American Society of Anesthesiologists®

Statement on Neurologic Complications of Neuraxial Analgesia/Anesthesia in Obstetrics

Developed by: *Committee on Obstetric Anesthesia*
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Purpose:

The purpose of this consensus statement is to discuss the risks of neurologic complications associated with neuraxial techniques in the obstetric population by describing the types and pathophysiology of neurologic deficits and/or injury, identifying techniques for recognition and evaluation of deficits and/or injury, and providing recommendations for best practices. This statement intends to support awareness, inform about best practices and early detection of neurologic complications to help minimize risk of harm, mobilize resources, and optimize functional outcomes and patient experience.

This statement and recommendations assist the practitioner and patient in making decisions about health care. These recommendations may be adopted, modified, or rejected according to clinical needs and constraints, are not intended to replace local institutional policies, are not intended as standards or absolute requirements, and their use cannot guarantee any specific outcome.[1]

Introduction:

Neuraxial analgesia/anesthesia is widely used in the delivery of anesthesia care in the obstetric context, helping nearly 3 million patients each year in the United States.[2] In 2020, 77% of parturients received neuraxial analgesia/analgesia and 31% of births occurred by cesarean delivery.[2] Peripartum neurological complications may significantly impact the parturient and lead to short-term, long-term discomfort or even neurologic deficits. Serious neurologic injury associated with regional anesthesia or pain medicine procedures is extremely rare.[3] Obstetric patients are even less likely than other patient populations to have serious neurologic injury

from neuraxial techniques.[3,4] However, awareness of, use of best practices and early detection of these injuries may help reduce or prevent permanent harm.[5-7]

The temporal association between neuraxial block and onset of neurological symptoms often means that anesthesiologists are consulted early in the presentation following childbirth.[6,7] Although most nerve injuries in obstetrics are related to factors other than regional anesthesia/analgesia, it is important to identify patients with immediate indication for neurologic or neurosurgical evaluation compared to patients with more common, less emergent neurologic injuries.[6-8]

Incidence:

The incidence of neuraxial anesthesia related nerve injury associated with regional anesthetic techniques varies widely among different patient populations and neurologic diagnoses. In a Swedish study of 1.7 million neuraxial blocks, the reported risk of spinal hematoma was 1:200,000 in young women having obstetric epidural blockade in comparison to 1:3600 for non-obstetric knee arthroplasty.[9] In a closed claims study of obstetric anesthesia, 37 women had nerve injury of which 43% represented radiculopathy of a lumbo-sacral root and 41% was secondary to a permanent or temporary spinal cord injury.[10] A closed claims study from Finland of 1.4 million neuraxial anesthesia/analgesia showed a higher rate of permanent injury with combined spinal epidural (CSE) techniques (1:9,900) in the overall population, but a lower incidence of permanent injury in the obstetric population of 1:144,000 epidural procedures and 1:66,000 spinal procedures.[11] In another study of over 318,000 obstetric patients, the overall rate of permanent injury was 1.2:100,000, with a higher rate for CSE of 3.9:100,000.[4] A prospective study of labor neuraxial procedures found a 0.96% incidence of peripheral nerve injuries of which about 75% were obstetric in nature.[12]

Neurologic Deficits and/or Injury:

Neurologic deficits and/or injury may be associated with many different events including but not limited to trauma, ischemia, entrapment, inflammation, toxicity, use of adjuvants, and pre-existing medical conditions.[3]

A. Obstetric-Related Neurologic Deficits

Obstetric-related neurologic injuries occur 5-10-fold more commonly than anesthetic-related neurologic injuries.[8] In the 0.96% of 19,840 patients with peripheral nerve symptoms after delivery, 0.76% were deemed exclusively obstetric in nature, with 0.2% including nerve root injury with possible epidural needle associated involvement.[12] Lumbosacral plexus injury at L4-S1 accounted for 37% of all injuries, and risk factors included gestational age >41 weeks (OR

