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The Cost of Doing Business

Over the past two years, the ASRA Board of Directors has been committed to improving transparency with regard to the Society’s inner workings. While it would be incorrect to surmise that past ASRA leadership has consciously withheld information from the membership, nonetheless, we have not been terribly effective in explaining organizational details – most of which even we Directors were unaware of until we began our service on the Board. This theme of transparency is perhaps even more apropos as part of the 2014 Year of the Member Initiative – what could be more relevant to the member than the frequently heard question: “Why does everything cost so much?” This quarter’s President’s Message will attempt to bring some clarity to the two financial transactions that most impact the individual member – meeting registration and society dues – and conclude with an overview of what actually happens with all of your money.

Attending an ASRA annual meeting is expensive. An ASRA member who registers early for the upcoming fall Pain Medicine meeting in San Francisco and attends a workshop and a problem-based learning discussion lunch will spend about $1000. With fees like that, ASRA must be making out like a bandit, right? Well, not exactly. Compared to like organizations, the Society’s cost per hour of continuing medical education (CME) credit places it in the middle of the pack – about $28/credit hour in 2012. Since then, ASRA has actually reduced most workshop fees twice and only slightly increased the base registration fee. Yet these fees do not begin to cover the meeting’s actual cost – the ~$460,000 in registration fees that ASRA collected from the just over 1000 participants at the recent spring meeting in Chicago covered only 60% of that meeting’s cost. Indeed, the costs of our annual meetings are mind-boggling. For instance, at the spring 2014 meeting, audiovisual services were well in excess of $100,000 and we spent over $15,000 for workshop models and roughly the same amount for credit card service charges. That Diet Coke you drank at the break – it was invoiced to ASRA at about $7.50 – a real bargain compared to the cost of the cookie! Some members ask why industry cannot pay for the meeting? The full answer is complicated, but suffice it to say that budgetary cutbacks on the part of pharmaceutical and device makers, coupled with ever-increasing scrutiny regarding conflict of interest and expenditure-reporting to federal agencies severely limit outside support of our meetings. Nevertheless, exhibits and grants significantly offset the Society’s expenses, and we clearly could not stage our annual meetings without industry support. In the end, our bottom line for ASRA’s 2012 and 2013 spring and fall meetings varied between a $115,000 loss and a $160,000 profit. I will explain shortly where that profit went.

What about dues? The Society’s dues have remained relatively stable over the past few years. At $225 for an active member, ASRA’s annual dues are at the lower end of major United States anesthesiology societies. When you toil a few hours to pay your annual dues, are you getting value for the expenditure? We hope so, considering the benefits – print and electronic versions of Regional Anesthesia and Pain Medicine, the quarterly ASRA News, substantially reduced base registration fees at the annual meetings, and weekend ultrasound/cadaver workshops, etc. Moreover, we hope that you find value and pride in the integral role that your membership plays in fulfilling ASRA’s mission of education and research in our subspecialties.

The ultimate value of your membership is perhaps best judged in light of how the Society spends your money and what happens with our operating margin, which averaged slightly over $300,000 during the five-year period from 2009-2013. If you were to look at ASRA as a business, we were a $2.9 million dollar company in 2013. Our revenues were primarily derived from member dues (25%) and meetings (50%), with the remaining coming from a variety of sponsorships, journal royalties, and other sources. As illustrated in Figure 1, 38% of the Society’s expenses went toward administering ASRA – paying our management partners and operating the day-to-day business. The remaining 62% of your Society’s money supported our mission of education and research. Approximately half of total operating revenue was spent on education – about 4% to purchase your journal subscriptions and the rest to supporting the costs associated with the annual meetings and workshops. Meeting expenses include that expensive glass of iced tea at the break, but also the costs associated with tracking and awarding...
Fall Meeting Preview

It is with much excitement that I am writing to you regarding the 13th Annual Pain Medicine Meeting taking place in San Francisco on November, 13-16, 2014. The Scientific/Education Planning Committee with the assistance of the ASRA Board of Directors and CME Committee, chaired by Dr. Terese Horlocker, have dedicated an extensive amount of time in developing and executing the scientific program. The “final” product demonstrates this effort with the creation of a scientific program that presents a platform where knowledge and experience can be shared with world-renowned experts.

The meeting starts off with refresher course lectures covering crucial topics required for the advancement of pain medicine. The first lecture by Dr. Linda Watkins will cover neuropathic pain with an update on the role of the glial cell in the development and maintenance of neuropathic pain. Dr. Watkins has published extensively on the role of the glial cell. Dr. Sriniwasa Raja will discuss the updated neuropathic pain treatment guidelines. The spine and discogenic back pain lectures by Drs. Alexander Vaccaro and Jon Lurie will illustrate the current understanding of the pathophysiology and treatment of degenerative disc disease with an emphasis on the future of molecular, gene, and cell-based therapies. Pain practitioners will also be provided with an in-depth look at the evidence for surgery for spine conditions as reported from the Spine Patient Outcomes Research Trial (SPORT). An update on complex regional pain syndrome will be provided by Drs. Gary Brenner and Steven Cohen. The field of neuromodulation is bright and significant advancements are occurring with the development of new technology and with our understanding of the mechanism of action. The refresher course lectures on neuromodulation by Drs. José De Andres (President of ESRA), Ricardo Vallejo, and Timothy Deer (President-Elect of the International Neuromodulation Society) will further define the anatomy and the mechanism of action of neuromodulation. A look into the future of neuromodulation will be provided with discussion on high-frequency, burst, and dorsal root ganglion (DRG) stimulation. The day will conclude with a discussion led by Drs. Sean Mackey and John Carrino on neuroimaging based pain detection. Dr. Hank Greely, the Director of the Center for Law and the Biosciences at Stanford University, will explore the legal implications of neuroimaging.

On Friday, Saturday, and Sunday, parallel sessions will cover interventional and non-interventional topics including financial and clinical decision-making for spine care, cancer pain, the future of education and publishing in pain medicine, implantable pain devices, headache, neck and facial pain, and improving interventional outcomes before-and-after placing a needle, office based opioid and substance abuse management, and medical marijuana for pain. The parallel sessions will be led by pain experts including such speakers as Drs. Oscar De Leon Casasola, Juan Francisco Asenjo, Marc Huntoon (Editor of Regional Anesthesia and Pain Medicine), Joseph Neal (President of ASRA and previous Editor of Regional Anesthesia and Pain Medicine) Robert Jamison, and Nagy Mekhail. The medical marijuana session will provide insight into the basic science, healthcare policy, and clinical evidence for the utilization of marijuana for pain management. We are fortunate to have Drs. Mark Wallace, Marcel Bonn-Miller and Mark Ware. Dr. Mark Ware from McGill University, the Executive Director of the Nonprofit Canadian Consortium for the Investigation of Cannabinoids, will provide input on the Canadian perspective. In the update on interventional pain care session, Dr. Samer Narouze will present the new anticoagulation guidelines for interventional pain management.

Three plenary sessions will occur covering “must know topics” including musculoskeletal ultrasound, the appropriate utilization of opioids and the FDA Safe Use Initiative Epidural Steroid Injection Working Group Recommendations. The musculoskeletal ultrasound interventional and diagnostic plenary session on Friday entitled “Using Vision to Help Make Decisions” will provide insight on the use of ultrasound for assessing and treating the musculoskeletal system. The session will end with a live demonstration of musculoskeletal ultrasound scanning protocols for common joints. International experts will lead this session including Drs. Samer Narouze, Vincent Chan, Marko Bodor, Philip Peng, and Levon Nazarian (Editor for the Journal of Ultrasound in Medicine). On Saturday, the plenary session entitled “The Challenges with Opioids in Chronic Pain Management” will serve to provide a...
On behalf of the ASRA Resident Section Committee, we welcome and encourage all residents and fellows to attend the 13th Annual ASRA Pain Medicine Meeting from November 13-16, 2014, in San Francisco, California. The conference will feature several interactive discussions and hands-on workshops led by many of the leading experts in the field of Pain Medicine. It will also provide unique networking opportunities for all those considering fellowship training or seeking potential career opportunities.

