

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**

PRACTICE advisories are systematically developed reports that are intended to assist decision making in areas of patient care. Advisories are based on a synthesis of scientific literature and analysis of expert opinion, clinical feasibility data, open forum commentary, and consensus surveys. Advisories developed by the American Society of Anesthesiologists (ASA) are not intended as standards, guidelines, or absolute requirements. They may be adopted, modified, or rejected according to clinical needs and constraints.

The use of practice advisories cannot guarantee any specific outcome. Practice advisories summarize the state of the literature and report opinions obtained from expert consultants and ASA members. Practice advisories are not supported by scientific literature to the same degree as standards or guidelines because of the lack of sufficient numbers of adequately controlled studies. Practice advisories are subject to periodic revision as warranted by the evolution of medical knowledge, technology, and practice.

* Developed by the American Society of Anesthesiologists Task Force on Infectious Complications Associated with Neuraxial Techniques: Terese T. Horlocker, M.D. (Chair), Rochester, Minnesota; David J. Birnbach, M.D., M.P.H., Miami, Florida; Richard T. Connis, Ph.D., Woodinville, Washington; David G. Nickinovich, Ph.D., Bellevue, Washington; Craig M. Palmer, M.D., Tucson, Arizona; Julia E. Pollock, M.D., Seattle, Washington; James P. Rathmell, M.D., Boston, Massachusetts; Richard W. Rosenquist, M.D., Iowa City, Iowa; Jeffrey L. Swisher, M.D., Larkspur, California; and Christopher L. Wu, M.D., Clarksville, Maryland.

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>.

Address correspondence to the American Society of Anesthesiologists: 520 North Northwest Highway, Park Ridge, Illinois 60068-2573. This Practice Advisory, as well as all published American Society of Anesthesiologists Practice Parameters, may be obtained at no cost through the Journal Web site, www.anesthesiology.org.

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.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are available in both the HTML and PDF versions of this article. Links to the digital files are provided in the HTML text of this article on the Journal's Web site (www.anesthesiology.org).

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 cate-

gory, 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.

- (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.

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-

§ 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.

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.

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.

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.

