PRACTICE PARAMETERS

Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies 2018

*An Updated Report by the American Society of Anesthesiologists Task Force on Prevention of Perioperative Peripheral Neuropathies**

PRACTICE advisories are systematically developed reports that are intended to assist decision-making in areas of patient care. Advisories provide a synthesis of scientific literature and analysis of expert opinion, clinical feasibility data, open forum commentary, and consensus surveys. Practice advisories developed by the American Society of Anesthesiologists (ASA) are not intended as standards, guidelines, or absolute requirements, and their use cannot guarantee any specific outcome. They may be adopted, modified, or rejected according to clinical needs and constraints, and they are not intended to replace local institutional policies.

Practice advisories summarize the state of the literature and report opinions obtained from expert consultants and ASA members. They 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.

This document updates the "Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies: An Updated Report by the American Society of Anesthesiologists Task Force on Prevention of Perioperative Peripheral Neuropathies," adopted by the ASA in 2010 and published in 2011.[1] A brief summary highlighting major differences between the current document and the 2011 Advisory regarding new study findings, evidence, and recommendations may be found in the Update Highlights box.

Update Highlights

This Practice Advisory updates the "Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies: An Updated Report by the American Society of Anesthesiologists Task Force on the Prevention of Perioperative Peripheral Neuropathies," adopted by the American Society of Anesthesiologists in 2010 and published in 2011.†

In October 2016, the Committee on Standards and Practice Parameters elected to search for new evidence to determine if recommendations in the existing Practice Advisory continue to be supported by current evidence. The resultant Advisory, presented in this issue, includes an update of the scientific literature and an updated format for individual recommendations.

Seven hundred and ninety-five new citations covering the period of January 1, 1999, through July 31, 2009, were identified and reviewed, with 31 new studies meeting the inclusion/exclusion criteria established by the Task Force. These studies were combined with studies reviewed and accepted by the previous update, resulting in a total of 114 articles found acceptable as evidence. The new literature consisted entirely of observational findings or case reports that found neuropathies occurring in brachial plexus, ulnar, radial, sciatic, femoral, and peroneal (fibular) nerves. The evidence continues to support the existing recommendations that address positioning strategies, protective padding, and proper placement of equipment as useful preventative actions. The recommendations contained the same content as the previous update but for clarification purposes are presented as declarative and bulleted, with informational statements footnoted rather than included in the text of the recommendations.

Methodology

Definition of Peripheral Neuropathy

For this updated Advisory, *perioperative peripheral neuropathy* refers to postoperative signs and symptoms related to peripheral nerve injury (*e.g.*, brachial plexus, sciatic, femoral). Symptoms may include but are not limited to paresthesias, muscle weakness, tingling, or pain in the extremities.

Purposes of the Advisory

The purposes of the Advisory are to (1) educate ASA members, (2) provide a reference framework for individual

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†American Society of Anesthesiologists: Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies: An updated report by the American Society of Anesthesiologists Task Force on the Prevention of Perioperative Peripheral Neuropathies. ANESTHESIOLOGY 2011; 114:741–54

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practices, and (3) stimulate the pursuit and evaluation of strategies that may prevent or reduce the frequency of occurrence or minimize the severity of peripheral neuropathies that may be related to perioperative positioning of patients.

Focus

Prevention of peripheral neuropathies is part of the larger process of perioperative care. This Advisory specifically focuses on perioperative positioning of the adult patient, use of protective padding, and avoidance of contact with hard surfaces or supports that may apply direct pressure on susceptible peripheral nerves. This Advisory does not focus on compartment syndromes or neuropathies that may be associated with anesthetic techniques (*e.g.*, spinal anesthesia).

This Advisory is intended to apply to adult patients who are or have been sedated or anesthetized. Areas in which these patients receive care include but are not limited to operating rooms and other anesthetizing locations, recovery rooms, intensive care units, outpatient procedural units, and office-based practices.

Application

The updated Advisory is intended for use by anesthesiologists or other providers working under the direction of anesthesiologists. It also may serve as a resource for other healthcare professionals.

Task Force Members and Consultants

In 2016, the ASA Committee on Standards and Practice Parameters requested that scientific evidence for this Advisory be updated. The update consists of an evaluation of literature that includes new studies obtained after publication of the original Advisory.

The original Advisory was developed by an ASA–appointed task force of 10 members, consisting of anesthesiologists in private and academic practices from various geographic areas of the United States, and two methodologists from the ASA Committee on Standards and Practice Parameters.

The Task Force developed the original Advisory by means of a six-step process. First, they reached consensus on the criteria for evidence. Second, original published articles from peer-reviewed journals relevant to perioperative peripheral neuropathy were evaluated. Third, consultants who had expertise or interest in peripheral neuropathy and who practiced or worked in various settings (*e.g.*, academic and private practice) were asked to: (1) participate in opinion surveys on the effectiveness of various perioperative management strategies, and (2) review and comment on a draft of the Advisory developed by the Task Force. Fourth, additional opinions were solicited from random samples of active members of the ASA. Fifth, the Task Force held an open forum at a national anesthesia meeting to solicit input on the key concepts of this Advisory.‡ Sixth, all available information was used to build consensus within the Task Force to finalize the Advisory. A summary of recommendations is found in appendix 1.

‡ Society for Ambulatory Anesthesia 14th Annual Meeting, Seattle, Washington, April 30, 1999.