We have planned an informative, interactive, and educational two-day program planned specifically for you. During the course of the program, you will learn more about your future careers, refine your procedural dexterity, and interact with distinguished faculty. The scheduled program will provide you with expert opinions and valuable advice about the fellowship application process, the transition to becoming an attending, the selection of private vs. academic practice, the pearls of appropriate practice management implementation, and the management of the difficult chronic pain patient population. Following an introductory lecture series given by world-renowned experts, you will also participate in physician-guided procedural workshops using fluoroscopy and ultrasound guidance on live models to practice and enhance your current skills. During the evenings, you will be able to gather information about various fellowship programs and meet with fellowship directors and potential future employers at the ASRA Get Together reception and annual career fair.

Along with the Resident and Fellow Educational Program, Dr. Provenzano and the Scientific/Education Planning Committee have planned a remarkable conference program, which you are all highly encouraged to attend as well. The program will provide you with vital information that is not typically provided during your training, and it will certainly help guide your future paths as pain medicine physicians. For instance, at this conference, you will have the unique opportunity to attend a presentation on the current status of opioid therapy and diversion given directly by a representative from the United States Drug Enforcement Agency!

We look forward to seeing you in San Francisco and ask that you please help spread the details of our meeting and program to your respective program’s residents and fellows.
This issue of *ASRA News* features the upcoming Fall Pain Medicine annual meeting chaired by Dr. David Provenzano. Drs. Provenzano and Doshi provide us with an overview of the meeting’s highlights and resident/fellow events that will be sure to appeal to trainees and pain medicine practitioners of all experience levels. In addition to the amazing educational offerings, this year’s Fall Pain Medicine meeting also happens to be in my “neck of the woods”—one of the greatest cities in the world—San Francisco, California. Here are a few things you may or may not have known about San Francisco.

San Francisco is the biggest little city. At just under 47 square miles and with more than 200,000 inhabitants, San Francisco is second only to New York City in terms of population density. Despite its relatively small size, “the City” (as we suburbanites refer to it) consists of many small neighborhoods, each with its own charm and character: Union Square, the Financial District, Pacific Heights, the Marina, Haight-Ashbury, Chinatown (Figure 1), Little Italy, Nob Hill, Russian Hill, SoMa (South of Market), the Fillmore, Japantown, Mission District, Noe Valley, Twin Peaks, Castro, Sunset, Tenderloin, and others. For this reason, San Francisco may arguably be the only option for die-hard New Yorkers who wish to relocate away from snow.

“San Francisco is the biggest little city”

Edward R. Mariano, M.D., M.A.S.  
Editor  
Follow me on Twitter @EMARIANOMD!
Even though it doesn’t snow, San Francisco weather is incredibly unpredictable, even when going from one side of the city to the other. “The coldest winter I ever spent was a summer in San Francisco,” a quote often mistakenly attributed to Mark Twain (no one really knows who actually said it), is nevertheless often true. Here in the San Francisco Bay Area, our local meteorologists provide daily forecasts for each of the region’s microclimates. The western side of the City along California’s coast is regularly plagued with fog while the eastern side of the City tends to be sunny most days of the year. It’s always a good idea to check the microclimate forecast before heading over to see the Golden Gate Bridge just in case it happens to be shrouded in fog. Also, average July temperatures in the City range in the 50s-60s Fahrenheit (no different than average November temperatures), so summer tourists often contribute to the local economy by buying “SF” logo sweatshirts for their walk across the City’s most famous bridge.

San Francisco is very family-friendly. If you’re debating whether or not to make a family trip out of the Fall Pain Meeting, my advice is to do it. Right around the conference hotel, the Hyatt Regency San Francisco, there are a number of attractions and events worth checking out. Every Saturday there is a huge farmers market at the Ferry Building across the street from the hotel (Figure 2). As you probably figured out, from the Ferry Building you can also take a ferry ride to a number of other destinations in the Bay Area (I recommend Sausalito, a short trip that takes you past Alcatraz). For kids, there are 3 parks within walking distance, the San Francisco Railway Museum, Exploratorium, and the cable car turnaround at Powell and Market Street; trips to Fisherman’s Wharf or the aquarium are a short taxi or cable car ride away. In addition, runners will love running up and down the Embarcadero which gives you a view of the Bay Bridge (Figure 3) and takes you past the City’s many piers; shoppers will be in heaven; and foodies have an impossible decision to make when choosing the location for every meal (try Slanted Door at the Ferry Building at least once).

Enough about San Francisco—you’ll have to see it for yourself. In addition to the Fall Pain Medicine meeting previews, this issue of ASRA News also includes fantastic original content covering the topics of digital subtraction angiography, pain outcomes, ASRA’s first entry into the app market, and much more. Enjoy!

We can focus our time and efforts on caring for our patients, instead of searching for information.

AS anesthesiology resident at the largest public hospital in America, I cannot emphasize enough the time and energy the ASRA COAGS© app has saved me and my busy co-residents. There have been many occasions in which I have found myself discussing the proper timing of anticoagulation and regional anesthesia with residents and attendings, especially for patients on less commonly used medications. And every time, we revert to doing an internet search for the most recent ASRA Guidelines.

While the risk of a bleeding complication is relatively low, the neurologic consequences can be profound and life-changing. And for this reason, we want to make educated, evidence-based decisions concerning anticoagulation and interventional procedures. In light of this effort, ASRA has provided easily accessible guidelines in order to assist anesthesia providers to take all possible precautions for prevention.

The ASRA COAGS© app offers a user-friendly, aesthetically-appealing platform to quickly reference the current recommended guidelines for placement of blocks in patients receiving anticoagulation.

The app allows you to choose from three different scenarios in which you may find yourself: neuraxial block, deep plexus/peripheral block, or superficial peripheral block. Once you choose your specific scenario, the app will give you the medication’s mechanism of action and management advice for placing a block, restarting anticoagulation and catheter removal. Not only that, the app also gives the user easy access to the full 2010 ASRA practice advisory.

For only $3.99, this easy resource can be used by even the most technologically-challenged practitioner and can make all the difference for our patients. With it, anesthesiologists can reliably make evidence-based decisions about invasive procedures based on our patient’s coagulation status. And finally, we can focus our time and efforts on caring for our patients, instead of searching for information.

ERRATUM

With regard to the article “Opioids for Chronic Pain: Damned If You Do, Damned If You Don’t” by Dr. Silverman published in the May 2014 issue of ASRA News, with reference to the case of Vasa v. Compass Medical, the employee killed was Dr. Mark Vasa (not Michael Vasa) who was employed by the hospital as a radiation oncologist.
ASRA has published the gold standard in recommendations on the use of regional anesthesia in patients on anticoagulation and antithrombolytic medications with the most recent practice advisory being published in 2010 (Regional Anesthesia in the Patient Receiving Antithrombotic or Thrombolytic Therapy - American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines - Third Edition). This is the most viewed document on ASRA’s website, and it impacts providers on a regular basis. However, since the publication is nearly 40 pages long, utilizing the content in real-time can be difficult in the clinical environment.

Many clinicians often create tables or note cards that consolidate the information into a usable format, but this is often created ad hoc by the clinician or the institution; several published forms that can be found on the internet contain errors. Therefore, we ventured to create an electronic application (app), one that was validated by the authors of the Practice Advisory committee and could be readily updated with push technology when new information was available. The goal was to make an interactive searchable experience for the clinician that

Figure 1: ASRA Coags© iOS app icon.

Figure 2: User interface within ASRA Coags© app, including search field, recommendation, and full text recommendations.
Anticoagulation in Regional Anesthesia Practice Advisory

provides a consolidated version of the Practice Advisory and one that could be utilized quickly and accurately. This app, ASRA Coags©, is now available on the Apple iTunes Store for iOS devices (Figure 1).

Within the app user interface (Figure 2), the clinician is presented with a search box and list of the medications discussed in the 2010 guidelines, including the ability to search for both United States trade names and generic names of medications. Once a medication is selected, the user is presented with the option to choose either neuraxial procedure, deep peripheral nerve block, or superficial nerve block. The next option presents the stage of the procedure the clinician is asking about: before placement of a block, restarting the medication while a catheter is in place, stopping a medication before pulling a catheter, or when to restart a medication after the catheter is pulled. Each option presents the proper recommendation based on the 2010 Practice Advisory.