References

- Erdine S, Aldemir T: Long-term results of peridural morphine in 225 patients. *Pain* 1991; 45:155-9
- Jakobsen KB, Chrsitensen M-K, Carlsson PS: Extradural anaesthesia for repeated surgical treatment in the presence of infection. *Br J Anaesth* 1995; 75:536-40
- Moen V, Dahlgren N, Irestedt L: Severe neurological complications after central neuraxial blockades in Sweden 1990-1999. *ANESTHESIOLOGY* 2004; 101:950-9
- Pegues DA, Carr DB, Hopkins C: Infectious complications associated with temporary epidural catheters. *Clin Infect Dis* 1994; 19:970-2
- Rygnestad T, Borchgrevink PC, Eide E: Postoperative epidural infusion of morphine and bupivacaine is safe on surgical wards. Organisation of the treatment, effects and side-effects in 2000 consecutive patients *Acta Anaesth Scand* 1997; 41:868-76
- Sillevis Smitt P, Tsafka A, Teng-van de Zande F, van der Holt R, Elswijk-de Vries I, Elfrink E, van den Bent MJ, Vecht CJ: Outcome and complications of epidural analgesia in patients with chronic cancer pain. *Cancer* 1998; 83:2015-22
- Sillevis Smitt P, Tsafka A, van den Bent M, de Bruin H, Hendriks W, Vecht C, Teng-van de Zande F: Spinal epidural abscess complicating chronic epidural analgesia in 11 cancer patients: Clinical findings and magnetic resonance imaging. *J Neurol* 1999; 246:815-20
- Smith KM, Deddish RB, Ogata ES: Meningitis associated with serial lumbar punctures and post-hemorrhagic hydrocephalus. *J Pediatr* 1986; 109:1057-60
- van Dongen RTM, Crul BJP, De Bock M: Long-term intrathecal infusion of morphine and morphine/bupivacaine mixtures in the treatment of cancer pain: A retrospective analysis of 51 cases. *Pain* 1993; 55:119-23
- Beaudoin MG, Klein L: Epidural abscess following multiple spinal anaesthetics. *Anaesth Intensive Care* 1984; 12:163-4
- Bengtsson M, Nettelblad H, Sjoberg F: Extradural catheter-related infections in patients with infected cutaneous wounds. *Br J Anaesth* 1997; 79:668-70
- Brookman CA, Rutledge ML: Epidural abscess: Case report and literature review. *Reg Anesth Pain Med* 2000; 25:428-31
- Bulow PM, Biering-Soeensen F: Paraplegia, a severe complication to epidural analgesia. *Acta Anaesthesiol Scand* 1999; 43:233-5
- Chevalier X, Lavabre C, Claudepierre P, Larget-Piet B: Iatrogenically induced vertebral osteomyelitis due to *Pseudomonas aeruginosa*. *Clin Exp Rheumatol* 1996; 14:191-4
- Dawson P, Rosenfeld JV, Murphy MA, Hellyar AG: Epidural abscess associated with postoperative epidural analgesia. *Anaesth Intensive Care* 1991; 19:569-72
- Eisen DP, MacGinley R, Christensson B, Larsson L, Woods ML: *Candida tropicalis* vertebral osteomyelitis complicating epidural catheterisation with disease paralleled by elevated D-arabinitol/L-arabinitol ratios. *Eur J Clin Microbiol Infect Dis* 2000; 19:61-3
- Gosavi C, Bland D, Poddar R, Horst C: Epidural abscess complicating insertion of epidural catheters. *Br J Anaesth* 2004; 92:294
- Heller AR, Ragaller M, Koch T: Epidural abscess after epidural catheter for pain release during pancreatitis. *Acta Anaesthesiol Scand* 2000; 44:1024-7
- Hill JS, Hughes EW, Robertson PA: A *Staphylococcus aureus* paraspinal abscess associated with epidural analgesia in labour. *Anaesthesia* 2001; 56:873-8
- Iseki M, Okuno S, Tanabe Y, Mitsuata H, Miyazaki T: Methicillin-resistant *Staphylococcus aureus* sepsis resulting from infection in paravertebral muscle after continuous epidural infusion for pain control in a patient with herpes zoster. *Anesth Analg* 1998; 87:116-8