3.8), late initiation of neuraxial anesthesia (OR 8.2), repeated neuraxial attempts (OR 2.8), forceps delivery (OR 9.8) and macrosomia (OR 6.8).[12] Lumbo-sacral plexopathy may be as common as 1:2000.[7] As the fetal head descends and rotates through the pelvis, the L4-5 nerve root may be exposed to compression at the pelvic brim or the lumbo-sacral plexus.[8] In efforts to reduce the national cesarean delivery rate, since 2014 nulliparous parturients are allowed to have longer than 3 hours for the second stage of labor before diagnosing arrest of labor, with an additional hour suggested in the setting of epidural analgesia.[13,14]

B. Anesthesia-Related Neurologic Deficits

Anesthetic-related neurologic deficits are lower in the obstetric population (1.2:100,000) compared to chronic pain patients (2.5:100,000) or perioperative patients (8:100,000), with CSE techniques being a higher relative risk (RR 6.5) compared to epidural, although still rare.[4] Closed claims studies suggest neurologic injury is associated with paresthesia on insertion, pain on injection, multiple attempts and delayed diagnosis and treatment.[8,15-19] Use of ultrasound during difficult neuraxial placement has been shown to reduce the incidence of paresthesia and increase first pass success, although studies have not been powered to detect differences in neurologic complications.[20-22]

C. Neuraxial Hematomas: Spinal or Epidural

Spinal canal (spinal or epidural) hematoma rarely occurs, estimated at 1:200,000 to 1:250,000 obstetric neuraxial procedures and associated with hemostatic abnormalities including anticoagulant use, severe thrombocytopenia, multiple attempts, and preexisting spinal pathology.[9,23] Epidural hematoma can occur spontaneously without neuraxial anesthesia and has also been associated temporally with needle/catheter placement or catheter removal in which 75% of cases will present within 24 hours.[3] In a review of 613 patients, almost one third of cases of spinal hematoma had no etiological factor identified.[24] A compressive epidural hematoma can cause irreversible neurological damage even when evacuated without delay,[11] however the goal associated with better outcomes is to perform decompressive surgery within 8–12 h.[5,25] Signs and symptoms concerning for spinal/epidural hematoma include acute back pain that may be transient and associated with progressive motor dysfunction, abnormal sensation, and bladder dysfunction.[26]

D. Neuraxial Infections: Epidural Abscess or Meningitis

Epidural abscess or meningitis is also rare, with an incidence of 1:63,000 to 1:145,000,[23,27] typically occurring a couple of days to a week after neuraxial blockade.[5] Concurrent medical diseases (e.g. diabetes, immunosuppression) and prolonged epidural catheterization may increase the relative risk.[28] In a review of 107 cases of spinal epidural abscess, the triad of back

pain, sensory deficit, and motor deficit was observed in 34% of patients, 40% of patients reported only back pain, and fever occurred in 74%.[25] Accurate and early diagnosis and therapy are important because spinal/epidural abscess/meningitis is associated with significant morbidity/mortality and early diagnosis is also associated with less severe neurologic deficits.[3,25] Most commonly, skin bacteria has been implicated, however, the proceduralist's oropharyngeal flora has also been causative in the unmasked setting.[28,29]

E. Neuraxial Direct Injury: Spinal Cord

Direct injury to the spinal cord from epidural or spinal needle insertion may rarely occur.[3,6,7] Symptoms of pain with radiation often precede injury. Pain on injection may indicate intraneuronal or intra-medullary location of needle.

F. Neuraxial Local Anesthetic Toxicity

Local anesthetic toxicity has been cited as associated with rare causes of neurotoxicity. Former use of high dose metabisulfite as a preservative (an acidic buffer), re-use of sterile equipment, and high concentration of local anesthetic (e.g. lidocaine 5% via microspinal catheter) have been associated with cauda equina syndrome or arachnoiditis.[30] Symptoms include progressive neurologic deficit or non-resolution of neuraxial block.

