupivacaine 0.125-0.25% either 5 ml/h continuous infusion or 5 ml bolus doses on demand. All patients with catheters are followed at regular intervals and necessary adjustments should be made to optimize pain therapy and also to assess possible complications like infection, migration of the catheter, failure, and persistent motor or sensory block.

References

Neurologic complications associated with regional anesthesia often have a diverse and complex etiology. Following peripheral nerve blockade (PNB), presenting features of potential nerve injury include paresthesia, dysesthesia, neuropathic pain, and weakness. Devastating complications of neuraxial anesthesia such as epidural hematoma and abscess have been subject to large series and its risk-benefit ratio examined. In recent years, regional anesthesia, and in particular PNB, has been increasingly utilized and has evolved significantly with the use of new procedures, technology, and equipment.

Neuraxial anesthesia

Moen et al performed a comprehensive retrospective study on severe complications following central neuraxial block (CNB) in Sweden. The denominator was estimated from a postal survey to all anesthetic departments, then modified according to commercial records of local anesthetics. To validate the number of CNBs performed relevant registers were consulted - the Swedish birth registry; the hip and knee arthroplasty registers and a national audit of hip fractures. From a denominator of 1,260,000 spinal and 450,000 epidural nerve blocks, there were 127 complications and permanent neurologic damage in 85 patients. Complications occurred more frequently in orthopedic patients (47/127) and in patients who had received epidural anesthesia (EA). To illustrate how infrequently major complications are published, only 17 from 127 complications were the subject of case reports. Hematoma in obstetric cases only occurred with coexisting severe coagulopathy, for example the HELLP (Hemolysis, Elevated Liver enzymes and Low Platelets) syndrome. This resulted in a risk of hematoma following obstetric epidural blockade of 1:200,000. The incidence of epidural hematoma following total knee arthroplasty in female patients was 1:3,600. In the Moen study, in addition to coagulopathy (often pharmacologically-induced) osteoporosis was proposed as an important risk factor (more common in females) and part of a degenerative process contributing to spinal canal stenosis. Spinal canal stenosis combined with continuous epidural blockade is a particular concern and requires a high level of vigilance and postoperative neurologic surveillance. The study detected iatrogenic meningitis (1:44,000) and abscess rarely. In a 1-year nationwide survey in Denmark, Wang et al estimated the incidence of spinal-epidural abscess after EA to be 1:1930. Risk factors were immunosuppression, prolonged duration of catheterization (> 5 days) and delayed diagnosis. The most common organism identified was Staphlococcus aureus. The incidence of abscess in this study was significantly higher than previously appreciated. In a review of neuraxial morbidity at a single hospital, Cameron et al published experience of over 8000 cases. Epidural site infection and pyrexia were triggers for investigation with 20 MRIs performed to diagnose 6 abscesses. The combined risk of abscess or hematoma was 1:1026 patients (95% CI 0.04 – 019%); however only one laminectomy was required, and there were no cases of permanent neurological deficits. Epidural abscess was associated with epidural site infection and fever in 5 out of 6 cases. The low rate of surgical intervention and lack of long-term sequelae were a distinguishing feature of this series. For a comprehensive review of infectious complications of regional anesthesia refer to a recent article by Horlocker. A collaborative effort involving all hospitals in the United Kingdom (UK) National Health Service, recently reported on serious complications of CNB. The article and especially the accompanying report contain substantial detail. The pessimistic and optimistic incidences of paraplegia or death were 1.8 (1.0 – 3.1) and 0.7 (0 – 1.6), n/100,000, 95% Confidence Interval (CI) respectively. The risk of permanent injury following adult perioperative EA was 1:5,800 and 1:12,200 using pessimistic and optimistic incidences respectively. In a large population-based cohort study, propensity scoring was used to remove important baseline differences between two groups of 44,094 patients who received either EA or GA. The incidence of decompressive
Incidence and Etiology of Neurologic Complications in Regional Anesthesia continued...

It is the author’s opinion that neuraxial anesthesia has been subject to more intense scrutiny than any other anesthesia procedure. This scrutiny is understandable given the potential devastating nature of neurologic complications following neuraxial anesthesia. The incidence of serious complications is consistently rare and clearly influenced by patient morbidities with outcome influenced by practice location. A good patient outcome following abscess and hematoma depends on a high level of vigilance, early diagnosis, and prompt treatment. Neuraxial catastrophes may be associated with organizational and professional failures. The obstetric population is the safest, while the aged, comorbid orthopedic surgical population appears to represent a higher risk group.

