Anesthesiology 2010; 112:000–000

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Practice Advisory for the Prevention, Diagnosis, and Management of Infectious Complications Associated with Neuraxial Techniques

*A Report by the American Society of Anesthesiologists Task Force on Infectious Complications Associated with Neuraxial Techniques**

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Received from American Society of Anesthesiologists, Park Ridge, Illinois. Submitted for publication October 22, 2009. Accepted for publication October 22, 2009. Supported by the American Society of Anesthesiologists and developed under the direction of the Committee on Standards and Practice Parameters, Jeffrey L. Apfelbaum, M.D. (Chair). Approved by the House of Delegates on October 21, 2009. A complete bibliography used to develop this Advisory is available as Supplemental Digital Content 1, at http://links.lww.com/ALN/A564.

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Methodology

A. Definition of Infectious Complications Associated with Neuraxial Techniques

For this Advisory, infectious complications are defined as serious infections associated with the use of neuraxial techniques. Neuraxial techniques include, but are not limited to, epidural, spinal, or combined spinal–epidural administration of anesthetics, analgesics, or steroids; lumbar puncture or spinal tap; epidural blood patch; epidural lysis of adhesions; intrathecal chemotherapy; epidural or spinal injection of contrast agents for imaging; lumbar or spinal drainage catheters; or spinal cord stimulation trials. Infectious complications include, but are not limited to, epidural, spinal, or subdural abscess; paravertebral, paraspinous, or psoas abscess; meningitis; encephalitis; sepsis; bacteremia; viremia; fungemia; osteomyelitis; or discitis. Although colonization of the catheter may be considered a precursor to infection, colonization *per se* is *not* considered an infection.

B. Purpose

The purpose of this Advisory is to reduce the risk of infectious complications associated with neuraxial techniques by identifying or describing (1) patients who are at increased risk of infectious complications, (2) techniques for reducing infectious risk, and (3) interventions to improve outcomes after infectious complications.

C. Focus

This Advisory focuses on patients receiving neuraxial techniques. The practice settings include inpatient (*e.g.*, operating rooms, intensive care units, postoperative surgical floors, labor and delivery settings, or hospital wards) and ambulatory facilities such as pain clinics.

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This Advisory does not address patients with implantable drug or chronic indwelling neuraxial analgesic delivery systems or injection techniques outside the neuraxis (*e.g.*, peripheral nerve blocks or joint and bursal injections).

D. Application

This Advisory is intended for use by anesthesiologists and other physicians and healthcare providers performing neuraxial techniques. The Advisory may also serve as a resource for other healthcare providers involved in the management of patients who have undergone neuraxial procedures.

E. Task Force Members and Consultants

The ASA appointed a Task Force of 10 members, including anesthesiologists in both private and academic practice from various geographic areas of the United States and 2 consulting methodologists from the ASA Committee on Standards and Practice Parameters.

The Task Force developed the Advisory by means of a seven-step process. First, they reached consensus on the criteria for evidence. Second, a systematic review and evaluation was performed on original, published, peer-reviewed, and other research studies related to infectious complications associated with neuraxial techniques. Third, a panel of expert consultants was asked to (1) participate in opinion surveys on the effectiveness of various strategies for prevention, diagnosis, and management of infectious complications associated with neuraxial techniques and (2) review and comment on a draft of the Advisory developed by the Task Force. Fourth, opinions about the Advisory were solicited from a random sample of active members of the ASA. Fifth, the Task Force held open forums at four major national meetings† to solicit input on its draft advisory statements. Sixth, the consultants were surveyed to assess their opinions on the feasibility of implementing this Advisory. Seventh, all available information was used to build consensus within the Task Force to formulate the advisory statements (appendix 1).

F. Availability and Strength of Evidence

Preparation of this Advisory followed a rigorous methodologic process (appendix 2). Evidence was obtained from two principal sources: scientific evidence and opinion-based evidence.

Scientific Evidence

Study findings from published scientific literature were aggregated and reported in summary form by evidence category, as described later. All literature (*e.g.*, randomized controlled trials, observational studies, and case reports) relevant to each topic was considered when evaluating the findings. For reporting purposes in this document, only the highest level of evidence (*i.e.*, levels 1, 2, or 3 identified below) within each category (*i.e.*, A, B, or C) is included in the summary.

Category A: Supportive Literature

Randomized controlled trials report statistically significant ($P < 0.01$) differences among clinical interventions for a specified clinical outcome.

Level 1: The literature contains multiple, randomized controlled trials, and the aggregated findings are supported by meta-analysis.‡

Level 2: The literature contains multiple, randomized controlled trials, but there is an insufficient number of studies to conduct a viable meta-analysis for the purpose of this Advisory.

Level 3: The literature contains a single randomized controlled trial.

Category B: Suggestive Literature

Information from observational studies permits inference of beneficial or harmful relationships among clinical interventions and clinical outcomes.

Level 1: The literature contains observational comparisons (*e.g.*, cohort and case–control research designs) of clinical interventions or conditions and indicates statistically significant differences between clinical interventions for a specified clinical outcome.

Level 2: The literature contains noncomparative observational studies with associative (*e.g.*, relative risk and correlation) or descriptive statistics.

Level 3: The literature contains case reports.

Category C: Equivocal Literature

The literature cannot determine whether there are beneficial or harmful relationships among clinical interventions and clinical outcomes.

Level 1: Meta-analysis did not find significant differences among groups or conditions.

Level 2: There is an insufficient number of studies to conduct meta-analysis, and (1) randomized controlled trials have not found significant differences among groups or conditions or (2) randomized controlled trials report inconsistent findings.

