Reducing Complications from Interscalene Blocks

An interscalene block (ISB) is a regional anesthetic technique that provides anesthesia and analgesia to the shoulder and lateral regions of the arm and forearm. The block involves injection of local anesthetic to block the brachial plexus. ISBs are also growing in popularity—a 25% increase in the number of ISBs administered has been reported over 5 years. A study of anesthesiologists in the United States revealed that more than 60% administer ISBs in their practice, and these respondents expected the use of this block to increase over time. (Refer to the sidebars for additional information on ISB techniques and variations.)

Benefits
The block is easy to learn and to perform. Landmarks for ISB are readily identifiable. The patient requires no special positioning of the arm or shoulder for the block to be performed. Moreover, because patients are comfortably positioned, pressure-induced neuropathies can be avoided. Also, when it involves the appropriate setup and experienced physicians, ISB should not prolong the perioperative course. Compared to general anesthesia, ISB provides excellent intraoperative anesthesia and postoperative analgesia with fewer side effects (e.g., nausea and vomiting, urinary retention, excessive sedation, overnight hospitalization, postoperative pain) and greater satisfaction of both the patient and healthcare team. ISB does not involve the endotracheal intubation required for general anesthesia, thus avoiding its associated respiratory complications. For patients at risk for respiratory complications secondary to intubation and general anesthesia, ISB may be considered an excellent technique.

Moreover, several studies demonstrated less intraoperative blood loss with the use of ISB than with use of general anesthesia. ISB may also reduce or prevent physiological responses associated with inadequately treated pain, such as increased sympathetic nervous system activity and increased production of antidiuretic hormone, cortisol, glucagon, aldosterone, and catecholamines—changes that reduce intestinal motility and promote hyperglycemia, tachycardia, hypertension, myocardial work, and the potential for myocardial ischemia. ISB improves shoulder mobility in the immediate postoperative period, facilitating physical therapy.

PA-PSRS Reports
While ISB has many advantages, it can be associated with problems, as indicated by the 23 reports submitted to PA-PSRS since its inception in June 2004. As the Table indicates (see next page), almost three-fourths of the PA-PSRS reports involving ISBs had at least one of the following complications: dyspnea, chest pain, chest tightness, seizure, irregular heartbeat, and ineffective pain control.

More than half (54%) of the ISB-related reports were Serious Events (i.e., indicating patient harm), compared to 4% of PA-PSRS reports overall.

Here are some ISB-related occurrences reported to PA-PSRS:

A 58-year-old patient underwent an interscalene block for shoulder surgery and sustained respiratory failure and died. A possible cause of death may have been a paralyzed hemidiaphragm caused by the block.

A patient was given an interscalene block, and within a few seconds, had a clonic-tonic seizure. The patient was intubated and admitted.

A patient who received an interscalene block for shoulder surgery reported she could not swallow. After three hours, she was transferred to the emergency room for inability to swallow.

Indications
When ISB is used as the sole anesthetic in patients with comorbidities, general anesthesia and

This article is reprinted from the PA-PSRS Patient Safety Advisory, Vol. 4, No. 4—December 2007. The Advisory is a publication of the Pennsylvania Patient Safety Authority, produced by ECRI Institute & ISMP under contract to the Authority as part of the Pennsylvania Patient Safety Reporting System (PA-PSRS).

Copyright 2007 by the Patient Safety Authority. This publication may be reprinted and distributed without restriction, provided it is printed or distributed in its entirety and without alteration. Individual articles may be reprinted in their entirety and without alteration provided the source is clearly attributed. This publication is disseminated via e-mail. To subscribe, go to https://www.papsrs.state.pa.us/Workflow/MailingListAddition.aspx.

To see other articles or issues of the Advisory, visit our Web site at http://www.psa.state.pa.us. Click on “Advisories” in the left-hand menu bar.
Reducing Complications from Interscalene Blocks (Continued)

endotracheal intubation can be avoided. ISB can be combined with general anesthesia, reducing postoperative pain and supplemental analgesics and extending the patient’s ability to sleep comfortably. Postoperative analgesia can also be extended by instilling a longer acting local anesthetic through an indwelling catheter into the area of the brachial plexus for continuous infusion.