In addition, to facilitate clinicians’ using their own clinical judgment and interpretation, we have embedded either the full text of the Practice Advisory Executive Summary for the selected medication’s relevant section and even the entire PDF of the full Practice Advisory.

By taking advantage of the collaboration between academic Regional Anesthesiologists at Vanderbilt, the authors of the ASRA Practice Advisory, and programming skills of Mustard Seed Software (Charleston, SC) (Figure 3), we have been able to create an accessible and easy-to-use electronic decision support tool for a challenging and clinically-important situation that arises frequently. Also, a multi-institutional trial investigating the effects of this app on adherence to the ASRA guidelines has recently been completed. Results are promising and will be forthcoming in published form later this year.

The most exciting future plans for this app are to incorporate the upcoming Fourth Edition Practice Advisory information directly into the app and to develop an Android version to extend the availability of this app to more users. We’re excited to make this available to the medical community and hope it provides a tool for better clinical care and patient safety.
CNS INJURIES AFTER EPIDURAL STEROID INJECTIONS

A retrospective review showed the overall safety of epidural steroid injections (ESIs). A 2.4% minor complication rate including pain and numbness was noted with interlaminar (IL) injections (6%) vs. the transforaminal approach (2.1%) in 103 of 4265 ESIs. Complications after cervical IL injections included vasovagal episodes, facial flushing, headache, dural puncture, and paraplegia from spinal hematoma. In the latest Closed Claims study, central nervous system (CNS) injuries after cervical IL ESIs included trauma to the spinal cord or nerve root, cord infarction or stroke after intraarterial injection, dural puncture, hematoma, and infection. It was noted that fluoroscopic guidance was used in 67% and contrast in 57% of the claims. After a careful review of the cases, Rathmell and colleagues concluded that the appropriate use of radiographic guidance would have prevented injury in 49% of the claims of spinal cord injury after cervical procedures.

Paraplegia after TF ESIs has been attributed to embolism caused by particulate steroid. The possible route of embolization includes the following arteries: a) segmental radicular artery accompanying the nerve root; b) ascending cervical and deep cervical arteries which are close to the cervical intervertebral foramina and also anastomose with the vertebral artery and the anterior spinal artery through segmental medullary arteries; c) artery of Adamkiewicz through its variable and aberrant origins; and d) sacral radicular arteries which follow each root of the cauda equina and connect with the ansa communications at the conus which in turn connects with the anterior spinal artery. The last set of arterial communications explains the occurrence of CNS injuries with S1 TF ESIs. For IL ESIs, the route of the embolus can be through the radiculomedullary artery in the lateral or midline posterior epidural space. The radiculomedullary arteries have been noted to enter the neuroforamina then travel superiority and laterally in the lateral epidural space joining the anterior spinal artery. Indeed, a cadaver study showed the presence of a posterior branch of the radiculomedullary artery supplying the dorsal aspect of the cauda equina.

INCIDENCE OF INTRAVASCULAR INJECTION AFTER EPIDURAL INJECTIONS

Prospective studies showed the incidence of intravascular injection to be 1.9% after lumbar IL injection, 10.8-15.5% after lumbar TF injections, and 10.9% after caudal injections. In one study, the authors noted the failure of blood aspiration in 74% of cases that proved to be intravascular. The sensitivity and specificity of the presence of blood, either spontaneously or after aspiration, was 44.7% and 97.9%, respectively. The incidence of intravascular

Figure 1: Serial images showing angiogram after contrast injection (A). The radicular artery is barely visible after contrast injection under live fluoroscopy (B) but is clear with DSA (C). From Rathmell JP, Aprill C, Bogduk N. Cervical transforaminal injection of steroids. Anesthesiology 2004;100:1595-1600 (reprinted with permission).
DSA SHOULD NOT BE USED ROUTINELY

Neuraxial delivery of corticosteroid or local anesthetic is generally well tolerated with a low incidence of serious complications. Still, adverse outcomes of irreversible paraplegia, stroke, and death have been reported from these interventions. Digital subtraction angiography (DSA) has been touted as an adjunct to interventional procedures to identify peri-injection vascular compromise.

DSA has emerged as a supportive measure and has demonstrated greater accuracy in detecting intravascular injections compared to aspiration and live fluoroscopy.\(^1\)\(^-\)\(^3\) DSA is commonly used as a safety measure in high-risk procedures such as cervical transforaminal epidural steroid injection (TFESI), or may be useful in clarifying an abnormal or unexpected flow pattern observed on live fluoroscopy (Figure 1). In a study of 134 patients, Mclean et al compared real-time fluoroscopy vs. DSA during 177 cervical TFESI. Intravascular injection was detected in 18% of real-time fluoroscopy cervical TFESIs vs. 32.8% when DSA was used (P = 0.0471).\(^1\) All of the vascular angiograms identified by both live fluoroscopy and by DSA were venous in origin.\(^1\) In one prospective study of vascular flow detection rate in lumbosacral TFESI, Lee et al performed 60 lumbar and 20 S1 TFESI and found 20 cases of intravascular injection (11 at S1, and 9 in the lumbar spine) utilizing DSA vs. real-time fluoroscopic guidance, predicting 12 of the 20 instances.\(^2\) These authors did not distinguish between arterial and venous uptake but conceded that “the majority of these vascular injections were venous” with a statistically-significant higher rate at S1.\(^2\) In a recent study by El Abd et al, these authors also evaluated the rate of detection of vascular uptake observed by DSA that is missed with traditional safety precautions, including live fluoroscopy. Of the 150 consecutive patients undergoing 222 TFESI in the cervical, lumbar, and sacral levels, 46 had evidence of intravascular flow patterns with live fluoroscopy with contrast, and DSA identified an additional 5 vascular venograms not identified on live fluoroscopy.\(^3\) DSA may detect inadvertent venous injection at a higher rate than live fluoroscopy, but there is less robust evidence that DSA enhances recognition of arterial flow.

DSA cannot reliably prevent adverse outcomes in neuraxial procedures (Table 1). DSA is limited by motion artifact with recognition subject to human interpretation. Any motion between the scout film and subsequent images will impair the subtraction process, causing degradation of image quality. Utilization of this technology does not negate the potential for human error. The

**“DSA cannot reliably prevent adverse outcomes in neuraxial procedures”**

Figure 1: Anterior-posterior view of a C6-7 cervical transforaminal epidural steroid injection: (A) conventional fluoroscopic exposure; (B) digital subtraction view.\(^2\)

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Pain is a subjective experience; therefore, unlike other chronic diseases, there is no single objective measurement to best characterize the extent of the problem or to evaluate treatment outcomes. Measuring a patient’s pain must correlate objective data with the patient’s subjective reporting to provide a comprehensive outcome representing the pain state. Complicating the measurement of pain is that there is often wide variability in how much pain a given stimulus or injury will cause. This variability is influenced by genetics, mood, beliefs, early life experiences with pain, sex, ethnicity, and other factors.

Chronic pain is often associated with an overall reduction in the patient’s quality of life, encompassing domains such as depression, anxiety, impaired social and physical function, and sleep disturbance. Moreover, there appears to be relative independence between pain and these co-existing stressors. Therefore, to capture the pain experience, it is necessary to also define and characterize these related domains. Recognizing that pain is challenging to accurately measure, why then must we strive to better evaluate outcomes in pain medicine? Current practice relies on evidence-based medicine to support clinical decision-making and to convince colleagues, patients, and payers of the most efficacious treatments. Standardization of outcome reporting will therefore allow for comparison and systematic review of the studies that do exist to help to answer the most pressing questions in the field of pain.

CONSIDERATIONS IN SELECTING AN OUTCOME MEASURE

Any tool used to measure pain should be appropriate for the provider and patient needs. It is of little use to have a patient fill out multiple forms if the provider lacks the staff or infrastructure to utilize the data. In defining a standard set of outcome measures, the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) consortium granted most weight to the following criteria:

A) **Reliability**—The instrument should demonstrate test-retest, inter-rater and internal reliability.