Level 3: Observational studies report inconsistent findings or do not permit inference of beneficial or harmful relationships.

Category D: Insufficient Evidence from Literature

The lack of scientific evidence in the literature is described by the following conditions:

(1) No identified studies address the specified relationships among interventions and outcomes.

† American Society of Regional Anesthesia, Huntington Beach, California, November 22, 2008. Postgraduate Assembly in Anesthesiology, New York, New York, December 13, 2008. American Society of Regional Anesthesia, Phoenix, Arizona, May 1, 2009. Society of Obstetrical Anesthesia and Perinatology, Washington DC, May 1, 2009.

‡ All meta-analyses are conducted by the ASA methodology group. Meta-analyses from other sources are reviewed but not included as evidence in this document.

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(2) The available literature cannot be used to assess relationships among clinical interventions and clinical outcomes. The literature either does not meet the criteria for content as defined in the Focus of the Advisory or does not permit a clear interpretation of findings due to methodologic concerns (*i.e.*, confounding in study design or implementation).

Opinion-based Evidence

All opinion-based evidence relevant to each topic (*e.g.*, survey data, open-forum testimony, Internet-based comments, letters, and editorials) is considered in the development of this Advisory. However, only the findings obtained from formal surveys are reported.

Opinion surveys were developed by the Task Force to address each clinical intervention identified in the document. Identical surveys were distributed to two groups of respondents: expert consultants and ASA members.

Category A: Expert Opinion

Survey responses from Task Force–appointed expert consultants are reported in summary form in the text. A complete listing of consultant survey responses is reported in a table in appendix 2.

Category B: Membership Opinion

Survey responses from a random sample of members of the ASA are reported in summary form in the text. A complete listing of ASA member survey responses is reported in a table in appendix 2.

Expert consultant and ASA membership survey responses are recorded using a five-point scale and summarized based on median values.§

Strongly agree: Median score of 5 (at least 50% of the responses are 5).
Agree: Median score of 4 (at least 50% of the responses are 4 or 4 and 5).
Equivocal: Median score of 3 (at least 50% of the responses are 3, or no other response category or combination of similar categories contain at least 50% of the responses).
Disagree: Median score of 2 (at least 50% of responses are 2 or 1 and 2).
Strongly disagree: Median score of 1 (at least 50% of responses are 1).

Category C: Informal Opinion

Open-forum testimony, Internet-based comments, letters, and editorials are all informally evaluated and discussed during the development of the Advisory. When warranted, the Task Force may add educational information or cautionary notes based on this information.

§ When an equal number of categorically distinct responses are obtained, the median value is determined by calculating the arithmetic mean of the two middle values. Ties are calculated by a predetermined formula.

Advisories

I. Prevention of Infectious Complications Associated with Neuraxial Techniques

Topics addressed with regard to the prevention of infectious complications related to neuraxial techniques are as follows: (1) conducting a history, physical examination, and preprocedure laboratory evaluation; (2) use and selection of neuraxial technique; (3) prophylactic antibiotic therapy; (4) use of aseptic techniques; (5) selection of antiseptic solution; (6) use of sterile occlusive dressings at the catheter insertion site; (7) use of a bacterial filter during continuous epidural infusion; (8) limiting disconnection and reconnection of neuraxial delivery systems; (9) management of an accidentally disconnected catheter; and (10) limiting the duration of catheterization. *Advisory statements for the above topics are reported below after descriptions of the evidence for all 10 topics.*

History, physical examination, and preprocedure laboratory evaluation: Although no controlled trials were found that addressed the impact of conducting a focused history (*e.g.*, reviewing medical records), a physical examination or a preprocedure laboratory evaluation, several studies with observational findings suggest that certain patient or clinical characteristics (*e.g.*, cancer, diabetes, and impaired immune response) may be associated with neuraxial-related infections (*Category B2 evidence*).[1–9] In addition, case reports indicate that conditions such as preexisting infections, pancreatitis, gastrointestinal bleeding, drug, or alcohol abuse may also be associated with neuraxial-related infections (*Category B3 evidence*).[10–30]

Both consultants and ASA members strongly agree that history, physical examination, and review of relevant laboratory studies should be conducted before performing neuraxial techniques. Consultants agree and ASA members strongly agree that history, physical examination, and review of relevant laboratory studies are useful in identifying patients at increased risk of infectious complications before performing neuraxial techniques.

Use and selection of neuraxial technique: The risk of developing infectious complications associated with specific neuraxial techniques is addressed by making the following comparisons: (1) epidural *versus* spinal techniques, (2) continuous infusion or catheter *versus* single injection techniques, (3) lumbar epidural *versus* thoracic epidural techniques, and (4) lumbar epidural *versus* caudal techniques.

No randomized controlled trials were found that reported differences between specific neuraxial techniques regarding infectious complications (*Category D evidence*). One nonrandomized comparative study reports no significant differences in bacterial contamination of needles when epidural lumbar puncture is compared with spinal lumbar puncture (*Category C2 evidence*).[31] The literature is insufficient to evaluate differences in infectious complications between continuous in-

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fusion or catheter and single injection techniques (*Category D evidence*). One case–control study reports no differences in epidural catheter infections when the lumbar insertion technique is compared with the thoracic insertion technique (*Category C3 evidence*).[32] Three nonrandomized comparative studies report no statistically significant ($P > 0.01$) differences in bacterial colonization of the catheter tip when the lumbar insertion site is compared with the caudal insertion site (*Category C3 evidence*).[33–35]

Both consultants and ASA members strongly agree that, for patients determined to be at risk of infectious complications, the decision to select a neuraxial technique should be determined on a case-by-case basis. Consultants agree and ASA members strongly agree that, for these patients, alternatives to neuraxial techniques should be considered. Moreover, both consultants and ASA members strongly agree that the evolving medical status of the patient should be considered in the selection of neuraxial technique. Both consultants and ASA members strongly agree that a lumbar puncture should be avoided in a patient with a known epidural abscess.