ISB can be used for intraoperative anesthesia and/or postoperative analgesia for upper arm and shoulder surgical procedures, including the following:

- Performing clavicle procedures
- Performing arthroscopic shoulder procedures
- Managing a frozen shoulder
- Repairing a fractured humerus
- Inserting vascular shunts
- Treating reflex sympathetic dystrophy/causalgia
- Preventing autonomic hyperreflexia in susceptible patients undergoing shoulder surgery

With surgery of the medial arm or axilla, ISB may require additional supplementation with a separate intercostobrachial nerve block.

Contraindications

Patient Condition
Several medical conditions are contraindications for ISB. ISB complications are more likely in patients who have limited pulmonary reserve, such as in the following conditions:

- Severe obstructive or restrictive respiratory disease unless mechanically ventilated
- Respiratory insufficiency
- Myasthenia gravis
- Status post-pneumonectomy on the contralateral side
- Contralateral hemidiaphragmatic dysfunction
- Pre-existing contralateral vocal cord paralysis

Patients whose anatomical landmarks are not easily identifiable may not be appropriate candidates for ISB, including patients who have the following conditions:

- Morbid obesity
- Short/thick necks
- Inadequate muscle tone in the interscalene area

However, ISB may be performed on patients with challenging anatomical landmarks with the use of a nerve stimulator and/or ultrasound.

Other patient conditions that must be considered and may be contraindications for ISB include the following:

- Local infection at the injection site
- Sepsis
- Coagulopathy
- Peripheral neuropathy
- Previous injury to the brachial plexus
- Inability to communicate and cooperate effectively (e.g., comatose, under general anesthesia)

Table. ISB Complications Reported to PA-PSRS in 23 Reports

<table>
<thead>
<tr>
<th>ISB Side Effect/Complication</th>
<th>Percent of ISB-Related PA-PSRS Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea</td>
<td>26%</td>
</tr>
<tr>
<td>Seizure</td>
<td>17%</td>
</tr>
<tr>
<td>Chest pain/tightness</td>
<td>13%</td>
</tr>
<tr>
<td>Irregular heartbeat</td>
<td>9%</td>
</tr>
<tr>
<td>Ineffective pain control</td>
<td>9%</td>
</tr>
<tr>
<td>Drooping eyelid</td>
<td>4%</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>4%</td>
</tr>
<tr>
<td>Decreased SpO2</td>
<td>4%</td>
</tr>
<tr>
<td>Unresponsive</td>
<td>4%</td>
</tr>
<tr>
<td>Rash</td>
<td>4%</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>4%</td>
</tr>
</tbody>
</table>

Table. ISB Complications Reported to PA-PSRS in 23 Reports

©2007 Pennsylvania Patient Safety Authority
Reducing Complications from Interscalene Blocks (Continued)

anesthesia, mentally ill, dementia) However, ISB can be performed on a sedated patient if the practitioner used ultrasound and a nerve stimulator.

- Inability to remain still and in the prescribed position
- Allergy to the local anesthetic to be administered

Other Significant Issues
Bilateral ISB is absolutely contraindicated. ISB is not appropriate in the absence of patient consent or if the following exist: a lack of resuscitative equipment or lack of adequate training for or lack of demonstrated proficiency by personnel performing ISB.

Common Side Effects
A successful ISB produces an ipsilateral phrenic nerve block. The phrenic nerve is the sole motor supply to the diaphragm, and ipsilateral hemidiaphragmatic paresis occurs in up to 100% of patients receiving ISBs. Usually, phrenic nerve palsy is well tolerated, and is often unnoticed by healthy patients. However, forced vital capacity decreases by approximately 25%, which can produce ventilator compromise in patients with limited pulmonary reserve, requiring assisted ventilation.

Horner’s syndrome may occur when the local anesthetic spreads to the stellate ganglion with its cervical sympathetic nerves. Symptoms include ptosis of the eyelid, miosis, and anhidrosis of the face. However, the existence of Horner’s syndrome, may not indicate that the brachial plexus is adequately blocked.

Dysphagia occurs frequently and may persist until the block begins to resolve.