B) **Validity**—The scale should measure what it is intended to measure.

C) **Responsiveness**—The scale must display the ability to detect changes over time and to distinguish between treatments.

D) ** Appropriateness**—The scale’s content should be in keeping with the measured outcome and relevant to the patient population being studied.

E) **Burden**—The scale should be easy to administer, complete, and score.

**UNIVARIABLE MEASURES**

Unidimensional scales measure pain as a single quality varying only in intensity. These methods are most effectively used in clinics and acute settings. Examples include:

- **Verbal Rating Scale (VRS).** VRS consists of a series of categorical descriptors ordered in increasing intensity (i.e., none, mild, moderate, severe). The advantages of the VRS are that it is easy to administer and report, particularly for elderly patients. Disadvantages are that it has fewer response choices, and the categorical options limit statistical analysis. It has demonstrated ability to distinguish treatment effect, test-retest reliability, and convergent validity.

- **Visual Analog Scale (VAS).** VAS is typically a 10 cm line anchored by “no pain” at one end and “worst pain” at the other. The patient marks a point on the line, and the clinician measures the length of the line on a 101-point scale. The advantages of the VAS are that there is good evidence for responsiveness, validity, test-retest reliability, and scores can be treated as ratio data. The limitations are that it can be more time-consuming, and elderly people may have difficulty using the scale.

- **Numerical Rating Scale (NRS).** NRS is the most frequently used univariable instrument. It consists of a rating scale from 0 to 10 (or 0 to 100 in some versions). Patients may respond verbally or by circling the appropriate number. It demonstrates sensitivity to change, test-retest reliability, and correlates well with other measures of pain intensity. The NRS is recommended by IMMPACT as a core domain measure for future chronic pain clinical trials.

- **Patient Global Impression of Change (PGIC).** PGIC represents an attempt to capture pain improvement more broadly using a single item measure. The patient is asked to rate his/her current status compared to a prior time point (i.e., very much improved). This scale is applicable to many conditions and treatments but lacks sensitivity. It is recommended by IMMPACT as a core domain measure and can be particularly helpful in gauging the clinical importance of changes.
EMOTION MEASURES

Clearly, there is a relationship between pain and emotional distress; there is also evidence of relative independence. Measurements of depression include the Patient-Reported Outcomes Measurement Information System (PROMIS) — Depression Item Bank,12 Beck Depression Inventory (BDI),13 Zung Self-Rating Depression Scale,14 and Hamilton Rating Scale for Depression.15 Anxiety and fear measures include the PROMIS — Anxiety Item Bank [12], Pain Anxiety Symptoms Scale,16 State-Trait Anxiety Inventory,17 and Fear-Avoidance Beliefs Questionnaire (FABQ).18

MULTIDIMENSIONAL MEASURES

Chronic pain requires a more comprehensive assessment than a univariable or single domain measure can provide. Multidimensional measures often combine several dimensions of pain, disability, emotional affect, and effect on quality of life into a single instrument. Commonly used scales include:

Brief Pain Inventory (BPI). BPI was developed to measure both intensity of pain and interference in the patient’s life.19 It consists of a 17-item scale that typically takes under 15 minutes to complete. The BPI Interference Scale, in particular, has been validated as a measure of physical functioning in multiple domains and is recommended by IMMPACT as a core HRQoL measure.9

McGill Pain Questionnaire (MPQ). MPQ was developed to specify the qualities of pain.20 Pain is scaled in three dimensions (sensory, affective, and evaluative) with 20 sets of words for each dimension. Multiple studies have supported the reliability and validity of the MPQ for specific pain syndromes.21 The Short-Form McGill Pain Questionnaire (SF-MPQ) was developed for research purposes and consists of 15 words from the sensory and affective categories with a four-point rating scale for each, a pain intensity VAS score, and overall assessment of pain VRS score.22

West Haven-Yale Multidimensional Pain Inventory (WHYMPI). WHYMPI best assesses adaptation to chronic pain.23 It can yield clinically useful information regarding pain coping styles. It is composed of 52 items with 12 subscales. Patients respond to the questions on a seven-point scale. The WHYMPI interference scale correlates with physical functioning and is recommended by IMMPACT as an alternative to the BPI.9

Medical Outcome Study 36-Item Short-Form (SF-36) Health Survey and Treatment Outcomes of Pain Survey. SF-36 is a frequently used measure of function and quality of life.24 It consists of eight subscales; while widely used, it features only two questions related to pain, and there are concerns about insensitivity to change when measuring an individual patient. The Treatment Outcomes of Pain Survey (TOPS) is an extension of the SF-36 specifically designed for patients with chronic pain.25,26 It consists of 120 items with a 61-item follow-up. It has been found to be sensitive to change and have good validity.

OBJECTIVE MEASURES

Several physiologic variables have been suggested as surrogates for pain, including autonomic activity29,30 or biomarkers of pain intensity.31 Caution with interpreting these peripheral measures is urged as they can be influenced by arousal other than pain and can be modulated by medications. Physical function tests, such as range of motion and strength, have been used as proxies for pain;32-34 however, these only modestly predict self-reported pain scores. More recently, attempts to objectively measure pain have focused on using neuroimaging. Indeed, recent studies suggest that brain imaging can be used to objectively distinguish evoked painful stimuli35 and the presence of chronic low back pain.36 Despite these promising early reports, there is still much research to be done to validate its use. Furthermore, given the expense and time involved, it is more likely that neuroimaging will primarily be used to help guide further research and understanding of brain mechanisms involved in pain. All of these data reinforce the complexity of pain and as such, it is unlikely that an objective measure for pain will soon emerge.

CLINICAL TRIALS AND OUTCOMES DATA

In addition to the clinical need to provide and document appropriate care for pain, there is clearly an impetus to provide the evidence necessary to guide and justify appropriate treatments. This has resulted in efforts to define and standardize outcome measures for pain and similar related disease states. IMMPACT has defined six core outcome domains that should be considered when designing clinical trials.37 Further, IMMPACT defines specific validated measures for each of the core outcome domains in IMMPACT-II.3

THE FUTURE OF PATIENT REPORTED OUTCOMES AND CLINICAL REGISTRIES

The National Institutes of Health recently funded PROMIS with the goal of developing modern, valid, reliable, and standardized questionnaires to measure patient-reported outcomes (PROs) that are free to use for the academic community. These assessment instruments were developed to yield item banks measuring domains such as pain, pain interference, fatigue, physical function, depression, anxiety, and social function calibrated against the U.S. Census 2000 population. These banks can be used to produce short forms or computerized adaptive tests for research and clinical use.12 The ongoing second phase of PROMIS focuses on the development of new tools to measure PROs, validation of the current item banks, and updating the calibration against Census 2010 population.

The Institute of Medicine report, Relieving Pain in America, proposed a need for greater development and use of patient outcome registries that can support point-of-care treatment decision making, as well as for aggregation of large numbers of patients to enable assessment of safety and effectiveness of therapies. These registries can help create “learning systems” that will provide clinicians with information about treatment success or failure on an ongoing basis, along with probability “filters” for information that may be particularly useful in the care of an individual patient.
Despite being described for well over one-hundred years, Postdural Puncture Headache (PDPH) remains a common and debilitating problem. The typical patient is young and healthy, caring for young children, and can be debilitated to the point where work or carrying out the activities of daily living is impossible. While an interventional procedure may not always be the appropriate therapeutic modality, regional anesthesiologists and pain specialists are frequently called upon to care for these patients.

To effectively manage patients presenting with a PDPH, the anesthesiologist must first understand the physiology related to headache manifestation. The life-blood of the brain and spinal cord is, in fact, not blood at all. Cerebrospinal fluid (CSF) maintains an idyllic ion and glucose environment that is maintained by a blood-brain barrier and blood-CSF barrier. In addition to providing the nutrients essential for optimal cerebral function, CSF forms a cushion to protect the neuraxis in the event of trauma. The total volume of CSF is 100-150 ml, and it is formed at a rate of 0.3-0.4 ml/hour in the choroid plexus of the cerebral ventricles. Ultimately, CSF flows from the cisterna magna into the cerebral and spinal subarachnoid space until it is reabsorbed by villi in the arachnoid membrane.