Prophylactic antibiotic therapy: The literature is insufficient to assess whether prophylactic antibiotic therapy reduces the risk of infectious complications associated with neuraxial techniques (*Category D evidence*). Case reports indicate that infectious complications may occur even when prophylactic antibiotic therapy is administered (*Category B3 evidence*).[10,36,37]

Both consultants and ASA members strongly agree that, when a neuraxial technique is selected in a known or suspected bacteremic patient, preprocedure antibiotic therapy should be administered.

Use of aseptic techniques: The literature is insufficient regarding the efficacy of aseptic techniques during neuraxial procedures (*e.g.*, removal of jewelry, hand washing, and wearing of caps, masks, and sterile gloves) in reducing infectious complications (*Category D evidence*). Studies with observational findings indicate that infections occur even when aseptic techniques are used (*Category B2 evidence*),[38–40] and case reports indicate similar outcomes (*Category B3 evidence*).[12,19,25–27,30,41–64]

The literature is insufficient regarding the choice of specific antiseptic solutions in reducing infectious complications associated with neuraxial techniques (*Category D evidence*). However, two randomized controlled trials indicate that the rate of positive bacteriologic cultures is reduced when the patient's skin is prepared with chlorhexidine compared with povidone-iodine before epidural catheterization (*Category A2 evidence*).[65,66] Two randomized controlled trials report reduced bacterial growth on the skin and/or on catheters and needles when alcohol is combined with povidone-iodine compared with povidone-iodine alone (*Category A2 evidence*).[66,67]

Both consultants and ASA members strongly agree that aseptic techniques should always be used during the placement of neuraxial needles and catheters, including hand washing, wearing of sterile gloves, wearing of caps, wearing of masks covering both the mouth and nose, use of individual packets of skin preparation, and sterile draping of the patient. In addition, both consultants and ASA members agree that aseptic techniques should include removal of jewelry, and they are equivocal regarding the wearing of gowns. Finally, consultants agree and ASA members are uncertain regarding whether aseptic techniques should include changing masks before each new case.

Selection of antiseptic solution: Although the literature is insufficient regarding whether the use of individual antiseptic packets compared with multiple-use bottles of antiseptic reduces infectious complications (*Category D evidence*), one observational study indicates that microbial contamination occurs when previously opened multiple-use bottles of povidone-iodine are used compared with no contamination with the use of unopened multiple-use bottles (*Category B1 evidence*).[68] Further, one case report indicates lumbar spondylodiscitis occurring in a patient whose skin was cleansed with povidone-iodine obtained from a multiple-use bottle (*Category B3 evidence*).[51]

The consultants indicate a preference for chlorhexidine with alcohol as a skin preparation solution before performing a neuraxial technique, whereas the ASA members indicate no clear preference among chlorhexidine with or without alcohol or povidone-iodine with or without alcohol.

Use of sterile occlusive dressings at the catheter insertion site: No comparative studies were found that indicates whether the use of sterile occlusive dressings at the catheter insertion site reduces infectious complications (*Category D evidence*). One observational study reports positive cultures in more than 30% of catheter tips (*Category B2 evidence*).[69] Four case reports indicate that skin or epidural abscesses can occur when occlusive dressings are used (*Category B3 evidence*).[27,52,70,71]

Both consultants and ASA members strongly agree that sterile occlusive dressings should be used at the catheter insertion site.

Use of a bacterial filter during continuous epidural infusion: No comparative studies were found that indicates whether the use of bacterial filters reduce infectious complications (*Category D evidence*). One nonrandomized comparative study found that the use of a bacterial filter during continuous epidural infusion does not reduce the number of positive cultures distal to the filter (*Category C2 evidence*).[72] Three studies with observational findings indicate that infections and epidural abscesses can occur in the presence of micropore filters (*Category B2 evidence*).[38,69,73]

ASA members agree and consultants are uncertain regarding whether bacterial filters should be used during continuous epidural infusion.

Limiting disconnection and reconnection of neuraxial delivery systems: The literature is insufficient to evaluate whether limiting disconnection and reconnection of neuraxial delivery systems are associated with reduced frequency of infectious complications (*Category D evidence*).

Both consultants and ASA members strongly agree that disconnection and reconnection of neuraxial delivery systems should be limited to minimize the risk of infectious complications.

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Management of an accidentally disconnected catheter: The literature is insufficient to evaluate whether removal of an accidentally disconnected catheter is associated with reduced frequency of infectious complications (*Category D evidence*).

ASA members are equivocal, and consultants disagree that accidentally disconnected catheters should be immediately removed. However, the Task Force believes that, to avoid infectious complications, an unwitnessed accidentally disconnected catheter should be removed.

Limiting the duration of catheterization: No comparative studies were found that indicate whether longer duration of catheterization is associated with increased frequency of infectious complications (*Category D evidence*). Studies with observational findings indicate that infections and epidural abscesses occur in the presence of longer durations (*Category B2 evidence*),[1,6,74–79] and case reports corroborate these findings (*Category B3 evidence*).[11,13,16,17,22,26,41,53,80–89] However, no literature was found that identified a specific duration of catheterization associated with an increased risk of infectious complications (*Category D evidence*).