- Knight JW, Cordingley JJ, Palazzo MG: Epidural abscess following epidural steroid and local anaesthetic injection. *Anaesthesia* 1997; 52:576-8
- Kvalsvik O, Borchgrevink PC, Gisvold SE: Epidural abscess following continuous epidural analgesia in two traumatized patients. *Acta Anaesthesiol Scand* 1998; 42:732-5
- Lin YC, Greco C: Epidural abscess following epidural analgesia in pediatric patients. *Paediatr Anaesth* 2005; 15:767-70
- Mahendru V, Bacon DR, Lema MJ: Multiple epidural abscesses and spinal anesthesia in a diabetic patient. *Reg Anesth* 1994; 19:66-8
- McDonogh AJ, Cranney BS: Delayed presentation of an epidural abscess. *Anaesth Intensive Care* 1984; 12:364-5
- Nordström O, Sandin R: Delayed presentation of an extradural abscess in a patient with alcohol abuse. *Br J Anaesth* 1993; 70:368-9
- Phillips JM, Stedeford JC, Hartsilver E, Roberts C: Epidural abscess complicating insertion of epidural catheters. *Br J Anaesth* 2002; 89:778-82
- Sakuragi T, Yasunaka K, Hirata K, Hori K, Dan K: The source of epidural infection following epidural analgesia identified by pulsed-field gel electrophoresis. *ANESTHESIOLOGY* 1998; 89:1254-6
- Sarubbi FA, Vasquez JE: Spinal epidural abscess associated with the use of temporary epidural catheters: Report of two cases and review. *Clin Infect Dis* 1997; 25:1155-8
- Yap KB, Finlay IG: Epidural infection associated with epidural catheterization in a cancer patient with back pain: Case report. *Palliat Med* 1994; 8:251-3
- Raedler C, Lass-Flörl C, Pühringer F, Kolbitsch CH, Lingnau W, Benzer A: Bacterial contamination of needles used for spinal and epidural anaesthesia. *Br J Anaesth* 1999; 83:657-61
- Dawson SJ, Small H, Logan MN, Geringer S: Case control study of epidural catheter infections in a district general hospital. *Commun Dis Public Health* 2000; 3:300-2
- Abouleish E, Orig T, Amortegui AJ: Bacteriologic comparison between epidural and caudal techniques. *ANESTHESIOLOGY* 1980; 53:511-4
- Kost-Byerly S, Tobin JR, Greenberg RS, Billett C, Zahurak M, Yaster M: Bacterial colonization and infection rate of continuous epidural catheters in children. *Anesth Analg* 1998; 86:712-6
- McNeely J, Trentadue N, Rusy LM, Farber NE: Culture of bacteria from lumbar and caudal epidural catheters used for postoperative analgesia in children. *Reg Anesth* 1997; 22:428-31
- Berman RS, Eiselem JH: Bacteremia, spinal anesthesia and development of meningitis. *ANESTHESIOLOGY* 1978; 48:376-7
- Videira RI, Ruiz-Neto PP, Brandao-Neto M: Post spinal meningitis and sepsis. *Acta Anaesthesiol Scand* 2002; 46:639-46
- Bevacqua BK, Slucky AV, Cleary WF: Is postoperative intrathecal catheter use associated with central nervous system infection? *ANESTHESIOLOGY* 1994; 80:1234-40
- Sellors J, Cyna A, Simmons S: Aseptic precautions for inserting and epidural catheter. *Anaesthesia* 2002; 57:593-605
- Yuan HB, Zuo Z, Yu KW, Lin WM, Lee HC, Chan KH: Bacterial colonization of epidural catheters used for short-term postoperative analgesia: Microbiological examination and risk factor analysis. *ANESTHESIOLOGY* 2008; 108:130-7
- Abaza KT, Bogod DG: Cerebrospinal fluid-cutaneous fistula and pseudomonas meningitis complicating thoracic epidural analgesia. *Br J Anaesth* 2004; 92:429-31
- Bajwa ZH, Ho C, Grush A, Kleefield J, Warfield CA: Discitis associated with pregnancy and spinal anesthesia. *Anesth Analg* 2002; 94:415-6
- Blackmore TK, Morley HR, Gordon DL: Streptococcus mitis-induced bacteremia and meningitis after spinal anesthesia. *ANESTHESIOLOGY* 1993; 78:592-4