Complications
Overall Incidence
The overall incidence of other short-term and long-term complications is reported to be 0.3% to 0.4%. However, one review indicates that for specific complications and side effects, the incidence may vary dramatically from study to study: from 0.2% for convulsions and pneumothorax to nearly 75% for Horner’s syndrome.

Unsuccessful Blockade
One of the most common complications is failure to achieve an adequate block, usually resulting from the anesthetic missing a nerve in the lower nerve root distribution. This has been reported to occur in 3% to 30% of all brachial plexus blockades attempted.

Unintended Blockade
If the recurrent laryngeal nerve is inadvertently blocked, vocal cord palsy occurs with symptoms of hoarseness and possibly acute respiratory insufficiency. This complication is ordinarily of little consequence unless bilateral laryngeal nerve palsy results, which may produce severe laryngeal obstruction.

Tapia’s syndrome, or cranial nerve X and XII palsy, may also occur following ISB. Symptoms include one-sided cord paralysis, aphony, and the patient’s tongue deviating toward the side of the block.

Another unintended consequence of ISB may be the rare but potentially fatal complication of neuraxial blockade, or total spinal anesthesia, in which the local anesthetic intended for the brachial plexus sheath reaches the central nervous system (CNS). This may occur as a result of:

- accidental injection of the local anesthetic into the epidural, subdural, or subarachnoid space, which more readily occurs when the ISB needle is not sufficiently caudad;
- subdural injection, which may occur when, anatomically, the dural cuff that surrounds the trunks of the brachial plexus extends beyond the intervertebral foramen; or
- use of perineural local anesthetics, which may travel in retrograde from the peripheral nerves to the CNS.

Total spinal anesthesia may result in loss of consciousness or cardiac and/or respiratory arrest, requiring intubation and ventilator support. If recognized immediately and adequate support is provided, this complication is not necessarily fatal.

Inadvertent blockade of the upper cervical nerve roots can lead to anesthesia in the head and neck. Contralateral anesthesia has also been reported.

Unintended blockade also results when the block is instilled in the incorrect side. The following PA-PSRS report highlights this problem:

The patient was scheduled for a left shoulder surgery. The anesthesiologist asked...
Reducing Complications from Interscalene Blocks (Continued)

the patient if he was having surgery on his right shoulder. The patient replied “yes,” and the anesthesiologist performed an ISB on the right shoulder. After the procedure, the nurse informed the anesthesiologist that the surgical consent was for the left shoulder.

Intravascular Injection
Several major blood vessels are located near the brachial plexus, creating a risk of vessel wall trauma and intravascular injection during ISB.\textsuperscript{1,6,5} Such vessels include the vertebral, subclavian, and carotid arteries.\textsuperscript{3,4,9}

Systemic Toxicity of Local Anesthetic\textsuperscript{1-5,9}
As with all uses of local anesthetics, toxicity rarely occurs unless the maximum safe dose of local anesthetic are exceeded or there is an inadvertent intravascular injection.\textsuperscript{2} Both of these mechanisms allow the local anesthetic to reach the brain, resulting in CNS toxicity that may produce seizures.\textsuperscript{1,4,6,12} CNS toxicity occurs during 0.2% of ISBs.\textsuperscript{2} Vertebral artery cannulization with a continuous interscalene catheter has resulted in CNS toxicity with the use of bupivacaine.\textsuperscript{2} Initial symptoms of CNS toxicity may include dizziness, tinnitus, perioral numbness, light-headedness, shivering, tremor, and muscle twitching. Ultimately, tonic-clonic seizures occur.\textsuperscript{2}

Cardiovascular toxicity may also occur during ISB placement, including severe dysrhythmia and cardiac arrest.\textsuperscript{2,3,9,12} The systemic effect of the local anesthesia exerts a dose-dependent decrease in myocardial contractility and decreases the rate of conduction in Purkinje fibers and the myocardium.

Bupivacaine is more cardiotoxic than ropivacaine, mepivacaine, or lidocaine because of slow recovery of sodium channels in the heart.\textsuperscript{2,3}

Pulmonary
Placing the block too inferiorly within the interscalene groove may result in a pneumothorax.\textsuperscript{1-5,12,14} This rare complication occurs during 0.2% of ISBs.\textsuperscript{2} Bronchospasm may also occur, which is probably caused by a sympathetic blockade down to the level of T1 to T4, combined with a relative excess of parasympathetic tone.\textsuperscript{5}

ISB Technique and Onset

In 1970, Winnie first described the ISB technique that is most commonly used today.\textsuperscript{1} This lateral approach is considered the current standard of practice, has a success rate of at least 94%,\textsuperscript{2} and involves the following.