Both consultants and ASA members strongly agree that catheters should not remain *in situ* longer than clinically necessary.

Advisory Statements for Prevention

History and physical examination relevant to the procedure and review of relevant laboratory studies should be conducted‖ to identify patients who may be at risk of infectious complications before performing neuraxial techniques. Consider alternatives to neuraxial techniques for patients at high risk. When neuraxial techniques are selected in a known or suspected bacteremic patient, consider administering preprocedure antibiotic therapy. Selection of neuraxial technique should be determined on a case-by-case basis, including consideration of the evolving medical status of the patient. Lumbar puncture should be avoided in the patient with a known epidural abscess.

Aseptic techniques should always be used during preparation of equipment (*e.g.*, ultrasound) and the placement of neuraxial needles and catheters, including (1) removal of jewelry (*e.g.*, rings and watches), hand washing, and wearing of caps, masks (covering both mouth and nose and consider changing before each new case), and sterile gloves; (2) use of individual packets of antiseptics for skin preparation; (3) use of chlorhexidine (preferably with alcohol) for skin preparation, allowing for adequate drying time#; (4) sterile draping of the patient; and (5) use of sterile occlusive dressings at the catheter insertion site.**

Bacterial filters may be considered during extended continuous epidural infusion. Limit the disconnection and reconnection of neuraxial delivery systems to minimize the risk of infectious complications. Consider removing unwitnessed accidentally disconnected catheters. Finally, catheters should not remain *in situ* longer than clinically necessary.

II. Diagnosis of Infectious Complications Associated with Neuraxial Techniques

Topics addressed with regard to the diagnosis of infectious complications consists of (1) periodically checking for signs or symptoms of infection (*e.g.*, erythema, tenderness, and fever), (2) ordering blood tests (*e.g.*, leukocyte count, sedimentation rate, and C-reactive protein), (3) ordering a culture or cerebrospinal fluid analysis, (4) ordering imaging studies (magnetic resonance imaging, computed tomography, and myelography), and (5) periodically checking patients' neurologic function. *Advisory statements for the above topics are reported below after descriptions of the evidence for all five topics*.

Periodically checking for signs or symptoms of infection: Studies with observational findings and case reports indicate that early signs and symptoms (*e.g.*, fever, backache, headache, erythema, and tenderness at the insertion site) may be associated with the onset of infectious complications, and additional symptoms (*e.g.*, stiff neck, photophobia, radiating pain, loss of motor function, and confusion) may indicate further development of the infectious complication (*Category B2-B3 evidence*).[2,4,7,10–30,36,37,41–58,60,62–64,69,70,80–82,84–86,89–157] The Task Force notes that signs or symptoms can either manifest within a few hours or may not be apparent for weeks after neuraxial administration.

Both consultants and ASA members strongly agree that periodic evaluation of patients for signs and symptoms (*e.g.*, fever, headache, backache, erythema, and tenderness at the insertion site) is essential for the early identification of infectious complications. They agree that signs and symptoms should be assessed once per day and strongly agree that signs and symptoms should be promptly attended to minimize the impact of an infectious complication. Finally, they strongly agree that, if an infection is suspected, an *in situ* catheter should be immediately removed.

Ordering blood tests: Numerous case reports indicate that blood tests (*e.g.*, leukocyte counts, sedimentation rates, and C-reactive protein) may be useful in identifying infection (*Category B3 evidence*).[11,12,20,21,24,25,27,29,30,43–46,48,51–53,57–63,81,89,92,100,104,108,114,115,119,121,123,124,127–129,132,133,138,139,145–147,153,156]

Both consultants and ASA members agree that, if an infection is suspected, blood tests should be ordered.

‖ Ordering, conducting, or requiring routine laboratory studies may not be necessary.

When chlorhexidine is not available, use of povidone-iodine with alcohol is preferred over povidone-iodine alone. Consult product labels for instructions regarding the proper use, application, and drying time for skin antiseptics.

** The Centers for Disease Control and Prevention and the American Society of Regional Anesthesia and Pain Medicine have also published recommendations regarding asepsis and management of patients undergoing neuraxial techniques. These are available at the CDC (http://www.cdc.gov/ncidod/dhqp/injectionSafetyPractices.html) and ASRA (http://www.asra.com/consensus-statements/3.html) Web sites, both accessed August 31, 2009.

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Ordering a culture or cerebrospinal fluid analysis: Studies with observational findings and case reports indicate that cultures (*e.g.*, blood, skin, abscess, or cerebrospinal fluid) can be useful in identifying the causal agent (*e.g.*, viral, bacterial, or fungal) of the infectious complication (*Category B2-B3 evidence*).[2,4,7,10–13,15–19,21–23,25,27–30,36–38,40–45,47–49,51–60,62,63,69,70,76–78,80–82,84–86,88,89,92–96,99–101,104,106–113,115-118,120,122–141,143,144,146–149,152–154,156–168]

Both consultants and ASA members strongly agree that, if an infection is suspected, the catheter tip should be cultured. In addition, they agree that additional cultures should be obtained.

Ordering imaging studies: Studies with observational findings and case reports indicate that conducting a magnetic resonance imaging, computed tomography, or myelogram is useful in identifying infectious complications (*e.g.*, epidural abscess, discitis, and osteomyelitis) (*Category B2–B3 evidence*).[4,7,10–13,15,17,19,20,23–27,29,41,42,46,48,51–54,61,62,70,81,82,84,86–89,92,93,95,96,100,101,104–106,108,110,113–118,122,123,129,130,132,135,136,138,139,141,143,145,147–150,153,156,157,165,166,169–173]

Both consultants and ASA members strongly agree that, if an abscess is suspected or neurologic deficit is present, imaging studies should be performed.