44. Bouhemad B, Dounas M, Mercier FJ, Benhamou D: Bacterial meningitis following combined spinal-epidural analgesia for labour. *Anaesthesia* 1998; 53:292-5
45. Cascio M, Heath G: Meningitis following a combined spinal-epidural technique in a labouring term parturient. *Can J Anaesth* 1996; 43:399-402
46. Chiang HL, Chia YY, Chen YS, Hung CC, Liu K, Lo Y: Epidural abscess in an obstetric patient with patient-controlled epidural analgesia—a case report. *Int J Obstet Anesth* 2005; 14:242-5
47. Cohen S, Hunter CW, Sakr A, Hijazi RH: Meningitis following intrathecal catheter placement after accidental dural puncture. *Int J Obstet Anesth* 2006; 15:172
48. Collis RE, Harries SE: A subdural abscess and infected blood patch complicating regional analgesia for labour. *Int J Obstet Anesth* 2005; 14:246-51
49. Couzigou C, Vuong TK, Botheral AH, Aggoune M, Astagneau P: Iatrogenic streptococcus salivarius meningitis after spinal anesthesia: Need for strict application of standard precautions. *J Hosp Infect* 2003; 53:313-4
50. Emmanuel ER: Post-sacral extradural catheter abscess in a child. *Br J Anaesth* 1994; 73:548-9
51. Hernández-Palazón J, Puertas-García JP, Martínez-Lage JF, Tortosa JA: Lumbar spondylodiscitis caused by *Propionibacterium acnes* after epidural obstetric analgesia. *Anesth Analg* 2003; 96:1486-8
52. Huang YY, Zuo Z, Yuan HB, Tsou MY, Chen MT, Tsai SK: A paraspinal abscess following spinal anaesthesia for caesarean section and patient-controlled epidural analgesia for postoperative pain. *Int J Obstet Anesth* 2005; 14:252-5
53. Ingelmo PM, Marino G, Fumagalli R: Sepsis after epidural catheterization in a child with chronic regional pain syndrome type I. *Paediatr Anaesth* 2005; 15:623-4
54. Jeffreys A, Horton R, Evans B: Epidural abscesses. *Br J Anaesth* 2006; 97:115-6
55. Laurila JJ, Kostamovaara PA, Alahuhta S: *Streptococcus salivarius* meningitis after spinal anesthesia. *ANESTHESIOLOGY* 1998; 89:1579-80
56. Meunier JF, Norwood P, Dartayet B, Dubousset AM, Ecofey C: Skin abscess with lumbar epidural catheterization in infants: Is it dangerous? Report of two cases *Anesth Analg* 1997; 84:1248-9
57. Newton JA, Lesnik IK, Kenned CA: *Streptococcus salivarius* meningitis following spinal anesthesia. *Clin Infect Dis* 1994; 18:840-1
58. Pinder AJ, Dresner M: Meningococcal meningitis after combined spinal-epidural analgesia. *Int J Obstet Anesth* 2003; 12:183-7
59. Ready LB, Helfer D: Bacterial meningitis in parturients after epidural anesthesia. *ANESTHESIOLOGY* 1989; 71:988-90
60. Sandkovsky U, Mihu MR, Adeyeye A, De Forest PM, Nosanchuk JD: Iatrogenic meningitis in an obstetric patient after combined spinal-epidural analgesia: Case report and review of the literature. *South Med J* 2009; 102:287-90
61. Schroeder TH, Krueger WA, Neeser E, Hahn U, Unertl K: Spinal epidural abscess—a rare complication after epidural analgesia for labour and delivery. *Br J Anaesth* 2004; 92:896-8
62. Schroter J, Wa DD, Hoffmann V, Bach A, Motsch J: Epidural abscess after combined spinal-epidural block. *Can J Anaesth* 1997; 44:300-44
63. Stallard N, Barry P: Another complication of the combined extradural-subarachnoid technique. *Br J Anaesth* 1995; 75:370-1
64. Villevielle T, Vincent-Rouquette I, Petitjeans F, Koulmann P, Legulluche Y, Rousseau JM, Diraison Y, Brinquin: Strepococcus mitis-induced meningitis after spinal anesthesia. *Anesth Analg* 2000;90:500-1
65. Kinirons B, Mimoz O, Lafendi L, Naas T, Meunier J-F, Nordmann P: Chlorhexidine versus povidone iodine in preventing colonization of continuous epidural catheters in children: A randomized, controlled trial. *ANESTHESIOLOGY* 2001; 94:239-44