PDPH symptoms likely result from downward traction on pain-sensitive intracranial structures or may occur via compensatory intracranial venodilation.

PDPH typically presents within seven days of dural puncture (although evidence also describes positional headaches with spontaneous dural leaks and intracranial hypotension). The headache worsens with assumption of an upright position and improves when supine, is predominately located in the frontal or occipital areas, and may involve the neck or shoulders. Accompanying symptoms may include nausea/vomiting, visual and auditory perturbations, vertigo or backache. Importantly, seizures, intracranial subdural hematomas, cerebral herniation and death have been described as catastrophic outcomes following dural puncture, and the lack of a postural component to the headache should prompt consideration of alternate etiologies.

Predisposing or causative factors for the development of PDPH are numerous, and the avoidance of large, cutting needles likely represents the best opportunity to decrease the incidence of PDPH. Aligning the spinal needle with the fibers of the dura (in the event a cutting needle is utilized), replacing the spinal needle stylet following injection/CSF withdrawal, and performing loss of resistance epidural access techniques with normal saline instead of air all may reduce the incidence of PDPH. Decreasing anesthesia trainee experience with epidural analgesia may be related to an apparent increase in the rate of inadvertent dural puncture in some locations. Decreased patient age (except for children, who are generally thought to be at low risk), low body mass index, history of previous PDPH, and female gender represent unalterable risks for development of PDPH. However, recent evidence suggests that cigarette smokers may be at lower risk for the development of PDPH symptoms.

Fortunately, an overwhelming majority of cases of PDPH spontaneously resolve. In fact, 72% of headaches spontaneously resolve within seven days, and 87% resolve within six months. A multidisciplinary approach including psychological therapy may be of particular usefulness to young patients with refractory symptoms, as they may require assistance understanding reasons for, and appreciating outcomes of, PDPH symptoms. Conservative treatment options of historical interest include bed rest, supine or prone posture and abdominal binders. Unfortunately, none of these has proven to be of any real benefit. Caffeine also appears to have little role in the treatment of PDPH as any effects are temporary, and the doses of caffeine required can be the equivalent of 20 cups of coffee or 30 sodas daily.

Fluid administration, while likely innocuous, has little data to support its routine application at the current time. Analgesics (non-steroidal anti-inflammatory drugs, acetaminophen and opioids) and antiemetics may have a role in the immediate symptomatic management of PDPH patients but have no role in hastening headache termination. A wide array of alternative pharmacologic therapies have been considered in an effort to reduce the need for more invasive therapies (Table 1). Unfortunately, negative results are rarely reported and randomized trials are often lacking.

Epidural blood patch (EBP) is the currently the “gold standard" for treatment of PDPH and results in headache resolution in...
more than 90% of cases. The ideal volume of blood required for successful EBP is not well established, but 16-20 ml is commonly used by anesthesiologists in the United States.27 The epidural blood patch is postulated to work via one of two mechanisms:

1. Formation of a clot or patch at the site of dural puncture and thereby halting the continued leakage of CSF.

2. Hydrostatic mechanism where blood injected into the epidural space causes thecal sac compression and cephalad CSF translocation.

Interestingly, an increased duration of PDPH symptoms (over 24 hours) has been associated with an increased success rate of EBP.3 However, significant prolongation of symptoms may be particularly harmful in the immediate post-partum period when it may impact the maternal bonding process.28 While the complications of EBP are typically mild (backache, paresthesias, EBP failure, and inadvertent dural puncture), a variety of rare but catastrophic outcomes have been reported.29 These include subdural hematoma, arachnoiditis, infected EBP, facial nerve paralysis, and permanent spastic paraparesis.29 True contraindications to EBP typically include those that apply to epidural or spinal anesthesia. Data regarding EBP in patients with HIV or malignancy is limited and predominately discussed in case reports.30-31

Epidural saline, dextran, opioids, or fibrin glue administration have all been described as remedies for PDPH, but mainstream application is limited by lack of data to support their use, potential for adverse outcomes, and/or lack of training.4 Sphenopalatine ganglion block, acupuncture and occipital nerve blockade may represent other potential methods for PDPH symptom alleviation, but evidence is currently lacking to support these interventions.32-34 Surgical therapy may ultimately be required should other measures prove ineffective, and one should not hesitate to refer a patient to a neurosurgeon should repeated EBP fail to result in headache resolution.5

Eradication of PDPH is likely not possible. However, a number of interventions can be attempted to minimize the incidence of this bothersome complication. The initial recommendation of prolonged bedrest now seems unwarranted and potentially dangerous in postsurgical patients. Threading an intrathecal catheter when attempted epidural anesthesia results in an inadvertent dural puncture may hold some promise in decreasing the incidence of PDPH, but great care needs to be exercised in communicating the presence of such a catheter to all healthcare providers (not an acceptable option in thoracic cases).35 In the event of an inadvertent dural puncture with attempted epidural analgesia, minimizing CSF loss also makes intuitive sense (though data definitively linking CSF loss to PDPH presentation are lacking). paramount to PDPH prevention is education and appropriate needle selection. Other physicians are often

### Table 1: Therapeutic agents with reported benefit for PDPH.

<table>
<thead>
<tr>
<th>Treatment Agent</th>
<th>Dosing Regimen</th>
<th>Duration of Therapy</th>
<th>Reported Success</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTH</td>
<td>1 mg IM</td>
<td>Can repeat 24 hours later</td>
<td>Unclearly defined</td>
<td>Collier et al17</td>
</tr>
<tr>
<td>ACTH</td>
<td>1.5 units/kg</td>
<td>30 minutes</td>
<td>2/2</td>
<td>Kshatri et al12</td>
</tr>
<tr>
<td>ACTH</td>
<td>60 units IM, repeated x1 after 24 hours PRN</td>
<td>Single injection in 40/48 patients, 44% of pts with relief within 6 hours</td>
<td>48/48</td>
<td>Gupta et al13</td>
</tr>
<tr>
<td>ACTH</td>
<td>80 mg IM q12 hours</td>
<td>2 days (author describes typical symptom resolution with single dose)</td>
<td>1/1</td>
<td>Ghai et al14</td>
</tr>
<tr>
<td>Cosyntropin</td>
<td>0.5 mg infusion</td>
<td>8 hours</td>
<td>1/1</td>
<td>Carter et al15</td>
</tr>
<tr>
<td>Ergotamine/ Caffeine</td>
<td>1 mg ergotamine/ 100 mg caffeine PO TID</td>
<td>4 days</td>
<td>VAS reduced 67% on day 3</td>
<td>Erol 201116</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>300 mg PO TID</td>
<td>4 days</td>
<td>VAS reduced 99% on day 3</td>
<td>Erol 201116</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>300 mg PO TID</td>
<td>4 days</td>
<td>Significant reduction in PDPH symptoms</td>
<td>Erol 200617</td>
</tr>
<tr>
<td>Hydrocortisone</td>
<td>200 mg IV x1, then 100 mg IV TID</td>
<td>2 days</td>
<td>Headache intensity reduced from 9.2 to 0.63 on day 2</td>
<td>Ashraf et al18</td>
</tr>
<tr>
<td>Methergine</td>
<td>0.25 mg PO TID</td>
<td>3 days</td>
<td>24/25</td>
<td>Hakim et al19</td>
</tr>
<tr>
<td>Mirtazapine</td>
<td>30 mg PO QHS</td>
<td>4 days</td>
<td>1/1</td>
<td>Sheen et al20</td>
</tr>
<tr>
<td>Pregabalin</td>
<td>50 mg TID</td>
<td>3 days (BID dosing continued until day 5)</td>
<td>2/2</td>
<td>Zencirci21</td>
</tr>
<tr>
<td>Sumatriptan</td>
<td>6 mg SQ</td>
<td>Sumatriptan therapy repeated PRN in two patients</td>
<td>4/6</td>
<td>Carp et al22</td>
</tr>
<tr>
<td>Sumatriptan</td>
<td>6 mg SQ</td>
<td>Patients assessed at one hour for headache resolution</td>
<td>1/10</td>
<td>Connelly et al23</td>
</tr>
<tr>
<td>Theophylline</td>
<td>200 mg IV x1, repeated 4 hours later PRN</td>
<td>Infusion over 40 minutes</td>
<td>VAS score reduced 59.1% relative to control group</td>
<td>Ergün et al24</td>
</tr>
<tr>
<td>Tramadol</td>
<td>50 mg PO q6 hours</td>
<td>7 days</td>
<td>1/1</td>
<td>Stephenson et al25</td>
</tr>
<tr>
<td>Tramadol</td>
<td>50-100 mg PO q6 hours</td>
<td>7 days</td>
<td>6/6</td>
<td>Barodka26</td>
</tr>
</tbody>
</table>