G. Vascular: Anterior Spinal Artery Syndrome

Anterior spinal artery syndrome is very rare in the obstetric population. Decreased perfusion of the anterior 2/3rds of the spinal cord may occur when an aberrant high takeoff of the artery of Adamkiewicz occurs leaving a branch of the internal iliac artery as the major blood supply, which may be susceptible to compression as it crosses the pelvic brim. Symptoms include sudden onset of symptoms and lack of fever, white count or pain.[30]

H. Other Central Nervous System Etiologies

Arterio-venous malformation (AVM), metastatic tumors and other pre-existing or evolving etiologies may also rarely impinge on the central nervous system and/or increase the chances of causing neurologic deficits. History of herniated disc is not an absolute contraindication to neuraxial analgesia/anesthesia.

I. Peripheral Nerve Deficits and/or Injuries

Postpartum peripheral nerve deficits and/or injuries occur in 0.3-2% of all deliveries[31,32] and include compressive injury to the lumbosacral nerve roots or trunk, femoral nerve, peroneal nerve, lateral femoral cutaneous nerve, sciatic nerve and obturator nerve. Risk factors

associated with lower extremity peripheral nerve injuries include nulliparity, patient positioning, fetal position, prolonged second stage of labor, and instrumental delivery.[31] Unilateral sensory deficits are most common, however, symptoms may involve motor deficits or bilateral distribution. The majority of cases report resolution of symptoms within 6 weeks to 2 months, however, it is reported that about 10% of cases persist at one year.[31,32]

Neurologic injury may occur within the central nervous system or peripheral nervous system, at several levels and by distinct mechanisms. A brief overview of symptoms associated with common deficits is provided. (See Table 1.)

Preoperative Anesthesia Assessment

The preoperative anesthesia assessment or predelivery consultation offers an opportunity to identify risk factors, medical conditions, neurologic symptoms, and discuss risks of neuraxial analgesia/anesthesia. Careful assessment and documentation before performing a neuraxial block helps guide informed decision making. The medical history includes documenting any existing neurological deficits, and any herbal or prescription medications that may affect coagulation, the presence of coagulopathy or thrombocytopenia and any existing infection or sepsis. The preoperative anesthesia assessment includes medical conditions that have been associated with increased chances for neurologic symptoms, injury, or claims which include diabetes, obesity, prior history of back pain/sciatica (OR 4.8) or pre-existing neurologic symptoms (OR 8).[10,33-35] Women who had epidurals for labor analgesia wanted to be informed of risks, even to the low level of 1:10,000-1:100,000.[36] Patients should be engaged as part of the shared decision making process and can even be asked to help self-monitor positioning and early reporting of symptoms.[37]

Previous Spine Surgery

Under most clinical circumstances, spinal anesthesia may be (a) technically easier to perform and (b) more reliable (i.e., higher clinical success rates) than epidural techniques in patients who have previously undergone spine surgery. Patients undergoing neuraxial anesthesia or analgesia after previous spine surgery do not seem to be at higher risk of new or progressive neurologic deficits.[3] Neuraxial ultrasound may help identify potential entry points to the spinal canal, reducing number of attempts.[20-22]

Intra-Partum Neuraxial Analgesia

Intra-partum monitoring of neuraxial analgesia includes vital signs, adequacy of pain relief and degree of motor blockade by a qualified individual.[5,38,39] The anesthesiologist should be alerted if there is an increasing or dense motor block.[5] Changing position during labor, avoiding hyperflexion of lower extremities and using lower concentrations of local anesthetic epidural infusions are suggested.[31,40]

Post-Neuraxial Post-Delivery Evaluation

Anesthesiologists are often consulted when a post-partum patient complains of or has symptoms of headache, back pain, and/or leg numbness/weakness. A timely response and evaluation is often warranted. ASA and AWHONN guidelines support evaluation of the degree of motor and sensory block following neuraxial anesthesia/analgesia.[38,39] Tools to assess motor function include the Bromage scale and the straight leg raise test. Neurologic monitoring after delivery includes assessment of motor block every hour until resolution.[38,39] If motor block persists at 4 hours from discontinuation of neuraxial anesthetic infusion or last dose of medication, an anesthesia professional should be consulted to evaluate.[38,39] A history and physical including a targeted neurologic exam should be performed.[7] (see Tables 2, 3) This may or may not require further escalation/management depending on the individual circumstances of the case (e.g., other features of the block, nature and timing of epidural boluses, duration infusion, etc.) but abnormalities should continue to be monitored.[5] Familiarity with or reference to dermatomal and nerve distribution patterns may be helpful.[30]