66. Shibata S, Shibata I, Tsudy A, Nagatani A, Sumikawa K: Comparative effects of disinfectants on the epidural needle/catheter contamination with indigenous skin bacterial flora. *ANESTHESIOLOGY* 2004; 101:A1363
67. Birnbach DJ, Meadows W, Stein DJ, Murray O, Thys DM, Sordillo EM: Comparison of povidone iodine and Dura-Prep, an iodophor-in-isopropyl alcohol solution, for skin infection prior to epidural catheter insertion in parturients. *ANESTHESIOLOGY* 2003; 98:164-9
68. Birnbach DJ, Stein DJ, Murray O, Thys DM, Sordillo EM: Povidone iodine and skin disinfection before initiation of epidural anesthesia. *ANESTHESIOLOGY* 1998; 88:668-72
69. Seth N, Macqueen S, Howard RF: Clinical signs of infection during continuous postoperative epidural analgesia in children: The value of catheter tip culture. *Paediatr Anaesth* 2004; 14:996-1000
70. Dhillon AR, Russell IF: Epidural abscess in association with obstetric analgesia. *Int J Obstet Anesth* 1997; 6:118-21
71. Simons R, Dinner L, Lappin S: Skin abscess obscured by epidural catheter fixation. *Anaesthesia* 2007; 62:418
72. Abouleish E, Amortegui AJ, Taylor FH: Are bacterial filters needed in continuous epidural analgesia for obstetrics? *ANESTHESIOLOGY* 1977; 46:351-4
73. James FM, George RH, Raiem H, White GJ: Bacteriologic aspects of epidural analgesia. *Anesth Analg* 1976; 55:187-90
74. de Jong, Kansen PJ: A comparison of epidural catheters with or without subcutaneous injections ports for treatment of cancer pain. *Anesth Analg* 1994; 78:94-100
75. De Leon-Casasola OA, Parker B, Lema M, Harrison P, Massey J: Postoperative epidural bupivacaine-morphine therapy: Experience with 4227 surgical cancer patients. *ANESTHESIOLOGY* 1994; 81:368-75
76. Holt HM, Andersen SS, Andersen O, Gahrn-Hansen B, Siboni K: Infections following epidural catheterization. *J Hosp Infect* 1995; 30:253-60
77. Mann TJ, Orlikowski CE, Gurrin LC, Keil AD: The effect of the biopatch, a chlorhexidine impregnated dressing, on bacterial colonization of epidural catheter exit sites. *Anaesth Intensive Care* 2001; 29:600-3
78. Mishra S, Bhatnagar S, Srikanti M, Gupta D: Clinical implication of routine bacterial culture from epidural catheter tips in postoperative cancer patients: A prospective study. *Anaesthesia* 2006; 61:878-82
79. Wang LP, Hauerberg J, Schmidt JF: Incidence of spinal epidural abscess after epidural analgesia: A national 1-year survey. *ANESTHESIOLOGY* 1999; 91:1928-36
80. Ania BJ: *Staphylococcus aureus* meningitis after short-term epidural analgesia. *Clin Infect Dis* 1994; 18:844-5
81. Bollensen E, Menck S, Buzanoski J, Prange HW: Iatrogenic epidural spinal abscess. *Clin Invest* 1993; 71:780-6
82. Hernandez JM, Coyle FP, Wright CD, Ballantyne JC: Epidural abscess after epidural anesthesia and continuous epidural analgesia in a patient with gastric lymphoma. *J Clin Anesth* 2003; 15:48-51
83. Hori K, Kano T, Fukushige T, Sano T: Successful treatment of epidural abscess with a percutaneously introduced 4-French catheter for drainage. *Anesth Analg* 1997; 84:1384-6
84. Larsson BA, Lundeberg S, Olsson GL: Epidural abscess in a one-year-old boy after continuous epidural analgesia. *Anesth Analg* 1997; 84:1245-7
85. Nordberg G, Mark H: Epidural abscess after epidural analgesia treated successfully with antibiotics. *Acta Anaesthesiol Scand* 1998; 42:727-31
86. Shintani S, Tanaka H, Irifune A, Mitoh Y, Udono H, Kaneda A, Shiigai T: Iatrogenic acute spinal epidural abscess with septic meningitis: MR findings. *Clin Neurol Neurosurg* 1992; 94:253-5
87. Sollmann WP, Gaab MR, Panning B: Lumbar epidural