Positioning
- Place the patient in supine position.\textsuperscript{2,3}
- Position the patient’s head—extended and rotated 45°—to the contralateral side.\textsuperscript{2,4} This position exposes anatomical landmarks.
- Rest the patient’s ipsilateral arm pronated along the side of the patient’s body, in a direction toward the patient’s ipsilateral knee.\textsuperscript{2}
- To accentuate the interscalene groove, ask the patient to
  — sniff forcefully;\textsuperscript{4} or
  — elevate his/her head slightly,\textsuperscript{2,4} which brings the clavicular head of the sternocleidomastoid muscle into view.

Palpation
- Roll fingers posteriorlateral off the clavicular head of the sternocleidomastoid muscle and drop onto the anterior scalene muscle.\textsuperscript{2,3}
- Palpate laterally to the interscalene groove that lies between the anterior and middle scalene muscles.\textsuperscript{2,4}

Needle Insertion
- Insert the needle point at the level of C6, identified by the cricoids cartilage.\textsuperscript{2} (This often is next to where the external jugular vein crosses over the sternocleidomastoid muscle.\textsuperscript{2})
- Insert the needle perpendicular to the skin in all planes.\textsuperscript{2,4}
- Use a 1 to 1.5 inch, 22- or 23-gauge needle because the brachial plexus is relatively superficial.\textsuperscript{2,4}

Advance the Needle
- Advance the needle in a caudal, medial, and slightly dorsal direction.\textsuperscript{2} A 45° to 60° caudal direction will more likely to prevent the needle from passing between two cervical transverse processes and puncturing the vertebral artery or the epidural or subarachnoid spaces.\textsuperscript{4}

(Continued on page 5)
Nerve Injury
Nerve injury may be apparent immediately or may not be recognized until two to three weeks after ISB is performed.\(^5,12\) The appearance of clinical symptoms may be delayed depending on the development of inflammation, micro hematoma, or perineural edema.\(^12\) The incidence of these injuries may be underestimated because the symptoms are usually minor and the anesthesiologist does not ordinarily see the patient beyond the first few postoperative days.\(^12\)

Neuropathies involve acute, nonacute, and permanent dysfunction.\(^2,4\) Acute nerve complications include pain and paresthesia,\(^2\) as well as brachial plexus injuries such as plexitis, palsy, and neuritis.\(^2,3,12\) Brachial plexus injury is extremely rare.\(^2\)

Long-term, nonacute complications that spontaneously resolve from one to more than nine months after ISB may include the following:

- Brachial plexus neuropathy\(^1,2,12\)
- Severe plexus lesion/damage\(^12\)

Rarely, permanent injury has been reported, such as permanent phrenic paralysis\(^1,10\) and even permanent loss of cortical cord function.\(^15\)

Moreover, the following conditions may be associated with but not caused by ISB:

- Sulcus ulnaris syndrome (i.e., entrapment neuropathy of the ulnar nerve at the medial epicondyle of the elbow)\(^1,12\)
- Complex regional pain syndrome\(^1,12\)
- Carpal tunnel syndrome\(^1,12\)

While ISB does not cause these conditions, ulnar neuropathies may be related to positioning of the arm or in susceptible patients with edema around the nerve.\(^12\)

Vasovagal Response
The “beach chair” (i.e., seated) position is often used for shoulder surgery. Sudden profound hypotension and bradycardia may occur in 13% to 24% of patients

### ISB Technique and Onset (Continued)

- **Injection**
  - The clinician injects the local anesthetic in 3 to 5 mL increments,\(^3\) and aspiration is repeated for every 10 mL injected.\(^3\)
  - Upon injection of local anesthesia, the interscalene groove distends (interscalene triangular swelling),\(^4\) bounded by the following:
    - Medial border of the middle scalene muscle
    - Lateral border of the anterior scalene muscle
    - Clavicle between the insertion points of these two muscles