Continued on page 23

American Society of Regional Anesthesia and Pain Medicine 2014
Local anesthetic systemic toxicity (LAST) is an unpredictable event that can turn a routine nerve block into a life-altering experience for both patient and physician. Fortunately, we are now learning to better manage these occurrences, improving the safety of regional anesthesia along the way. The ASRA Working Group on LAST published several papers and a practice advisory in 2010 summarizing the history, clinical presentation, prevention, models and treatment of LAST, based on expert opinion and laboratory findings. 1-3 These papers emphasize that LAST has a unique pathophysiology, distinct from those addressed by ACLS guidelines. We review here aspects of LAST physiology and treatment that distinguish it from other forms of circulatory shock.

CARDIOVASCULAR INSTABILITY
Much of LAST management focuses on cardiovascular symptoms. Early signs include hypertension and tachycardia which reflect CNS excitation, followed by contractile depression and arrhythmias, which can progress to cardiac arrest that typically resists ACLS measures. 4 Recent evidence shows that local anesthetics, particularly bupivacaine, cause a multimodal form of toxicity via inhibition of ionotropic signaling (e.g., voltage-gated sodium channels, potassium channels, calcium channels), metabotropic signaling (e.g., beta-adrenergic receptor), and mitochondrial metabolism (e.g., oxidative phosphorylation). 5-8

High quality BLS and ACLS are the cornerstone of resuscitation for all causes of cardiac arrest, avoiding vasopressin, limiting epinephrine dose, and administering intravenous lipid emulsion (ILE). 1 We present here the logical basis for these distinctions and other relevant treatment differences, noting that recommendations are likely to evolve further as new evidence emerges.

EPINEPHRINE
Animal models show mixed results for the efficacy of epinephrine in LAST but generally demonstrate that it restores blood pressure rapidly, although not always in a sustained manner. These trials also demonstrate that epinephrine is highly arrhythmogenic, worsens arterial pH and may impair the efficacy of lipid infusion (Figure 1). 10-13 Because these undesirable effects are dose-dependent, we currently advise that if epinephrine is used, it should be administered in incremental doses of <1 mcg/kg each. Notably, the standard 1 mg bolus dose of epinephrine (~15 mcg/kg) has not been shown to improve survival to outcome following out-of-hospital cardiac arrest. 14

Figure 1: Rate-pressure product (RPP, a surrogate for cardiac output) versus epinephrine dose in a rat model of bupivacaine toxicity, at the 15-minute time point. At 15 minutes, epinephrine-treated animals that received 10 mcg/kg or more of epinephrine showed decreased RPP.

“High quality BLS and ACLS are the cornerstone of resuscitation for all causes of cardiac arrest”
VASOPRESSIN
ACLS guidelines allow a single dose of vasopressin (40 units) as a potential substitute for one dose of epinephrine. However, this is unlikely to be efficacious in LAST since intense systemic vasoconstriction will decrease cardiac output in the setting of a poorly contracting (i.e., poisoned) heart. A negative effect on outcome was confirmed in an animal model of LAST where vasopressin reproducibly caused pulmonary edema and severely impeded cardiovascular recovery from bupivacaine overdose (Figure 2). This drug is therefore not recommended to treat LAST.

ARRHYTHMIA
Alleviating the underlying toxicity is likely the best means of addressing arrhythmias during LAST. Defibrillation and cardioversion should still be performed according to ACLS guidelines, but by themselves may not be sufficient. Choices of anti-arrhythmic agents after countershock are limited; local anesthetics such as lidocaine and procainamide would clearly exacerbate LAST and cardio-depressant agents such as beta blockers and calcium channel blockers should also be avoided. Amiodarone can also induce hypotension and, while not optimal, it is an acceptable choice if tolerated in terms of blood pressure.

CARDIOPULMONARY BYPASS
It is advisable to notify the nearest cardiopulmonary bypass facility once a diagnosis of LAST is established and the patient exhibits signs of cardiovascular toxicity. This is prudent since patient, physician, and systems factors can hinder successful recovery.

Figure 2: Blood pressure tracings in rat models of bupivacaine toxicity treated with lipid, epinephrine, and vasopressin (ADH), respectively; along with oxygen and chest compressions (labeled). ILE demonstrates slow but sustained return of perfusion; epinephrine shows rapid but non-sustained improvement; and vasopressin does not demonstrate return to baseline at any point. Time course of experiment, approximately 10 minutes. Courtesy, Weinberg lab.
In response to this recommendation Stanford University and one of the authors (SM) entered into a partnership with the NIH to develop, implement and expand an open source, open standard and free health and treatment registry platform: Health Electronic Registry of Outcomes (HERO). HERO is a platform that is used to collect outcomes data on large numbers of patients suffering from chronic pain. The platform can eventually be expanded to include other health conditions. The platform supports: clinical decision support at the point-of-care, comparative-effectiveness research, longitudinal outcomes research, and large simple trial designs. The NIH PROMIS computer adaptive testing domains are integrated into HERO, providing a fast and efficient means of capturing patient reported outcomes. More information can be found at http://snapl.stanford.edu/hero/.

CONCLUSIONS
The assessment of pain remains a challenge, but the landscape is improving in development and adoption of appropriate outcome measures. Most clinicians and researchers recognize that chronic pain is a multidimensional experience requiring appropriate attention to sensory, emotional, functional, and cognitive aspects in addition to the univariable pain intensity scores. Given the multitude of instruments available to assess pain outcomes, deciding upon a specific tool for any given situation can be difficult. Indeed, a recent systematic review of pain outcomes in chronic low back pain demonstrated 75 different outcome measures cited to evaluate therapy. Regardless of the measures chosen, each scale represents a compromise between factors of sensitivity and specificity, comprehensiveness and burden. The key to choosing an instrument is to be sure that it measures the appropriate domain of interest and to balance the quality and quantity of information.

The results of IMMPACT and PROMIS have suggested core outcome domains, validated measures, and item banks that can be easily accessed by researchers and clinicians alike. In addition, specific pain conditions may require tailored measurements for that population and outcome. Use of standardized outcomes and measurements, and making these readily accessible to providers and patients, holds significant promise to ensure the best delivery of care and the advancement of pain medicine.

ACKNOWLEDGMENTS
Dr Mackey was funded by NIH K24DA029262. Dr Mackey is the guarantor for this article, and takes responsibility for the integrity of the work as a whole.

REFERENCES
Currently, in the field of pain medicine we are facing many challenges. In order to meet the challenges head on and to allow for successful navigation of the new healthcare landscape, the program will also be providing education through the special half-day session, “Advanced Practice Management,” led by Dr. Kevin Vorenkamp. Topics covered will include CPT coding, navigating local coverage determinations, ICD-10, compliance, economic indicators for the pain practice, effective organization for the clinical care team, insurance contracting, and shared risk agreements. In addition, parallel sessions will include lectures on economic topics covering spine care, value base purchasing, hospital/physician practice relationships and agreements and current procedural terminology creation for new treatments.