Periodically checking patients' neurologic function: Several case reports indicate that the presence of neurologic deficits (*e.g.*, motor and sensory loss and paraplegia) may indicate the presence of an infectious complication (*Category B3 evidence*).[7,12,27,92,95,101,106,115,129,138,143,166]

Both consultants and ASA members strongly agree that, if an abscess is suspected or neurologic deficit is present, consultation with other appropriate specialties should be promptly obtained.

Advisory Statements for Diagnosis

Daily evaluation of patients with indwelling catheters for early signs and symptoms (*e.g.*, fever, backache, headache, erythema, and tenderness at the insertion site) of infectious complications should be performed throughout their stay in the facility.†† To minimize the impact of an infectious complication, promptly attend to signs or symptoms. If an infection is suspected: (1) remove an *in situ* catheter and consider culturing the catheter tip, (2) order appropriate blood tests, (3) obtain appropriate cultures, and (4) if an abscess is suspected or neurologic dysfunction is present, imaging studies should be performed and consultation with other appropriate specialties should be promptly obtained.

III. Management of Infectious Complications

Topics addressed with regard to management or treatment of infectious complications includes (1) administration of antibiotics, (2) consultation with appropriate specialists to determine optimal nonsurgical treatment, and (3) consultation with a surgeon to determine whether surgical intervention or percutaneous drainage is necessary. *Advisory statements for the above topics are reported below after descriptions of the evidence for all three topics*.

Administration of antibiotics: Numerous case reports indicate that appropriate antibiotic therapy is an effective treatment for infections (*Category B3 evidence*).[20,23,27–29,36,41–46,48,50,51,54,55,57–60,63,80,84,85,94,95,99,100,105–107,110–114,117,123,125–129,131,132,134,136,140,141,144,146,150–154,156,165,166,174]

Both consultants and ASA members strongly agree that appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious infection.

Collaboration with appropriate medical specialists to determine optimal nonsurgical treatment: The literature is insufficient to evaluate the impact of collaboration with appropriate medical specialists on outcome (*Category D evidence*). The Task Force believes that appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious infection, and consultation with a physician with expertise in the diagnosis and treatment of infectious diseases should be considered. However, the Task Force recognizes that even with prompt medical intervention, recovery may be poor or incomplete.

The consultants agree and ASA members strongly agree that a specialist or physician with expertise in the diagnosis and treatment of infectious diseases should be consulted at the first sign of a serious infection.

Collaboration with a surgeon to determine whether surgical intervention is warranted: No controlled studies were found that reported differences in neurologic outcome associated with either percutaneous drainage or surgical interventions (*Category D evidence*). Case reports indicate that percutaneous drainage of an abscess may be effective in the resolution of symptoms (*Category B3 evidence*).[11,83,148] Case reports indicate that surgical interventions (*e.g.*, surgical drainage of an abscess, debridement, and laminectomy) for an abscess may be effective and can result in improved neurologic function, although in some cases motor or sensory deficits may persist (*Category B3 evidence*).[10,12,15,18,19,21,26,27,29,48,52–54,56,61,62,70,81,82,86–88,96,101,104,107,108,115,116,118,124,132,135,139,141,143,145,147,149,157,166,173,175]

Both consultants and ASA members strongly agree that, if an abscess is present, surgical consultation should be obtained to determine whether percutaneous drainage of the abscess or surgery (*e.g.*, laminectomy) is warranted.

Advisory Statements for Management

Appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious neuraxial infection. Consultation with a physician with expertise in the diagnosis and treatment of infectious diseases should be considered. If an abscess is present, surgical consultation should be obtained to determine whether percutaneous drainage of the abscess or surgery (*e.g.*, laminectomy) is warranted.

†† Immunocompromised patients may not manifest typical signs and symptoms of infection.

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Appendix 1: Summary of Advisory Statements

I. Prevention of Infectious Complications Associated with Neuraxial Techniques

- A history and physical examination relevant to the procedure and review of relevant laboratory studies should be conducted‡‡ to identify patients who may be at risk of infectious complications before performing neuraxial techniques.
  - Consider alternatives to neuraxial techniques for patients at high risk.

‡‡ Ordering, conducting, or requiring routine laboratory studies may not be necessary.

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- When neuraxial techniques are selected in a known or suspected bacteremic patient, consider administering preprocedure antibiotic therapy.
- Selection of neuraxial technique should be determined on a case-by-case basis, including consideration of the evolving medical status of the patient.
- Lumbar puncture should be avoided in the patient with a known epidural abscess.

- Aseptic techniques should always be used during the preparation of equipment (*e.g.*, ultrasound) and the placement of neuraxial needles and catheters, including the following:
  - Removal of jewelry (*e.g.*, rings and watches), hand washing, and wearing of caps, masks (covering both mouth and nose and consider changing before each new case), and sterile gloves.
  - Use of individual packets of antiseptics for skin preparation.
  - Use of chlorhexidine (preferably with alcohol) for skin preparation, allowing for adequate drying time.§§
  - Sterile draping of the patient.
  - Use of sterile occlusive dressings at the catheter insertion site.

- Bacterial filters may be considered during extended continuous epidural infusion.
- Limit the disconnection and reconnection of neuraxial delivery systems to minimize the risk of infectious complications.
- Consider removing unwitnessed accidentally disconnected catheters.
- Catheters should not remain *in situ* longer than clinically necessary.