- **Onset of ISB**
  - If a peripheral nerve stimulator is used, twitching disappears immediately upon beginning the anesthetic injection. The local anesthetic moves the nerves away from the end of the stimulator needle.\(^3\) Motor blockage occurs within five minutes of injecting the local anesthetic.\(^2\) By five minutes, most patients exhibit cervical sympathetic ganglia blockade, including the following:\(^2\)
    - Unequal pupil size
    - Increased regional skin temperature and skin blood flow
    - Weakened vasoconstrictor response to inspiratory gasp

If bupivacaine is used, the first indication of the onset of ISB is the “money sign”—when the patient rubs thumb against the index and middle fingers.\(^1\) Within a few minutes, the patient cannot raise a straightened arm. Within 15 minutes, the block is sufficiently complete to begin surgery.\(^4,5\)

### Notes
Reducing Complications from Interscalene Blocks (Continued)

who have ISBs and are positioned in this manner for the operative procedure.\textsuperscript{1,3} The Bezold-Jarisch reflex occurs when venous pooling and increased sympathetic tone produce a low-volume, hypercontractile ventricle. This reflex activates the parasympathetic nervous system and sympathetic withdrawal.\textsuperscript{2} While the arterial vasodilation and bradycardia are usually transient and reversible,\textsuperscript{1,3} cardiac arrest may occur.\textsuperscript{2}

Other Complications
Other reported complications of ISB include hematoma,\textsuperscript{5,12} aspiration of blood,\textsuperscript{12} tracheal abrasion/puncture,\textsuperscript{5} infection,\textsuperscript{5} pneumothorax,\textsuperscript{3} and auditory disturbance.\textsuperscript{1}

Risk Reduction Strategies
Several strategies can reduce complications, enhancing patient safety.

Prior to ISB
- The clinician performing the block needs to undergo training and demonstrate competencies in the various ISB techniques available.\textsuperscript{2}
- Patients selected for ISB are undergoing major shoulder surgery (reconstruction) or minor arthroscopic shoulder procedures.\textsuperscript{2} ISB success varies anatomically, and the clinician’s familiarity with this success distribution will guide whether this block is appropriate for the operative procedure planned.\textsuperscript{4}
- ISBs are contraindicated for patients with certain conditions, such as patients who are unable to tolerate a 25% reduction in pulmonary function.\textsuperscript{2}

**ISB Variations**

**Local Anesthetic**
The following agents are used for ISB:\textsuperscript{1,2}

- 2% to 3% 2-chloroprocaine
  - Short duration (i.e., less than one hour)
  - Rapid onset

- 1% to 1.5% lidocaine or 2% mepivacaine
  - Medium duration (i.e., three hours)
  - Rapid onset

- 0.5% to 0.75% bupivacaine or ropivacaine
  - Prolonged duration (i.e., more than 7 hours) or continuous ISB blockade
  - Longer onset

**Multiple Injections**
Winnie’s\textsuperscript{3} standard technique relies on using a single injection of local anesthetic within the fascial compartment. More recently, multiple injections using as little as a total of 20 mL have been administered safely and effectively, compared to the 40 mL of a single injection.\textsuperscript{1,2} The injections are targeted at specific predetermined locations within the brachial plexus sheath.\textsuperscript{1} However, the multiple injection technique may increase the risk of nerve trauma\textsuperscript{2} from unrecognized injection of local anesthetic into a partially anesthetized peripheral nerve.\textsuperscript{1} Moreover, patients may be less receptive to multiple injections.\textsuperscript{2}

**Adjunctive Medications**
Adjunctive medications to local anesthetics may affect the quality of anesthesia or its time of onset or duration.