The treatment of pain often involves a multidisciplinary effort with the coordination of multiple specialties. Recognizing the importance of coordinated care, we have brought in experts from other specialties including chiropractic medicine, physical therapy, psychiatry, radiology, neurology, and spine surgery. Two radiologists, Dr. John Carrino and Dr. Levon Nazarian, will be teaching at the meeting. Drs. Lurie and Vaccaro both investigators on the Spine Patient Outcomes Research Trials (SPORT) will provide significant input on the treatment of spine pain. We will also have education from both a physical therapist (Dr. Gregory Marchetti) and a chiropractor (Dr. Kevin Pursel). Dr. Robert Jamison (psychology) will also be speaking at the meeting. He has published extensively on opioids and substance abuse management. Dr. Charles Brock (neurology) will moderate a session on head, neck and facial pain.

In addition to the great didactics that will be available at this meeting, we will also have an extensive workshop program organized by Dr. Carlos Pino. The offered workshops will cover high-end interventional techniques including radiofrequency, spinal cord stimulation, botulinum toxin, visceral and sympathetic blocks, joint injections, spine injections, ultrasound-guided procedures, and head and neck blocks. There will also be a 2-hour interactive session on challenging cases and complication management that will allow you interact with experts and to develop management strategies for difficult cases.

Significant efforts have also gone into the development of the Resident Fellow Education Program developed by the Resident Section Committee and Drs. Ellen Rosenquist and Anish Doshi (Chair of the Resident Section Committee). The program includes a dedicated didactic session, job fair offering opportunity, and personalized workshop experience (see accompanying article by Dr. Doshi).

We are also pleased to offer again the comprehensive Physician Assistant and Nurse Practitioner educational program on Saturday and Sunday which is being led by Dr. Bridget Calhoun, Chair of the Physician Assistant Program at Duquesne University. The course will cover key knowledge requirements needed for all Physician Assistants and Nurse Practitioners caring for individuals suffering from chronic pain. For physicians that work in a coordinated care model, we strongly encourage you to invite Nurse Practitioners and Physician Assistants that are part of the team.

The program will include 27 PBLDS that will allow participants to meet with experts and discuss interesting and challenging topics including pulsed radiofrequency, intrathecal drug guidelines, medical cannabis, interpretation of EMG and nerve conduction studies, coding and billing, and pediatric pain management.

We also encourage scientists to submit their research to the meeting which will be reviewed by the ASRA Research Committee led by Drs. Colin McCartney and Gary Brenner. Best of meeting abstracts and resident/fellow scientific abstracts will be selected. The ASRA Pain Medicine Meeting is a great place to present your research in front of leaders in the field of pain management.

For the first time, ASRA will also be partnering with the North American Spine Society to allow select individuals to participate in both meetings. The North American Spine Society Annual Meeting will also be held in San Francisco at the same time. Details will be forthcoming.

We look forward to welcoming you to the beautiful city of San Francisco. In addition to the excellent educational opportunities being offered at this meeting, we will also be developing a social event program that will allow for interaction among participants and faculty and for the continuation of the “family” environment seen at ASRA events. We anticipate the Pain Medicine Meeting will be a memorable experience for all of you. Additional information on the meeting can be found at www.asrametings.com/13th-annual-pain-medicine-meeting/.
The spontaneous presence of blood in the hub of the needle, in the absence of intravascular cannulation, is secondary to tissue trauma or penetration of a blood vessel during advancement of the needle. A negative aspiration does not preclude intravascular injection. Aspiration failed to produce a flashback of blood in 74% of cases that turned out to be intravascular. Although 97-98% specific, the sensitivity of the presence of flash or blood on aspiration to predict intravascular injection ranged from 25% to 45%. The inability of aspiration to predict intravascular injection has been partly attributed to collapse of the blood vessel during aspiration.

**DIGITAL SUBTRACTION ANGIOGRAPHY**

Digital subtraction angiography (DSA) involves conversion of the fluoroscopic image to digital data, image subtraction then expansion. Subtraction involves the removal of the mask (background) image from the succeeding contrast image, resulting in contrast-filled structures that are free of background detail. The final phase of DSA is expansion of the subtracted image to enhance the image. Subtraction and enhancement occurs in real-time allowing for technique adjustment.

The usefulness of DSA was shown in a case report by Baker et al. Conventional fluoroscopy was not conclusive of intravascular injection even after contrast; subsequent injection with DSA showed the contrast medium filling a tiny vessel traveling directly to the spinal cord. The procedure was aborted with no ill effects. Rathmell et al demonstrated the ability of DSA to convincingly show intraarterial injection when contrast injection with live fluoroscopy was equivocal (Figure 1).

McLean et al retrospectively analyzed their prospectively-collected data. In their study, 177 cervical transforaminal ESIs were performed in 134 patients between June 2004 and April 23, 2007. Intravascular injection was noted in 17.9% of the patients before DSA was used and 32.8% after DSA was introduced (Table). They concluded that the use of DSA nearly doubled their detection of intravascular cannulation. This study has obvious limitations: only one physician did all injections; other factors such as the presence of foraminal stenosis, history of prior surgery, or number of attempts were not noted; and it was not clear whether contrast injection with and without DSA was compared in the same patient. The implication of their study is that the incidence of intravascular injection was probably the same before they used the DSA but was not detected by contrast injection alone, an unproven assumption.

In a prospective study, Lee et al compared DSA with aspiration of blood to detect intravascular injection. In this study, two fluoroscopic images – contrast injection under live fluoroscopy and injection with DSA – were saved after each injection. The overall rate of IV injection was 23% (20 of 87 injections). Of the 20 IV injections, 12 were noted with DSA compared to 5 with contrast injection under live fluoroscopy. The sensitivity of DSA was 60% compared to 25% with aspiration (Table).

Simultaneous intravascular and epidural injections, as previously noted, are more common than pure intravascular injection. Intravascular injection in the presence of epidural spread of contrast is better analyzed by DSA (Figure 2). Compared to live fluoroscopy, smaller volumes of contrast are needed with DSA. Although respiratory or motion artifacts often occur, DSA provides improved visualization of the vessel course. The limitations of using DSA...
Table 1: Incidence of Intravascular Injection with and without Digital Subtraction Angiography

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of subjects or injections</th>
<th>Number of positive intravascular injections</th>
<th>P value</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>McLean et al*</td>
<td>(Subjects)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast injection under real-time fluoroscopy</td>
<td>67</td>
<td>12 (17.9%)</td>
<td>0.0471</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSA</td>
<td>67</td>
<td>22 (32.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lee et al**</td>
<td>(Injections)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast injection under real-time fluoroscopy after aspiration</td>
<td>5</td>
<td>25%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSA</td>
<td>12</td>
<td>60%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


include additional radiation, added expense of the equipment ($15,000-$20,000.00), and not enough studies supporting its superiority over contrast injection under live fluoroscopy. It is also not foolproof since paraplegia after TF ESI has occurred in spite of a negative DSA.24

SHOULD DSA BE USED IN ALL EPIDURAL STEROID INJECTIONS?
The application of DSA does not make up for inadequate knowledge, meticulous preparation and technique, or proper interpretation of questionable images. The routine use of DSA is not recommended as its superiority over aspiration has not been definitely shown. However, if there is blood on the needle, either spontaneously or after aspiration, the use of a DSA adds a valuable piece of information in preventing avoiding events that may be preventable.

References:
false negative rate of live fluoroscopy is unknown but has been observed in one study to be 0.75%, with a calculated sensitivity of 99.25%, and specificity of 100% to detect inadvertent vascular injections. DSA may provide greater sensitivity and specificity but the exact limits of detection are unclear along with an unvalidated safety profile.

DSA exposes the patient and medical staff to significantly more radiation than traditional fluoroscopy. Extrapolation from the interventional vascular studies suggests that DSA may increase exposure to ionizing radiation at a rate of 3-5 times the exposure of CT angiography (CTA). The routine use of DSA may have a poor risk/benefit ratio due to escalated radiation exposure and rates of preventing rare catastrophic outcomes that may be averted by other safety measures during interventional procedures.

DSA may also lead to increase healthcare costs without justification of benefit. Adding digital subtraction capabilities to an existing fluoroscopic C-arm will vary depending on manufacturer make and model; some estimates range from $15,000-18,000 USD.