II. Diagnosis of Infectious Complications Associated with Neuraxial Techniques

- Daily evaluation of patients with indwelling catheters for early signs and symptoms (*e.g.*, fever, backache, headache, erythema, and tenderness at the insertion site) of infectious complications should be performed throughout their stay in the facility.||||
- To minimize the impact of an infectious complication, promptly attend to signs or symptoms.
  - If an infection is suspected:
    - Remove an *in situ* catheter and consider culturing the catheter tip.
    - Order appropriate blood tests.
    - Obtain appropriate cultures.
    - If an abscess is suspected or neurologic dysfunction is present, imaging studies should be performed and consultation with other appropriate specialties should be promptly obtained.

III. Management of Infectious Complications

- Appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious neuraxial infection.
- Consultation with a physician with expertise in the diagnosis and treatment of infectious diseases should be considered.
- If an abscess is present, surgical consultation should be obtained to determine whether percutaneous drainage of the abscess or surgery (*e.g.*, laminectomy) is warranted.

Appendix 2: Methods and Analyses

A. State of the Literature

For this Advisory, a literature review was used in combination with opinions obtained from expert consultants, ASA members, and other sources (*e.g.*, other professional society members, open forums, and Internet postings) to provide guidance to practitioners regarding infectious complications associated with neuraxial techniques. Both the literature review and opinion data were based on evidence linkages or statements regarding potential relationships between prevention, diagnosis or management interventions, and infectious complications. The evidence linkage interventions are listed below.##

I. Prevention of infectious complications associated with neuraxial techniques.

- History (*i.e.*, a focused review of medical records), physical examination, and patient interview to identify patients who may be at risk of infectious complications before neuraxial administration.
- Aseptic techniques during the placement or removal of neuraxial needles:
  - Hand washing, wearing of sterile gloves, caps, masks and gowns, and sterile draping of the patient.
  - Use of sterile occlusive dressings at the catheter insertion site.
  - Use of individual packets of antiseptics for skin preparation.
- Limiting the disconnection and reconnection of neuraxial delivery systems.
- Immediate removal of an accidentally disconnected catheter.
- Use of bacterial filters during continuous epidural infusion.
- Skin preparation:
  - Chlorhexidine versus povidone-iodine.
  - Skin preparation with *versus* without alcohol.

II. Diagnosis of infectious complications associated with neuraxial techniques.

- Signs and symptoms of an infection.
- Blood tests.
- Culture from either blood, cerebrospinal fluid, or discharge material from the insertion site.
- Neurologic function tests.
- Imaging studies (magnetic resonance imaging, computed tomography, and myelography).

III. Management of infectious complications.

- Antibiotic therapy.
- Consultation with appropriate specialists to determine optimal nonsurgical treatment.
- Surgical consultation on identification of an abscess.

For the literature review, potentially relevant studies were identified using electronic and manual searches of the literature. The literature search covered a 48-yr period from 1962 through 2009. Over 500 citations were initially identified, yielding a total of 420 articles that addressed topics related to the specific evidence linkages in this Advisory and potentially met our criteria for inclusion. After review of the articles, 232 studies did not provide direct evidence and were subsequently eliminated. A total of 188 articles contained direct

§§ When chlorhexidine is not available, use of povidone-iodine with alcohol is preferred over povidone-iodine alone. Consult product labels for instructions regarding the proper use, application and drying time for skin antiseptics.

|||| Immunocompromised patients may not manifest typical signs and symptoms of infection.

Unless otherwise specified, outcomes for the listed interventions refer to the occurrence of infectious complications.

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linkage-related evidence. (A complete bibliography used to develop this Practice Advisory is available as Supplemental Digital Content 1 at http://links.lww.com/ALN/A564.) No evidence linkage contained enough studies with well-defined experimental designs and statistical information to conduct a quantitative analysis (*i.e.*, meta-analysis).

Interobserver agreement among Task Force members and two methodologists was established by interrater reliability testing. Agreement levels using a κ statistic for two-rater agreement pairs were as follows: (1) type of study design, $\kappa = 0.79-0.92$; (2) type of analysis, $\kappa = 0.84-1.00$; (3) evidence linkage assignment, $\kappa = 0.81-1.00$; and (4) literature inclusion for database, $\kappa = 0.75-1.00$. Three-rater chance-corrected agreement values were (1) study design, Sav = 0.965, Var (Sav) = 0.001; (2) type of analysis, Sav = 0.961, Var (Sav) = 0.001; (3) linkage assignment, Sav = 0.637, Var (Sav) = 0.025; (4) literature database inclusion, Sav = 0.824, Var (Sav) = 0.019. These values represent moderate to high levels of agreement.

B. Consensus-based Evidence

Consensus was obtained from multiple sources, including (1) survey opinions from consultants who were selected based on their knowledge or expertise in neuraxial techniques, (2) survey opinions solicited from active members of the ASA, (3) testimony from attendees of publicly held open forums at four national anesthesia meetings, (4) Internet commentary, and (5) Task Force opinion and interpretation. The survey rate of return was 39% (n = 46 of 119) for consultants, and 239 surveys were received from active ASA members. The results of the surveys are reported in tables 1 and 2 and in the text of the Advisory.