Imaging

Although rare, symptoms such as acute onset back pain, radicular leg pain, urinary and anal dysfunction together with bilateral lower leg numbness and weakness need rapid neuroimaging along with neurosurgery/neurology consultation to exclude a central nervous system lesion. Decompressive surgery may be indicated for mass effect, ideally within 8-12 hours from the onset of symptoms.[5-7] Magnetic resonance imaging (MRI) differentiates soft tissues, identifies coexisting spinal canal pathology, and locates an epidural catheter more effectively than does computerized tomography (CT).[3] However, CT scan can identify those space-occupying compressive processes that may require emergent surgical decompression (i.e., spinal abscess or hematoma) and is often more readily available.[3] Policies should therefore account for the ease of local access to imaging and the possible need for further referral.[5] Note that not all indwelling epidural catheters are compatible with MRI.

Consultation with Neurology or Neurosurgery

New onset neurologic weakness after a symptom-free interval or progressive increase of neurologic symptoms should be evaluated promptly as it could imply changing pathology such as increasing compression from an enlarging mass (e.g. hematoma or abscess).[6,7] Definitive diagnosis and treatment are best determined in consultation with neurology or neurosurgery colleagues.[3] Acute obstetric surgical related injury should also be considered with the possibility of nerve transection, excessive traction, or wayward ligatures. A review reported that more than 90% of surgically explored iatrogenic nerve injuries were linked to intraoperative causes.[3]

Timing of Symptoms

Fortunately, neurologic deficits are generally present within the first 48 hours after delivery and most are transient or short term (<2-3 months). Neurologic deficits after delivery occurred in

0.11% of women who had neuraxial anesthesia/analgesia, with 85% first noticing symptoms with the first attempt to stand.[41] Women should be informed of the time scale for return of motor and sensory function and encouraged to report any delay.[5] Symptoms may even be first reported or noted after discharge in 1.4%, of which 96% being obstetric-related[42] and many women did not even report symptoms to their physician.[43]

The timing of resolution and the prognosis for neurologic deficits often depends on the degree of the initial deficit and signs of improvement within the first 24 h.[6,7] Routine recovery of sensorimotor block after cesarean delivery typically occurs 2–3 h after intrathecal bupivacaine and 3–5 h after epidural bupivacaine and/or lidocaine, although this can vary both as an individual and related to total dose of local anesthetic received, and recovery can be highly variable.[5] In obstetrical patients referred to a neurology service, full neurologic recovery took 5 plus–minus 2.5 weeks in 64%, with minor residual symptoms in the remaining 36%.[41]

Management

Patients with neurologic deficits will benefit from emotional support, physical therapy, and possibly social worker assistance. Further neurologic work-up may include electromyography (EMG) testing or nerve conduction studies. Note that in acute injury, EMG changes will not be seen for up to a week and many neurologists wait up to six weeks before testing.

Pure sensory deficits that occur within the territory of the lower dermatome or a classic compression point, for example, common peroneal nerve compression at the fibular head, can be observed and are expected to resolve within days to weeks.[3] Repeated observation and objective neurological examinations should be strategically timed to assess for progressive improvement or deterioration of symptoms. Neurologic consultation should be considered when the deficit involves motor function, is progressive, is characterized by recrudescence of neural blockade, or is difficult to localize and/or reconcile with the expected distribution of the anesthetic block or surgery. Functional deficits from neurological injuries should be rehabilitated in concert with physical therapy and rehabilitation specialists.[3]

Recommended Best Practices

Preoperative evaluation should include pertinent medical history that relate to factors that may increase chances for neurologic symptoms post-delivery. These factors should be included in the process of informed consent/shared decision making. The patient may even be engaged to help check their own positioning and communications regarding changes in pain, sensory or motor function. Paresthesia that occurs with needle advancement or injection should prompt the cessation of the procedure and repositioning of the needle should be considered.[3] Use of ultrasound for neuraxial placement may be helpful for anticipated difficult blocks.[20-22]