**Epinephrine**
When added to local anesthetic solutions, epinephrine decreases systemic absorption, reducing the potential for local anesthetic toxicity to the central nervous and cardiovascular systems.\textsuperscript{1,2} Decreased systemic absorption promotes a longer brachial plexus block duration and improved quality of anesthesia.\textsuperscript{1,2} It may also help detect intravascular injection\textsuperscript{2} because of the drug’s systemic effects if it reaches the vascular system. Because ropivacaine is already a potent vasoconstrictor, adding epinephrine has little effect on the duration of this block.\textsuperscript{2} Forty to 60 mL of 1.5% mepivacaine (~10 mg/kg) with epinephrine 1:200,000 can provide anesthesia for 3 to 4 hours.\textsuperscript{4}

**Alpha-2-Adrenergic Agonists**
Interscalene administration of clonidine also prolongs the blockade of short and intermediate local anesthetics and ropivacaine.\textsuperscript{2} However, it does not reduce systemic absorption of local anesthetics to the same degree as epinephrine; therefore, it produces greater peak plasma concentrations of local anesthesia. As a result, clonidine’s margin of safety for systemic toxicity tends to be narrower. Clonidine may be used when epinephrine is contraindicated.\textsuperscript{2}

**Sodium Bicarbonate**
By increasing the pH of the local anesthetic, sodium bicarbonate increases the amount of the uncharged, nonionized form of the drug.\textsuperscript{1,2} Nonionized local anesthesia crosses nerve membranes more readily, resulting in rapid onset of the block. While this rapid onset does not occur with all local anesthetics, 1 mEq of sodium bicarbonate per 10 mL of mepivacaine significantly decreases the onset time without prolonging the duration of motor or sensory brachial plexus blockade.\textsuperscript{5}

(Continued on page 7)
Reducing Complications from Interscalene Blocks (Continued)

- It is prudent to have monitoring and resuscitation equipment available, including electrocardiography, pulse oximetry, and oxygen administered by nasal cannula.

- Marking the surface anatomy prior to the block will help ensure that ISB is performed accurately and effectively.

- ISBs are performed after the patient has fasted and has fully consented.

- Educating patients about ISB reduces anxiety, promotes cooperation, and ensures patients will notify the physician if complications arise. Such information can be reinforced by providing a brochure to the patient at the surgeon’s office. Information can include the following:
  - Explanation of the procedure
  - Purpose of a brachial plexus nerve block
  - Indications and contraindications for ISB
  - Use of a numerical or visual scale to rate pain
  - Potential side effects and complications
  - Picture of brachial plexus anatomy
  - Importance of notifying the physician when first paresthesia occurs during ISB placement

During ISB

- Performing the ISB with strict adherence to asepsis will reduce the risk of infection.

---

ISB Variations (Continued)

**Continuous Interscalene Brachial Plexus Blockade**

A catheter inserted into the interscalene brachial plexus sheath can provide continuous perineural infusion of a long-acting local anesthetic. This procedure can improve short-term analgesia and rehabilitation.

**Ambulatory Interscalene Brachial Plexus Blockade**

Disposable elastometric balloon pumps and programmable mechanical pumps have been used successfully to provide analgesia for patients at home after rotator cuff repairs, but no large scale trials of this modality have occurred to date.

**Brachial Plexus Sonography**

High-resolution ultrasound can be used for ISB in the following ways:

- Identify and teach about brachial plexus anatomy
- Safely guide the interscalene needle during insertion and probing
- Correctly place a catheter under direct dynamic visualization

This methodology is well suited for patients with anatomical landmarks that are difficult to identify (e.g., morbid obesity).

**Posterior Approach**

A posterior approach to ISB may provide anesthesia to the forearm and hand, which the traditional approach does not. The following steps comprise the posterior approach:

- A 21-gauge 9 cm needle attached to a 5 mL syringe is inserted 3 cm lateral to the interspinous line at a level midway between the C6 and C7 spinous processes.
- The needle is inserted perpendicular to the skin, through the trapezius, splenius cervicus, and levator scapulae muscles; over the C7 transverse process; and through the posterior and middle scalene muscles.
- The needle tip is within the brachial plexus sheath when a definitive loss of resistance is felt, indicating penetration of the fascial layer on the anterior surface of the middle scalene muscle.
- The clinician then injects a total of 40 mL of local anesthetic incrementally.
- A peripheral nerve stimulator can be used to locate the interscalene brachial plexus from the posterior approach.