The consultants were asked to indicate which, if any, of the evidence linkages would change their clinical practices if the Advisory was instituted. The rate of return was 14% (n = 17 of 119). The percent of responding consultants expecting a change in their practice associated with each linkage topic was as follows: (1) history and physical examination = 5.9%; (2) use and selection of neuraxial techniques = 5.9%; (3) aseptic techniques = 41.2%; (4) disconnection and reconnection of catheters = 23.5%; (5) duration of catheterization = 6.9%; (6) checking for signs and symptoms of an infectious complication = 5.9%; (7) use of antibiotics = 5.9%; and (8) consultation with other specialists = 5.9%. Eighty-eight percent of the respondents indicated that the Advisory would have no effect on the amount of time spent on a typical case, and 11.8% indicated an average increase of 2.8 min in the amount of time expected to spend on a typical case with the implementation of this Advisory. Eighty-two percent indicated that new equipment, supplies, or training would not be needed to implement the guidelines, and 76.4% indicated that implementation of the guidelines would not require changes in practice that would affect costs.

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Table 1. Consultant Survey Responses

		Percent Responding to Each Item				
	N	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I. Prevention of infectious complications:						
1a. A history, physical examination, and review of relevant laboratory studies should be conducted before performing neuraxial techniques	46	73.9*	23.9	2.2	0.0	0.0
1b. A history, physical examination, and review of relevant laboratory studies is useful in identifying patients at increased risk of infectious complications before performing neuraxial techniques	46	33.6	58.7*	8.7	0.0	0.0
For patients determined to be at risk of infectious complications:						
2a. The decision to select a neuraxial technique should be determined on a case-by-case basis	46	73.9*	23.9	2.2	0.0	0.0
2b. Alternatives to neuraxial techniques should be considered	46	47.8	47.8*	4.4	0.0	0.0
2c. Consider the evolving medical status of the patient in selection of a neuraxial technique	46	65.2*	34.8	0.0	0.0	0.0
3. When a neuraxial technique is selected in a known or suspected bacteremic patient, preprocedure antibiotic therapy should be administered	45	60.0*	26.7	13.3	0.0	0.0
4. Lumbar puncture should be avoided in a patient with a known epidural abscess	46	56.5*	23.9	17.4	2.2	0.0
Aseptic techniques:						
5. Aseptic techniques should always be used during the placement of neuraxial needles and catheters	46	93.5*	6.5	0.0	0.0	0.0
6. Aseptic techniques should include:						
Removal of jewelry	46	30.4	41.3*	15.2	13.0	0.0
Hand washing	46	76.1*	17.4	2.2	4.4	0.0
Wearing of sterile gloves	46	100.0*	0.0	0.0	0.0	0.0
Wearing of caps	45	64.4*	22.2	4.4	6.7	2.2
Wearing of gowns	46	19.6	13.0	21.7*	28.3	17.4
Wearing of masks covering both mouth and nose	46	80.4*	10.9	2.2	6.5	0.0
Changing masks before each new case	46	28.3	30.4*	23.9	10.9	6.5
Use of individual packets for skin preparation	46	50.0*	28.3	8.7	8.7	4.4
Sterile draping of the patient	46	78.3*	15.2	2.2	4.4	0.0
Use of sterile occlusive dressing at the catheter insertion site	46	60.9*	17.4	13.0	8.7	0.0
7. Which skin preparation solution do you prefer before performing a neuraxial technique (mean rank)?†						
Chlorhexidine	2.40					
Chlorhexidine with alcohol	1.65					
Povidone-iodine	3.21					
Povidone-iodine with alcohol	2.57					
Other	4.96					
8. Bacterial filters should be used during continuous epidural infusion	46	26.1	17.4	26.1*	21.7	8.7
9a. Limit the disconnection and reconnection of neuraxial delivery systems to minimize the risk of infectious complications	46	50.0*	37.0	10.9	2.2	0.0
9b. Immediately remove accidentally disconnected catheters	46	4.4	13.0	32.6	43.5*	6.5
9c. Catheters should not remain *in situ* longer than clinically necessary	46	56.5*	34.8	6.5	0.0	2.2
II. Diagnosis of infectious complications:						
10a. Periodic evaluation of patients for signs and symptoms (*e.g.*, fever, backache, headache, erythema, and tenderness at the insertion site) is essential for the early identification of infectious complications	46	52.2*	37.0	6.5	4.4	0.0

(*continued*)

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Table 1. Continued

	Percent Responding to Each Item					
	N	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
10b. After neuraxial insertion or catheter insertion, how frequently should signs and symptoms be assessed? (Percentage response for n = 45)						
More than twice a day	2.2					
Twice a day	37.8					
Once a day	57.8*					
Once every other day	0.0					
Less than once every other day	2.2					
11. Signs or symptoms should be promptly attended to minimize the impact of an infectious complication	46	71.7*	28.3	0.0	0.0	0.0
12. If an infection is suspected: an *in situ* catheter should be immediately removed	46	67.4*	21.7	6.5	2.2	2.2
The catheter tip should be cultured	46	54.4*	30.4	4.4	4.4	6.5
Blood tests should be ordered	46	34.8	47.8*	8.7	6.5	2.2
Additional cultures should be obtained	45	21.7	30.4*	37.0	8.7	2.2
If an abscess is suspected or neurologic deficit is present, imaging studies should be performed	45	91.1*	8.9	0.0	0.0	0.0
If an abscess is suspected or neurologic deficit is present, consultation with other appropriate specialties should be promptly obtained	46	95.7*	2.2	2.2	0.0	0.0
III. Management of infectious complications:						
13. Appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious infection	46	50.0*	30.4	8.7	8.7	2.2
14. A specialist or physician with expertise in the diagnosis and treatment of infectious diseases should be consulted at the first sign of a serious infection	46	37.0	43.5*	10.9	8.7	0.0
15. If an abscess is present, surgical consultation should be obtained to determine whether percutaneous drainage of the abscess or surgery (*e.g.*, laminectomy) is warranted	46	78.3*	21.7	0.0	0.0	0.0

* Median. † Respondents were asked to rank solutions from 1 (most preferred) to 5 (least preferred); mean rank reported.
N = the number of consultants who responded to each item.