- hematoma and spinal abscess following peridural anesthesia. *Reg Anaesth* 1987; 10:121-4
88. Sowter MC, Burgess NA, Woodsford PV, Lewis MH: Delayed presentation of an extradural abscess complicating thoracic extradural analgesia. *Br J Anaesth* 1992; 68:103-5
 89. Tham EJ, Stoodley MA, Macintyre PE, Jones NR: Back pain following postoperative epidural analgesia: An indicator of possible spinal infection. *Anaesth Intensive Care* 1997; 25:297-301
 90. Aldrete JA, Williams SK: Infections from extended epidural catheterization in ambulatory patients. *Reg Anesth Pain Med* 1998; 23:491-5
 91. Aram L, Krane EJ, Kozloski LJ, Yaster M: Tunneled epidural catheters for prolonged analgesia in pediatric patients. *Anesth Analg* 2001; 92:1432-8
 92. Athmaja TR, Sanders GM: An unusual presentation of epidural *Acinetobacter* infection. *Reg Anesth Pain Med* 2005; 30:577-9
 93. Baer ET: Post-dural puncture bacterial meningitis. *ANESTHESIOLOGY* 2006; 105:381-93
 94. Berga S, Trierweiler MW: Bacterial meningitis following epidural anesthesia for vaginal delivery: A case report. *Obstet Gynecol* 1989; 74:437-9
 95. Bertol V, Ara JR, Oliveros A, Gros B: Neurologic complications of lumbar epidural analgesia: Spinal and paraspinous abscess. *Neurology* 1997; 48:1732-3
 96. Borum SE, McLeskey CH, Williamson JB, Harris FS, Knight AB: Epidural abscess after obstetric epidural analgesia. *ANESTHESIOLOGY* 1995; 82:1523-6
 97. Bromage PR: Spinal extradural abscess: Pursuit of vigilance. *Br J Anaesth* 1993; 70:471-3
 98. Brooks K, Pasero C, Hubbard L, Coghlan RH: The risk of infection associated with epidural analgesia. *Infect Control Hosp Epidemiol* 1995; 16:725-8
 99. Bussink M, Gramke H, van Kleef M, Marcus M: Bacterial meningitis ten days after spinal anesthesia. *Reg Anesth Pain Med* 2005; 30:210-1
 100. Cesari M, Onder G, Torre S, Landi F, Carbonin P, Gambassi G: A "painful" epidural analgesia. *J Am Geriatr Soc* 2004; 52:329-30
 101. Chan ST, Leung S: Spinal epidural abscess following steroid injection for sciatica. *Spine* 1989; 14:106-8
 102. Choy JC: Mortality from peripartum meningitis. *Anaesth Intensive Care* 2000; 28:328-30
 103. Christie IW, McCabe S: Major complications of epidural analgesia after surgery: Results of a six-year survey. *Anaesthesia* 2007; 62:335-41
 104. Coapes CM, Roysam GS: Vertebral osteomyelitis secondary to epidural catheter use: A case report. *Spine* 2001; 26:1492-4
 105. Collier CB, Gatt SP: Epidural abscess in an obstetric patient. *Anaesth Intensive Care* 1999; 27:662-6
 106. Cooper AB, Sharpe MD: Bacterial meningitis and cauda equina syndrome after epidural steroid injections. *Can J Anaesth* 1996; 43:471-4
 107. Crawford ME, Andersen HB, Augustenborg G, Bay J, Beck O, Benveniste D, Larsen LB, Carl P, Djernes M, Eriksen J, Greall AM, Henriksen H, Johansen SH, Jorgensen HOK, Moller IW, Pedersen JEP, Ravlo O: Pain treatment on outpatient basis utilizing extradural opiates. A Danish multicenter study comprising 105 patients. *Pain* 1983; 16:41-7
 108. Cummings KC III, Dolak JA: Case report: Epidural abscess in a parturient with pruritic urticarial papules and plaques of pregnancy (PUPPP). *Can J Anaesth* 2006; 53:1010-4
 109. Darchy B, Forceville X, Bavoux E, Soriot F, Domart Y: Clinical and bacteriologic survey of epidural analgesia in patients in the intensive care unit. *ANESTHESIOLOGY* 1996; 85:988-98
 110. Darouiche RO, Hamill RJ, Greenberg SB, Weathers SW, Musher DM: Bacterial spinal epidural abscess. Review of 43 cases and literature survey. *Medicine* 1992; 71:369-85