Intrapartum steps to help reduce nerve injuries include changing lower extremity position frequently during a prolonged second stage of labor, avoiding prolonged hyperflexion of thigh and knees, avoiding extreme thigh abduction and external rotation, and minimizing motor and overly dense sensory block by using lower concentrations of local anesthetic for epidural analgesia during labor.[31,40] Monitoring of pain relief and motor block during labor epidural and monitoring of vitals and motor function recovery following delivery are important.

Early recognition and intervention may help improve outcomes in patients with hemorrhagic, infectious, or inflammatory conditions.[5]

An anesthesia provider should be called to evaluate any patient whose motor block has not resolved after 4 hours since the last dose of local anesthetic.[38,39] Policies and triggers for communication should be encouraged to help prompt assessment and further testing or consultation, if needed. Patients should be included in discussions.

Patient Engagement

Patient description of localizing (e.g. left, right, midline) during neuraxial instrumentation may be recognized as a helpful sign. Positioning the patient during labor, pushing, delivery or the recovery period may contribute to various peripheral nerves' compression and the patient should be encouraged to help check that their position is one that is normally comfortable for them, especially in the case of preexisting back pain or other neurologic symptoms.[8] Patients may be educated to report increasing motor or sensory blockade post-partum.

Conclusion

Neurologic complications associated with neuraxial analgesia/anesthesia in obstetric anesthesia are rare. Understanding the pathophysiology and risk factors associated with neuraxial and peripheral nerve injury and early detection may allow anesthesiologists to minimize the number or shorten the duration of adverse neurologic outcomes.

Key Points

- Clinicians are advised to be aware of and to avoid conditions that have been linked to the formation of epidural hematoma or epidural abscess.
- Discrimination between surgical, anesthetic, and patient factors is often difficult.
- In the setting of neuraxial anesthesia, concern of compressive spinal cord dysfunction requires emergent neuroimaging.
- Magnetic resonance imaging (MRI) is the preferred imaging modality. However, imaging should not be delayed to obtain an MRI or to get a neurologic consultation. Computerized

tomography (CT) is acceptable as initial imaging to exclude a compressive lesion.

- Diagnosis of a compressive lesion (epidural hematoma or spinal epidural abscess) within or near the neuraxis requires emergent surgical consultation for consideration of decompression.

- Preoperative assessments should include pertinent past medical history, discussion of potential risk factors, patient engagement and shared decision making.

- Monitoring post-procedure and in the immediate post-partum period helps to identify and manage people with potential neurological injuries.

- Policies should encourage prompt assessment, communication, and escalation of care when significant neurologic symptoms occur and/or persist.

Table 1

Obstetric-related lower extremity nerve deficits

Type of Nerve	Type of Deficit	Anatomy	Mechanism of Injury	Risk Factors/Prevention
Lumbosacral plexus L2-S2	Sensory: posterior thigh, leg numbness Motor: weak hip adduction, foot drop	Lumbosacral trunk formed by L4 and L5 and travels in close contact with sacral ala and is joined by sacral nerve root S1 at pelvic brim	Compression of plexus by fetal head as it descends in to pelvis, use of forceps	Fetal macrosomia, malpresentations (occipitoposterior or brow presentations), cephalopelvic disproportion, pelvic features (platypelloid pelvis, shallow anterior sacral ala, flattened sacral promontory)
Sciatic Nerve L2-S3 Variations in piriformis muscle	Sensory: posterior thigh, paresthesias over dorsum of foot and lateral calf Motor: knee flexion, foot drop Piriformis syndrome:	The largest nerve in the body, the ventral divisions of the L2-S3 nerve roots combine to form the sciatic nerve, passing through the greater sciatic foramen where it has already split into the larger tibial and smaller peroneal trunks.	Compression by fetal head at pelvic brim Piriformis syndrome due to hip flexion	High lithotomy position with prolonged hip hyperflexion and excessive external rotation, forceps-associated vaginal delivery. Variation in piriformis muscle causes nerve