ALTERNATE SAFETY MECHANISMS
Several methods have been proposed to reduce the risk of intravascular injection, including needle selection, procedural approach, lidocaine challenge, imaging, and medication selection. Despite utilizing all of these methodologies, morbidity and mortality have occurred with the exception that spinal cord infarction has never been reported in association with non-particulate steroid injectate (dexamethasone). Steroid choice is a crucial safety consideration during neuraxial interventions. Indeed, of the 18 known reported cases of spinal cord infarction from TFESI, all were performed utilizing particulate steroid medications.

Many authors have suggested that the introduction of particulate steroid medication into a radiculo-medullary artery as the primary cause of spinal cord infarction. Depot steroids such as methylprednisolone and triamcinolone aggregate into clusters ranging from 1 to greater than 100 μm, potentially leading to occlusion of the medullary arterioles measuring 10-15 μm in diameter. While pain interventionists have long maintained that particulate steroid medications are superior to non-particulate agents, supporting research is less definitive. Some authors have maintained that steroids may not provide added benefit.

To date, one reported case of paraplegia exists following right side L5-S1 TFESI, utilizing 40 mg of triamcinolone, despite DSA and lidocaine test dose being negative for signs of intravascular uptake.

NEW TECHNOLOGIES
New imaging technologies are currently available, improving image quality, contrast, with little or no additional radiation. Dynamic range management (DRM) utilizes algorithms to optimize fluoroscopic imaging. Rather than processing the entire image at once, anatomical sub-images are processed separately for optimum brightness, contrast and enhancement levels and then re-combined to create the final image. Utilizing these algorithms, reduction in the black to white variation in the image can be obtained without reducing vessel contrast. DRM has been employed in other medical contexts and found to reduce ionizing radiation dose as compared to DSA without compromising clinical image quality.

CONCLUSION
The routine use of DSA is not warranted based on the current medical evidence. This modality exposes patients, practitioners and ancillary staff to additional radiation; yet the current literature does not demonstrate additional detection of arterial flow beyond traditional fluoroscopy. Other measures, including the use of dexamethasone vs. particulate steroids in transforaminal epidural steroid injections, should instead be utilized first to decrease the risk of catastrophic complications related to vascular injection (Table 2).

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Table 1: Disadvantages of DSA

<table>
<thead>
<tr>
<th>Disadvantage</th>
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</thead>
<tbody>
<tr>
<td>Increased radiation</td>
</tr>
<tr>
<td>Increased cost</td>
</tr>
<tr>
<td>Subject to motion artifact</td>
</tr>
<tr>
<td>Unclear resolution</td>
</tr>
<tr>
<td>Not validated margin of safety</td>
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<tr>
<td>Subject to interpretation error</td>
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</table>

Table 2: Techniques used to increase safety

<table>
<thead>
<tr>
<th>Technique</th>
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</thead>
<tbody>
<tr>
<td>Blunt needle</td>
</tr>
<tr>
<td>Live fluoroscopy</td>
</tr>
<tr>
<td>Non-particulate steroid</td>
</tr>
<tr>
<td>Lidocaine test dose</td>
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<tr>
<td>Extension tubing</td>
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</tbody>
</table>

“DSA exposes the patient and medical staff to significantly more radiation than traditional fluoroscopy.”
Outcomes in Pain Medicine: A Brief Review continued...


References:


unaware of the adverse outcomes associated with large-gauge cutting needles used for dural puncture. Communication and education between anesthesiaology and neurology and emergency medicine teams may help to prevent a large number of PDPHs.

We now have a number of different treatment options for PDPH patients, but many unanswered questions remain. Hopefully, we as regional anesthesiologists can lead the effort to further investigate new methods of treatment and how to individualize those treatments to particular patients.

References:

resuscitation despite the use of ILE.\textsuperscript{1} If the patient remains pulseless after lipid infusion, CPB is the best opportunity for surviving the event.\textsuperscript{19}

SEIZURE SUPPRESSION
In addition to cardiovascular instability, severe LAST can present with signs of neurologic derangement.\textsuperscript{2,3} The ASRA practice advisory prioritizes seizure suppression in addition to airway management to avoid hypoxemia and acidosis since both worsen LAST.\textsuperscript{21-23} Benzodiazepines are recommended for treating such seizures.\textsuperscript{1} Propofol may seem an appealing alternative for this purpose because it is handy, effective, and delivered in a lipid emulsion. However, the potential benefits of propofol are outweighed by its cardio-depressant effects. Moreover, effective lipid resuscitation (see below) requires bulk administration (~100 mL of 20% lipid for an adult), and the small volume of a seizure-suppressing propofol dose (~5-10 mL of 10% lipid) provides no benefit in reversing toxicity. Propofol is therefore recommended as a second line treatment for seizure control and then only in small doses.\textsuperscript{3}

LIQUID INFUSION
Laboratory studies and case reports show that ILE can be an effective antidote, reversing both cardiac and CNS signs of LAST (Figure 2).\textsuperscript{13-24} This antidotal effect derives from several mechanisms, including some demonstrated only recently. It has long been known that lipophilic local anesthetics will partition into a lipid phase both in vivo and in vitro.\textsuperscript{25-27} However, in silico modeling casts doubt on whether the lipid ‘sink’ can by itself exert sufficient effect to reverse LAST.\textsuperscript{28} Moreover, pharmacologic investigations in human volunteers have shown that ILE shortens the context-sensitive half-life of bupivacaine but does not produce a demonstrable sink effect.\textsuperscript{29} Recent reports suggest that inhibiting fatty acid metabolism prevents ILE reversal of bupivacaine cardiac toxicity, supporting a metabolic mechanism for lipid infusion.\textsuperscript{30} In addition, ILE rapidly exerts a direct inotropic effect in normal hearts that can contribute to resuscitation from LAST.\textsuperscript{31} ILE also improves cardiac function in recovery from an ischemic insult by activating cell-saving signaling pathways.\textsuperscript{32} Finally, free fatty acids can also interfere with bupivacaine binding of sodium channels on the plasma membrane.\textsuperscript{33-34} In sum, ILE improves the pharmacokinetic disposition of local anesthetic and exerts positive effects on diverse metabolic and signaling pathways that in combination accelerate recovery from LAST.

PREPARATION AND PREVENTION
While it is reassuring to have a rational plan to treat LAST, preventing it in the first place is obviously preferred.\textsuperscript{35} ASRA recently released a nine-point safety checklist to review prior to nerve block that includes preparedness for LAST.\textsuperscript{3} Vigilance for clinical signs of LAST will reduce the risk of local anesthetic toxicity (estimated to be approximately 1 in 1000 peripheral nerve blocks).\textsuperscript{36} Risk factors should be identified in selecting patients for regional analgesia; these include pre-existing cardiac disease, small size, extremes of age, metabolic or mitochondrial disease, liver disease, acidosis, and possibly, use of sodium channel blocking medication such as phenothiazines or lamotrigine.\textsuperscript{1,27,28} The ASRA practice advisory recommends using the lowest effective dose of local anesthetic, and some (though not all) experts in the field also favor using epinephrine or other tracer in the local anesthetic solution to serve as a marker of intravascular injection.\textsuperscript{1} Ultrasound guidance reduces, but does not eliminate the risk of LAST.\textsuperscript{29-41}

The use of a checklist during resuscitation has been shown to improve practitioner decision-making in simulated LAST.\textsuperscript{3} Simulation experience is also a sensible preparation for LAST, and a local anesthetic resuscitation kit should be readily available wherever regional anesthesia is performed.\textsuperscript{1} Because the severity of LAST can vary greatly, clinicians must use their discretion to decide at which point to use lipid emulsion; however, it is important to note that LAST can progress to cardiovascular collapse even after initial symptoms subside.\textsuperscript{42} The authors encourage incidents of lipid resuscitation to be reported at www.lipidrescue.org.

In summary, recommendations for treatment of LAST are evolving away from the standard ACLS protocol. One may understandably hesitate in deviating from traditional methods of resuscitation. However, laboratory findings continue to provide support for these specific interventions, and clinical experience indicates that patients are increasingly surviving this often fatal event.\textsuperscript{9}

References:
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