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Table 2. ASA Membership Survey Responses

	Percent Responding to Each Item					
	N*	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
I. Prevention of infectious complications:						
1a. A history, physical examination, and review of relevant laboratory studies should be conducted before performing neuraxial techniques	238	74.0*	23.1	2.2	0.4	0.4
1b. A history, physical examination, and review of relevant laboratory studies is useful in identifying patients at increased risk of infectious complications before performing neuraxial techniques	238	50.0*	37.0	10.9	1.7	0.4
For patients determined to be at risk of infectious complications:						
2a. The decision to select a neuraxial technique should be determined on a case-by-case basis	238	68.1*	30.3	0.4	0.4	0.8
2b. Alternatives to neuraxial techniques should be considered	237	55.7*	40.1	2.5	1.3	0.4
2c. Consider the evolving medical status of the patient in selection of a neuraxial technique	238	63.5*	35.3	1.3	0.0	0.0
3. When a neuraxial technique is selected in a known or suspected bacteremic patient, preprocedure antibiotic therapy should be administered	236	59.3*	22.0	17.4	0.4	0.9
4. Lumbar puncture should be avoided in a patient with a known epidural abscess	238	78.2*	16.8	5.0	0.0	0.0
Aseptic techniques:						
5. Aseptic techniques should always be used during the placement of neuraxial needles and catheters	238	91.2*	8.8	0.0	0.0	0.0
6. Aseptic techniques should include:						
Removal of jewelry	235	30.2	23.0*	27.2	17.0	2.6
Hand washing	237	69.6*	21.1	7.6	1.3	0.4
Wearing of sterile gloves	239	94.6*	3.8	0.8	0.4	0.4
Wearing of caps	236	57.2*	21.6	14.4	5.5	1.3
Wearing of gowns	233	11.2	9.0	34.8*	39.5	5.6
Wearing of masks covering both mouth and nose	233	58.4*	24.9	9.0	7.7	0.0
Changing masks before each new case	232	18.5	21.1	29.7*	25.4	5.2
Use of individual packets for skin preparation	235	59.2*	30.6	8.5	1.3	0.4
Sterile draping of the patient	237	60.8*	22.8	6.8	8.9	0.8
Use of sterile occlusive dressing at the catheter insertion site	239	54.4*	29.3	11.7	3.8	0.8
7. Which skin preparation solution do you prefer before performing a neuraxial technique (mean rank)?†						
Chlorhexidine	2.45					
Chlorhexidine with alcohol	2.45					
Povidone-iodine	2.28					
Povidone-iodine with alcohol	2.62					
Other	4.86					
8. Bacterial filters should be used during continuous epidural infusion	236	23.7	29.7*	30.5	14.4	1.7
9a. Limit the disconnection and reconnection of neuraxial delivery systems to minimize the risk of infectious complications	238	52.9*	39.9	6.7	0.4	0.0
9b. Immediately remove accidentally disconnected catheters	237	13.9	23.2	36.3*	24.9	1.7
9c. Catheters should not remain *in situ* longer than clinically necessary	238	65.6*	32.4	2.1	0.0	0.0
II. Diagnosis of infectious complications:						
10a. Periodic evaluation of patients for signs and symptoms (*e.g.*, fever, backache, headache, erythema and tenderness at the insertion site) is essential for the early identification of infectious complications	237	54.4*	40.9	4.6	0.0	0.0

(*continued*)

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Table 2. Continued

	Percent Responding to Each Item					
	N*	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
10b. After neuraxial insertion or catheter insertion, how frequently should signs and symptoms be assessed? (Percentage response for n = 236)						
More than twice a day	13.1					
Twice a day	29.7					
Once a day	55.1*					
Once every other day	0.4					
Less than once every other day	1.7					
11. Signs or symptoms should be promptly attended to minimize the impact of an infectious complication	237	76.8*	21.5	1.7	0.0	0.0
12. If an infection is suspected:						
An *in situ* catheter should be immediately removed	235	75.3*	22.1	2.6	0.0	0.0
The catheter tip should be cultured	235	60.9*	26.4	11.5	0.9	0.9
Blood tests should be ordered	237	43.9	28.9*	23.6	3.4	0.4
Additional cultures should be obtained	232	30.6	28.0*	37.9	3.0	0.4
If an abscess is suspected or neurologic deficit is present, imaging studies should be performed	233	83.3*	14.6	1.7	0.4	0.0
If an abscess is suspected or neurologic deficit is present, consultation with other appropriate specialties should be promptly obtained	234	94.4*	5.6	0.0	0.0	0.0
III. Management of infectious complications:						
13. Appropriate antibiotic therapy should always be administered at the earliest sign or symptom of a serious infection	236	61.9*	21.6	13.1	3.0	0.4
14. A specialist or physician with expertise in the diagnosis and treatment of infectious diseases should be consulted at the first sign of a serious infection	238	58.4*	26.5	11.3	3.8	0.0
15. If an abscess is present, surgical consultation should be obtained to determine whether percutaneous drainage of the abscess or surgery (*e.g.*, laminectomy) is warranted	238	81.1*	16.4	2.1	0.4	0.0

* Median. † Respondents were asked to rank solutions from 1 (most preferred) to 5 (least preferred); mean rank reported.
N = the number of ASA members who responded to each item.

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