**Notes**

Reducing Complications from Interscalene Blocks (Continued)

- **Needle placement:**
  - Traditionally, needle placement for ISB has been perpendicular to the skin in every plane. However, there may be a greater possibility of the needle passing through the intervertebral foramen if the needle is advanced too deeply in this position. Therefore, the risk of spinal cord damage during ISB is greater.
  - A recent study of 50 patients using magnetic resonance imaging of the cervical region revealed that a needle angle of 60° relative to the sagittal plane at the level of C6, aimed in a slight posterior, steeply caudal trajectory, would more likely avoid inadvertent sub arachnoid, epidural, or vertebral artery injection.
  - Seizures are less likely when using an axillary approach to brachial plexus blockade, rather than a supraclavicular or interscalene approach. However, this must be balanced with the increased risk of local anesthetic toxicity if the axillary trajectory involves a transarterial approach.

- **Drugs:**
  - Avoiding highly concentrated local anesthetics (e.g., greater than 1.5% lidocaine) may reduce the risk of nerve injury.
  - When large doses of long-acting local anesthetic are required, ropivacaine has a more favorable toxicity profile than bupivacaine.
  - If the patient receiving ISB will be placed in a beach chair position for shoulder surgery, prophylactic β-adrenergic blockade may decrease the occurrence of vasovagal events. If this complication occurs, giving a β1-agonist (Ephedrine) increases heart rate, systolic and diastolic blood pressure, and cardiac output.
  - Giving the lowest effective dose (e.g., via multiple injection technique) may reduce iatrogenic complications.

- **Needle probing/injection**
  - Withdraw the needle and consider canceling ISB if a patient complains of severe pain or paresthesia.
  - Discontinuing needle probing at the first paresthesia or muscle twitch may reduce the risk of iatrogenic injury.

- **Paresthesia versus Peripheral Nerve Stimulator**
  - An effective ISB results when the local anesthetic is injected in close proximity to the brachial plexus. There are two end points that indicate accurate needle tip placement:
    1. Paresthesia
      - Paresthesia is an electric shock sensation over a nerve distribution that occurs as the needle tip encroaches the epineurium. While Winnie indicated that a successful ISB is associated with obtaining paresthesia below the level of the shoulder, a recent study revealed a 100% ISB success rate with paresthesia sites of the upper arm, elbow, forearm, hand, as well as the shoulder. Advantages of paresthesia are that no extra equipment is required and the technique’s portability. The disadvantage is the potential for nerve injury as the needle tip encroaches or breaches the epineurium. Paresthesia also requires the patient to communicate a response to the electric sensation once it is felt.
    2. Peripheral nerve stimulator
      - A nerve stimulator induces muscle twitches through a nerve stimulator needle. A deltoid twitch or a biceps twitch determines accurate needle placement and therefore ISB success. The advantage of this technique is its objectiveness (by means of skeletal muscle movement) in determining accurate or inaccurate placement. For example, if nerve stimulation evokes hiccups, the needle tip may be too far anterior. A trapezius twitch would require needle placement more anteriorly. The incidence of certain complications may be reduced. Use of a short, beveled nerve stimulator needle increases the success rate of the block, but it may not decrease the risk of nerve damage.

- **Notes**

- Diligent aspiration, alternated with small incremental injection, may reduce the risk of intravascular injection of local anesthetic during ISB.
Reducing Complications from Interscalene Blocks (Continued)

Documentation
Comprehensive documentation\(^\text{10}\) of the following will capture important information related to ISB:

- Preoperative discussion of the ISB procedure, benefits, risks, possibility of nerve damage, and education materials provided
- Approach/trajectory of needle
- Type and length of needle used
- Type, dose, and concentration of local anesthetic and adjunctive medications administered
- Method used to confirm needle placement
  (For additional information on the following methods, refer to the sidebar “Paresthesia versus Peripheral Nerve Stimulator.”)
  - If peripheral nerve stimulator is used to confirm needle placement:
    - The type and settings
    - The strength and location of muscle contractions
    - Number of attempts
    - Presence or absence of paresthesia and actions taken in response
  - If paresthesia is used to confirm needle placement:
    - Number of attempts
    - Presence and location of paresthesia
- Patient response
- Actions taken in response to acute complications

Follow-Up
When patients experience dysphagia, check periodically for the gag reflex. Do not permit the patient to drink liquids and do not discharge the patient until the dysphagia resolves. Because ISB may have long-term sequelae, many clinicians have proactively established a mechanism for long-term follow-up, should the need arise.\(^\text{10}\)

Implementing these strategies will help to ensure that patients undergoing ISB will enjoy its benefits while reducing the risk of iatrogenic complications associated with this technique.