Peripheral nerve blockade

Borgeat et al documented the incidence, etiology and evolution of paresthesia, dysesthesia or pain not related to surgery following interscalene block (ISB) and shoulder surgery. The proportion of patients with symptoms reduced over time (14% at 10 days, 7.9% at one month, 3.9% at 3 months, 0.9% at 6 months, and 0.2% at 9 months postoperatively). Important diagnoses were sulcus ulnaris syndrome, carpal tunnel syndrome and complex regional pain syndrome. Liu et al compared nerve stimulator with ultrasound guided ISB in a randomized controlled trial and found a similar incidence of postoperative neurological symptoms. Auroy et al used voluntary reporting and a telephone hotline service offering expert advice to estimate the incidence of major complications of regional anesthesia in France. The incidences of block related neuropathy were 2.9 (0 – 14.5), ISB; 1.8 (0 – 6.3), axillary block; 2.9 (0 – 7.8), femoral block and 2.4 (0 – 8.2), sciatic block [n/10,000, 95% CI]. From a total of 50,000 PNB there were 12 neurologic complications and 7 had sequelae at 6 months. The Australasian Regional Anaesthesia Collaboration collected data on a total of 6950 patients who received 8189 PNB. Of the 6950 patients, 6069 patients were successfully followed up. In these 6069 patients, there were a total of 7156 PNB forming the denominator for late neurologic complications. Thirty patients (0.5%) had clinical features (paresthesia 22, pain 4, motor 3 and none 1) meeting the criteria for neurologic assessment. Three of the 30 patients had a block-related nerve injury, giving an incidence of 0.4 per 1000 blocks (95% confidence interval, 0.08-1.1:1000). The remainder of the 30 patients had patient-related etiologies (cervical spine degeneration, ulnar entrapment, carpal tunnel syndrome, lumbar canal stenosis, diabetic and peripheral neuropathies, n = 9), surgical etiologies (swelling, direct trauma, peroneal injury, n = 7), or anesthesia was excluded as the cause (n = 9).

Anatomical, patient, surgical and anesthetic factors

The attachments of the brachial plexus together with the high ratio of neural to connective tissue in its proximal components may place it at risk of stretch or compression injuries. It is therefore not surprising that neurological sequelae after ISB and shoulder surgery are not uncommon, but fortunately most neurologic features resolve with time. Surgical patients may have a preoperative subclinical neuropathy that becomes clinically-evident in the postoperative period. Entrapment neuropathies may involve the ulnar, median, lateral femoral cutaneous nerves, or proximal nerve roots. The ulnar nerve is particularly vulnerable at the elbow, and its course through the superficial postcondylar groove and cubital tunnel place it at risk of compression. Flexion of the elbow and pronation of the forearm places the nerve at increased risk. Risk factors for ulnar neuropathy include male gender, extremes of body habitus and prolonged admission. Postoperative forearm and wrist swelling may induce an acute median nerve neuropathy or exacerbate existing carpal tunnel syndrome. Spinal canal stenosis is relevant to peripheral nerve injury (PNI) in that its severity may be asymmetrical and may exaggerate what may have otherwise been a mild deficit. Intrinsic peripheral neuropathies have many causes including diabetes, vascular disease, chemotherapy and other metabolic etiologies. Smoking and medical conditions such as diabetes and hypertension adversely impact the caliber and function of the small blood vessels that supply nerves. An editorial written by Hebl that accompanied a case report of brachial plexopathy after ultrasound-guided ISB in a patient with multiple sclerosis highlighted important factors relating to neurologic complications associated with PNB. The main message was that PNI often originates from multiple sources and that patient,
surgical, and anesthetic factors may all be contributory in determining outcome. In addition, distinguishing between these factors may be difficult if not impossible for a given case.

Surgical procedures have a native risk of nerve injury and this has been highlighted in recent studies. During major orthopedic surgery, patients are placed in positions they would not normally tolerate if not anesthetized. Further, tourniquet neuropathy can cause nerve damage either by ischemia or mechanical deformation with damage greatest at the edge of the tourniquet and the fast conducting myelinated fibers the most vulnerable. The risk of regional anesthesia has been examined recently in the context of total knee arthroplasty in 20-year cohort study.17 During the time period of the study, there was a substantial increase in utilization of PNB; however there was no change in the incidence of PNI. PNI within 3 months of TKA was not associated with PNB or anesthesia type. PNI risk was increased with age and tourniquet time.

Mechanisms of nerve injury related to regional anesthesia include direct toxicity of local anesthetics (concentration and time dependent) and mechanical trauma from the needle and/or injectate.18 A cadaver sciatic nerve model has indicated that as few as 3% of fascicles may be injured during deliberate intraneural injection.19 The clinical implications of this and other experimental models (e.g., animal) are unknown and of note no deliberate human intraneural model incorporating histological analysis will be possible. Peripheral nerve injection injury has been studied recently in a rodent model and demonstrated that even extrafascicular injection of ropivacaine caused marked histologic abnormalities, although not as severe as intrafascicular injection.20

In summary, postoperative neurologic sequelae following PNB are not infrequent and most resolve. The incidence of serious neurologic complications related to PNB is infrequent or rare. Distinguishing and determining the relative contribution of each of those factors is challenging. PNI frequently have patient, anesthetic and surgical etiologies with evidence mounting that support its complex and multifactorial etiology.

References
3. Cameron CM, Scott DA, McDonald WM, Davies MJ: A review of neuroaxial epidural morbidity: experience of more than 8,000 cases at a single teaching hospital. Anesthesiology 2007; 106: 997-1002

American Society of Regional Anesthesia and Pain Medicine
2012
Save the Date!

11th Annual ASRA Pain Medicine Meeting
November 15-18, 2012 • Miami, FL • Fountainebleu Hotel

Visit http://www2.kenes.com/asra/Pages/Home.aspx for up-to-date information and highlights.

Tailor Your Curriculum
The ASRA Fall meeting will allow participants to tailor their educational experience and select content based on their individual needs, by registering for any of the following:

- Exam/Demonstration Workshops
- Hands-On Workshops (Cadaver and/or Model)
- Special Session Workshops (full and half day)
- Lunchtime Problem Based Learning Discussions (lunch included)
- Breakfast Interactive Sessions (breakfast included)
- Primary Care Track
- Residents Program