 111. Davis L, Hargreaves C, Robinson PN: Postpartum meningitis. *Anaesthesia* 1993; 48:788-9
 112. Dougherty JH Jr, Fraser RA: Complications following intraspinal injections of steroids: Report of two cases. *J Neurosurg* 1978; 48:1023-5
 113. Dysart RH, Balakrishnan V: Conservative management of extradural abscess complicating spinal extradural analgesia for caesarean section. *Br J Anaesth* 1997; 78:591-3
 114. Edelstein S, Edoute Y: Bacterial sacroiliitis probably induced by lumbar epidural analgesia. *Infect Dis Obstet Gynecol* 2003; 11:105-8
 115. Ericsson M, Algers G, Schliamser SE: Spinal epidural abscess in adults. Review and report of iatrogenic cases. *Scand J Infect Dis* 1990; 22:249-57
 116. Evans PR, Misra U: Poor outcome following epidural abscess complicating epidural analgesia for labour. *Eur J Obstet Gynecol Reprod Biol* 2003; 109:102-5
 117. Ferguson CC: Infection and the epidural space: A case report. *AANA J* 1992; 60:393-6
 118. Ferguson JF, Kirsch WM: Epidural empyema following thoracic extradural block. *J Neurosurg* 1974; 41:762-4
 119. Fine PG, Hare BD, Zahniser JC: Epidural abscess following epidural catheterization in a chronic pain patient: A diagnostic dilemma. *ANESTHESIOLOGY* 1988; 69:422-4
 120. Goucke CR, Graziotti P: Extradural abscess following local anaesthetic and steroid injection for chronic low back pain. *Br J Anaesth* 1990; 65:427-9
 121. Harding SA, Collis RE, Morgan BM: Meningitis after combined spinal-extradural anaesthesia in obstetrics. *Br J Anaesth* 1994; 73:545-7
 122. Hearn M: Epidural abscess complicating insertion of epidural catheters. *Br J Anaesth* 2003; 90:706-7
 123. Hooten WM, Kinney MO, Huntoon MA: Epidural abscess and meningitis after epidural corticosteroid injection. *Mayo Clin Proc* 2004; 79:682-6
 124. Huang RC, Shapiro GS, Lim M, Sandhu HS, Lutz GE, Herzog RJ: Cervical epidural abscess after epidural steroid injection. *Spine* 2004; 29:E7-9
 125. Hunt JR, Rogor BM, Collins JR: The potential for contamination of continuous epidural catheters. *Anesth Analg* 1977; 56:222-5
 126. Idigoras P, Valiente A, Iglesias I, Trieu-Cuot P, Poyart C: Meningitis due to *Streptococcus salivarius*. *J Clin Microbiol* 2001; 39:3017
 127. Kindler C, Seeberger M, Siegemund M, Schneider M: Extradural abscess complicating lumbar extradural anaesthesia and analgesia in an obstetric patient. *Acta Anaesthesiol Scand* 1996; 40:858-61
 128. Kocamanoglu IS, Sener EB, Tur A, Ustin E, Sahinoglu H: Streptococcal meningitis after spinal anaesthesia: Report of a case. *Can J Anesth* 2003; 50:314-5
 129. Koka VK, Potti A: Spinal epidural abscess after corticosteroid injections. *South Med J* 2002; 95:772-4
 130. Kruger M, Harries K, Dumont S: Osteomyelitis following epidural analgesia in an immunocompromised patient. *Anaesthesia* 1998; 53:314-5
 131. Lee JJ, Parry H: Bacterial meningitis following spinal anaesthesia for caesarean section. *Br J Anaesth* 1991; 66:383-6
 132. Lindner A, Warmuth-Metz M, Becker G, Toyka VV: Iatrogenic spinal epidural abscesses: Early diagnosis essential for good outcome. *Eur J Med Res* 1997; 2:201-5
 133. Liu S, Pope A: Spinal meningitis masquerading as post-dural puncture headache. *ANESTHESIOLOGY* 1996; 85:1493-4
 134. Lurie S, Feinstein M, Hiefert C, Manet Y: Iatrogenic bacterial meningitis after spinal anaesthesia for pain relief during labor. *J Clin Anesth* 1999; 11:438-9
 135. Mamourian AC, Dickman CA, Drayer BP, Sonntag VKH: Spinal epidural abscess: Three cases following spinal epidural injection demonstrated with magnetic resonance imaging. *ANESTHESIOLOGY* 1993; 78:204-7