	lower lumbar or posterior buttock pain			compression at greater sciatic foramen
Superior Gluteal nerve L4-S1	Sensory: buttock pain Motor: abductor weakness, limping	Gluteal nerve passes greater sciatic foramen between gluteus medius and minimus and divides in to superior gluteal nerve and inferior gluteal nerve	Compression around the sciatic foramen	
Common peroneal nerve L4-S1	Sensory: paresthesias over the lateral calf and dorsum of foot just proximal to first and second toes Motor: Foot drop, weakness of eversion and dorsiflexion	Nerve passes over the lateral head of fibula and descends down the lateral calf	Compression against the lateral head of fibula, pressure by stirrups or side rail	Lithotomy position, legs leaning against bedrail, prolonged squatting during childbirth, hyperflexion of knees during delivery, patient holding her own legs with fingers placed over the anterior tibia with palms over the fibular head, labor partner pushing her legs back
Lateral femoral cutaneous nerve L2-L3	Sensory: burning, pain, numbness of anterolateral thigh called meralgia paresthetica	Nerve exits pelvis under the inguinal ligament and then passes medial and inferior to the anterior superior iliac spine	Prolonged pushing with hip flexion using stirrups and nerve compressed under inguinal ligament	Obesity, tight clothing (causes increased pressure at inguinal ligament) May be avoided by frequent changes of position during labor, shortening of pushing time by allowing for passive descent of fetus
Femoral nerve L2-L4	Sensory: anterior thigh and medial leg Motor: quadriceps weakness, hip flexion (if proximal injury), knee extension	Nerve emerges from psoas muscle and travels under inguinal ligament	Prolonged pushing in extreme hip flexion with stirrups and nerve compressed under inguinal ligament Retraction	Use of the squatting bar to keep hips hyperflexed. Hips should be unflexed (rested) between periods of pushing.

			during cesarean delivery Nerve compressed within the groin (e.g., by hematoma)	
Obturator nerve L2-L4	Sensory: medial thigh Motor: hip adduction and internal rotation (Medial thigh pain worse with thigh extension, medial rotation and adduction)	The obturator nerve passes through the psoas muscle to the lateral pelvic brim, lateral pelvic wall and obturator canal.	Compression by descending fetal head or forceps against the lateral pelvic wall or in the obturator canal	Athletes, osteitis pubis, lithotomy position, and pelvic fractures. Pudendal nerve blocks can cause hematomas and entrapment of nerve.

Modified from Zakowski M. Obstetric-related neurological complications. *Int Anesthesiol Clin.* Summer 2014;52(3):40-60.

Table 2

Signs and Symptoms warranting urgent evaluation and consultation[7]

Lower limb numbness and weakness persisting beyond the duration expected of local anesthetic(s) used.
New neurologic signs or symptoms appearing after initial recovery
Radicular pain
Cauda equina syndrome
Sudden onset of severe back pain
Headache and neck stiffness
Bowel or bladder dysfunction

Table 3

History and physician examination, suggested.[7]

History
Onset, duration, degree of sensory and/or motor deficits
Risk factors for neurologic injury
Obstetric history (e.g. forceps delivery, prolonged labor/pushing)
Anesthetic history (e.g. neuraxial difficulties)

Examination

Vital Signs including temperature

Targeted neurologic exam

- Sensation
- Light touch, pinprick
- Distribution – dermatomal or peripheral nerve
- Muscle strength
- Reflexes

Back examination

- Tenderness/erythema
- Pain superficial or deep
- Sensation over paraspinous muscles (posterior rami)

Tables 2 and 3 Modified from ref: Morosan M., Wotherspoon D. Clinical Guideline for Management of Maternal Postnatal Neurology Injuries. https://www.nnuh.nhs.uk/publication/download/management-of-maternal-postnatal-neurology-injuries-v2-1/: Norfolk and Norwich University Hospitals NHS Foundation Trust; 2022. Accessed June 2023.

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