Notes
Self-Assessment Questions

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

1. Which one of the following needle trajectories may reduce the risk of inadvertent subarachnoid, epidural, or vertebral artery injection?
   A. A needle angle of 60° relative to the sagittal plane at the level of C6 and aimed in a slight posterior, steeply caudal direction
   B. Needle is perpendicular to the skin in every plane
   C. A needle angle of 45° relative to the sagittal plane and aimed anteriorally in the interscalene groove

2. The concentration of local anesthetic used in ISB has no effect on the risk of nerve injury.
   A. True
   B. False

3. Surgical procedures appropriate for ISB include all EXCEPT which one of the following?
   A. Clavicle/shoulder procedures
   B. Treatment of sympathetic dystrophy
   C. Surgery of the hand/forearm/medial elbow
   D. Insertion of vascular shunts
   E. Insertion of a pacemaker

4. Contraindications and patient conditions to consider before performing ISB include all EXCEPT which one of the following:
   A. Patients with low body mass index
   B. Myasthenia gravis
   C. Contralateral hemidiaphragmatic dysfunction
   D. Sepsis
   E. Peripheral neuropathy

5. Complications and unintended consequences of ISB include all EXCEPT which one of the following?
   A. Chronic obstructive pulmonary disease and epicondylitis
   B. Carpal tunnel syndrome
   C. Seizure
   D. Unintended nerve blockade
   E. Vocal cord palsy

6. Risk reduction strategies for ISB include all EXCEPT which one of the following?
   A. Avoiding use of highly concentrated local anesthetics
   B. Marking surface anatomy
   C. Discontinuing needle probing at the first paresthesia or muscle twitch
   D. Availability of monitoring/resuscitative equipment

The Patient Safety Authority works with the Pennsylvania Medical Society to offer AMA PRA Category 1 Credits™ for selected portions of the PA-PSRS Patient Safety Advisory through the online publication Studies in Patient Safety: Online CME Cases. Go to http://www.pamedsoc.org to find out more about patient safety CME opportunities.
The *PA-PSRS Patient Safety Advisory* is issued quarterly, with periodic supplements. Previous issues are available on the Patient Safety Authority Web site at [http://www.psa.state.pa.us](http://www.psa.state.pa.us). Click on “Advisories and Related Resources” in the left-hand menu bar.

Selected articles in previous issues include:

- “*Airway Fires during Surgery*” (March 2007)
- “*Bone Cement Implantation Syndrome*” (December 2006)
- “*Delays in the OR: Stress between ‘Running Two Rooms’ and ‘Time Outs’*” (September 2006)
- “*Diligence and Design in Behavioral Health Impact Patient Safety*” (September 2007)
- “*Doing the ‘Right’ Things to Correct Wrong-Site Surgery*” (June 2007)
- “*I’m Stuck and I Can’t Get Out! Hospital Bed Entrapment*” (December 2006)
- “*Improving Safety of Telephone or Verbal Orders*” (June 2006)
- “*Inadvertent Mix-Up of Morphine and Hydromorphone: A Potent Error*” (September 2007)
- “*Mismanagement of Expressed Breast Milk*” (June 2007)
- “*Safety in Using Promethazine (Phenergan)*” (March 2007)
- “*Who Administers Propofol in Your Organization?*” (March 2006)
The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error ("Mcare") Act. Consistent with Act 13, ECRI Institute, as contractor for the PA-PSRS program, is issuing this publication to advise medical facilities of immediate changes that can be instituted to reduce Serious Events and Incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority’s Web site at www.psa.state.pa.us.

ECRI Institute, a nonprofit organization, dedicates itself to bringing the discipline of applied scientific research in healthcare to uncover the best approaches to improving patient care. As pioneers in this science for nearly 40 years, ECRI Institute marries experience and independence with the objectivity of evidence-based research. More than 5,000 healthcare organizations worldwide rely on ECRI Institute’s expertise in patient safety improvement, risk and quality management, and healthcare processes, devices, procedures and drug technology.

The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP’s efforts are built on a non-punitive approach and systems-based solutions.