136. Ngan Kee WD, Jones MR, Thomas P, Worth RJ: Extradural abscess complicating extradural anaesthesia for caesarean section. *Br J Anaesth* 1992; 69:647-52
137. North JB, Brophy BP: Epidural abscess: A hazard of spinal epidural anaesthesia. *Aust N Z J Surg* 1979; 49:484-5
138. Raj V, Foy J: Paraspinal abscess associated with epidural in labour. *Anaesth Intensive Care* 1998; 26:424-6
139. Rathmell JP, Garahan MB, Alsofrom GF: Epidural abscess following epidural analgesia. *Reg Anesth Pain Med* 2000; 25:79-82
140. Roberts SP, Petts HV: Meningitis after obstetric spinal anaesthesia. *Anaesthesia* 1990; 45:376-7
141. Royakkers AA, Willigers H, Van der Ven AJ, Wilmlink J, Durieux M, van Kleef M: Catheter-related epidural abscesses—don't wait for neurological deficits. *Acta Anaesthesiol Scand* 2002; 46:611-5
142. Rubin L, Sprecher H, Kabaha A, Weber G, Teitler N, Rishpon S: Meningitis following spinal anaesthesia: 6 cases in 5 years. *Infect Control Hosp Epidemiol* 2007; 28:1187-90
143. Saady A: Epidural abscess complicating thoracic epidural analgesia. *ANESTHESIOLOGY* 1976; 44:244-6
144. Schneeberger PM, Janssen M, Voss A: Alpha-hemolytic streptococci: A major pathogen of iatrogenic meningitis following lumbar puncture. Case reports and a review of the literature. *Infection* 1996; 24:29-33
145. Shealy CM: Dangers of spinal injections without proper diagnosis. *J Am Med Assoc* 1966; 197:1104-6
146. Siman-Tov T, Gadoth N: Enterococcal meningoencephalitis following epidural anaesthesia. *Isr Med Assoc J* 2004; 6:780-1
147. Strong WE: Epidural abscess associated with epidural catheterisation: A rare event? Report of two cases with markedly delayed presentation. *ANESTHESIOLOGY* 1991; 74:943-6
148. Tabo E, Ohkuma Y, Kimura S, Nagaro T, Arai T: Successful percutaneous drainage of epidural abscess with epidural needle and catheter. *ANESTHESIOLOGY* 1994; 80:1393-5
149. Tay SM, Lee R: Case report: Catheter-related epidural abscess. *Ann Acad Med Singapore* 2001; 30:62-5
150. Thomas TA, Cooper GM: Maternal deaths from anaesthesia: An extract from Why Mothers Die 1997-1999, the confidential enquiries into maternal deaths in the United Kingdom. *Br J Anaesth* 2002; 89:499-508
151. Torres E, Albe D, Frank A, Diez-Tejedor E: Iatrogenic meningitis due to *Streptococcus salivarius* following a spinal tap. *Clin Infect Dis* 1993; 17:525-6
152. Trautmann M, Lepper PM, Schmitz FJ: Three cases of bacterial meningitis after spinal and epidural anaesthesia. *Eur J Clin Microbiol Infect Dis* 2002; 21:43-5
153. Wang JS, Fellows DG, Vakharia S, Rosenbaum AE, Thomas PS: Epidural abscess—early magnetic resonance imaging detection and conservative therapy. *Anesth Analg* 1996; 82:1069-71
154. Watanakunakorn C: *Escherichia coli* meningitis and septicemia associated with an epidural catheter. *Clin Infect Dis* 1995; 21:713-4
155. Wood CE, Goresky GV, Klassen KA, Kuwahara B, Neil SG: Complications of continuous epidural infusions for post-operative analgesia in children. *Can J Anaesth* 1994; 41:613-20
156. Yaniv LG, Potasman I: Iatrogenic meningitis: An interesting role for resistant viridans streptococci? Case report and review of the last 20 years. *Scand J Infect Dis* 2000; 32:693-6
157. Yuste M, Canet J, Garcia M, Gil MA, Vidal F: An epidural abscess due to resistant *Staphylococcus aureus* following epidural catheterisation. *Anaesthesia* 1997; 52:163-5
158. Barreto RS: Bacteriological culture of indwelling epidural catheters. *ANESTHESIOLOGY* 1962; 23:643-6
159. Bubeck J, Boos K, Krause H, Thies KC: Subcutaneous tunneling of caudal catheters reduces the rate of bacterial colonization to that of lumbar epidural catheters. *Anesth Analg* 2004; 99:689-93
160. Conangla G, Rodriquez I, Alonao-Tarres C, Avila A, de la Campa AG: *Streptococcus salivarius* meningitis after spinal anaesthesia. *Neurologia* 2004; 19:331-3
161. De Cicco M, Matovic M, Castellani GT, Basaglia G, Santini G, Del Pup C, Fantin D, Testa V: Time-dependent efficacy of bacterial filters and infection risk in long-term epidural catheterization. *ANESTHESIOLOGY* 1995; 82:765-71
162. Kilpatrick ME, Girgis JI: Meningitis: A complication of spinal anaesthesia. *Anesth Analg* 1983; 62:513-5
163. Nickels JH, Poulos JG, Chaouki K: Risks of infection from short-term epidural catheter use. *Reg Anesth* 1989; 14:88-9
164. Pandian JD, Sarada C, Radhakrishnan VV, Kishore A: Iatrogenic meningitis after lumbar puncture: A preventable health hazard. *J Hosp Infect* 2004; 56:119-24
165. Pinczower GR, Gyorke A: Vertebral osteomyelitis as a cause of back pain after epidural anaesthesia. *ANESTHESIOLOGY* 1996; 84:215-7
166. Simpson J, Foinette KM, Lobo DN, Rowlands BJ: Spinal epidural abscess: Adding insult to injury? *Injury* 1999; 30:504-8
167. Simpson RS, Macintyre PE, Shaw D, Norton A, McCann JR, Tham EJ: Epidural catheter tip cultures: Results of a 4-year audit and implications for clinical practice. *Reg Anesth Pain Med* 2000; 25:360-7
168. Strafford MA, Wilder RT, Berde CB: The risk of infection from epidural analgesia in children: A review of 1620 cases. *Anesth Analg* 1995; 80:234-8
169. Cameron CM, Scott DA, McDonald WM, Davies MJ: A review of neuraxial epidural morbidity: Experience of more than 8,000 cases at a single teaching hospital. *ANESTHESIOLOGY* 2007; 106:997-1002
170. McGahan JP, Dublin AB: Evaluation of spinal infections by plain radiographs, computed tomography, intrathecal metrizamide, and CT-guided biopsy. *Diagn Imaging Clin Med* 1985; 54:11-20
171. Morau EL, Lotthe AA, Morau DY, Parneix M, Hocquet AF, Colson PH: Bifocal tuberculosis highlighted by obstetric combined spinal-epidural analgesia. *ANESTHESIOLOGY* 2005; 103:445-6
172. Tung GA, Yim JWK, Mermel LA, Philip L, Rogg JM: Spinal epidural abscess: Correlation between MRI findings and outcome. *Neuroradiology* 1999; 41:904-9
173. Yamaguchi M, Kawakubo A, Ide R, Hara K, Sumikawa K: Epidural abscesses associated with epidural block in a patient with immunosuppressive disease. *Masui* 1999; 48:506-8
174. Aromaa U, Lahdensuu M, Cozantis DA: Severe complications associated with epidural and spinal anaesthetics in Finland 1987-1993. A study based on patient insurance claims. *Acta Anaesthesiol Scand* 1997; 41:445-52
175. Konig H-J, Schleep J, Kraehling KH: Transverse lesion of the cord after contamination of a peridural catheter: A case report. *Reg Anesth* 1985; 8:60-2

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.

- 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.

§§ 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.

- 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

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 na-

tional 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.

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 <i>in situ</i> 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)

Table 1. Continued

	N	Percent Responding to Each Item				
		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 <i>in situ</i> 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.

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 <i>in situ</i> 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)

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 <i>in situ</i> 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.