Availability and Strength of Evidence

Preparation of this update used the same methodologic process as was used in the original Advisory to obtain new scientific evidence. Opinion-based evidence obtained from the original Advisory is reported in this update. The protocol for reporting each source of evidence is described below.

Scientific Evidence. The scientific evidence used in the development of this Advisory is based on cumulative findings from literature published in peer-reviewed journals. Literature citations are obtained from healthcare databases, direct internet searches, Task Force members, liaisons with other organizations, and manual searches of references located in reviewed articles.

Findings from the aggregated literature are reported in the text of this Advisory by evidence category, level, and direction and in appendix 2. Evidence categories refer specifically to the strength and quality of the *research design* of the studies. Category A evidence represents results obtained from randomized controlled trials (RCTs), and Category B evidence represents observational results obtained from nonrandomized study designs or RCTs without pertinent comparison groups. When available, Category A evidence is given precedence over Category B evidence for any particular outcome. These evidence categories are further divided into evidence levels. Evidence levels refer specifically to the strength and quality of the summarized study *findings* (*i.e.*, statistical findings, type of data, and the number of studies reporting/replicating the findings). In this document, only the highest level of evidence is included in the summary report for each intervention–outcome pair, including a directional designation of benefit, harm, or equivocality.

Category A. RCTs report comparative findings between clinical interventions for specified outcomes. Statistically significant ($P < 0.01$) outcomes are designated as either beneficial (B) or harmful (H) for the patient; statistically nonsignificant findings are designated as equivocal (E).

- Level 1: The literature contains a sufficient number of RCTs to conduct meta-analysis,§ and meta-analytic findings from these aggregated studies are reported as evidence.
- Level 2: The literature contains multiple RCTs, but the number of RCTs is not sufficient to conduct a viable meta-analysis for the purpose of this Advisory. Findings from these RCTs are reported separately as evidence.
- Level 3: The literature contains a single RCT, and findings from this study are reported as evidence.

§ 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. Because a minimum of five independent RCTs are required for meta-analysis, meta-analyses were not conducted for this Practice Advisory.

Category B. Observational studies or RCTs without pertinent comparison groups may permit *inference* of beneficial or harmful relationships among clinical interventions and clinical outcomes. Inferred findings are given a directional designation of beneficial (B), harmful (H), or equivocal (E). For studies that report statistical findings, the threshold for significance is $P < 0.01$.

Level 1: The literature contains nonrandomized comparisons (*e.g.*, quasiexperimental, cohort [prospective or retrospective], or case-control research designs) with comparative statistics between clinical interventions for a specified clinical outcome.

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

Level 3: The literature contains noncomparative observational studies with descriptive statistics (*e.g.*, frequencies, percentages).

Level 4: The literature contains case reports.

Insufficient Literature. The *lack* of sufficient scientific evidence in the literature may occur when the evidence is either unavailable (*i.e.*, no pertinent studies found) or inadequate. Inadequate literature cannot be used to assess relationships among clinical interventions and outcomes because a clear interpretation of findings is not obtained due to methodologic concerns (*e.g.*, confounding of study design or implementation) or the study does not meet the criteria for content as defined in the "Focus" of the Advisory.

Opinion-based Evidence. All opinion-based evidence from the original Advisory‖ (*e.g.*, survey data, open-forum testimony, internet-based comments, letters, and editorials) relevant to each topic was considered in the development of this Advisory. Only the findings obtained from formal surveys are reported in this document.

Opinion surveys were developed by the Task Force to address each clinical intervention identified in the document. Identical surveys were distributed to expert consultants and a random sample of members of the participating organizations.

Expert Opinion. Survey responses from Task Force–appointed expert consultants are reported in summary form in the text, with a complete listing of consultant survey responses reported in appendix 2.

Membership Opinion. Survey responses from active ASA members are reported in summary form in the text, with a complete listing of ASA member survey responses reported in appendix 2.

‖ American Society of Anesthesiologists: Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies: A report by the American Society of Anesthesiologists Task Force on Prevention of Perioperative Peripheral Neuropathies. ANESTHESIOLOGY 2000; 92:1168–82

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

Advisories

Preoperative History and Physical Assessment

Literature Findings. Certain patient characteristics have been reported to be associated with perioperative neuropathies. Although the literature is insufficient to examine the relationship between the performance of a preoperative history or physical assessment and the prevention of perioperative peripheral neuropathies, observational studies have reported an association of preoperative patient conditions (*i.e.*, obesity diabetes, vascular disease, age, and low body mass index) with both upper and lower extremity neuropathies (*Category B2-H evidence*).[2–4] Descriptive observational studies report brachial and ulnar neuropathies occurring in patients with specific preexisting conditions such as diabetes, vascular disease, alcoholism, sex, and extremes of body weight (*Category B3 evidence*).[5–8] Case reports indicate that both upper and lower neuropathies occur with diabetes, preexisting paresthesias, heavy alcohol use, and smoking history (*Category B4 evidence*).[8–10] Such conditions often are noted in a patient's medical history or found during a physical assessment.

Survey Findings. Ninety-three percent of the consultants who responded agree that a focused preoperative history may identify patients with an increased risk for the development of peripheral neuropathies during the perioperative period. Eighty-eight percent of the ASA membership respondents agree with the above statement. The majority of consultants and responding ASA members who agree with the above statement indicate that the following preexisting patient attributes are important to review: body habitus, preexisting neurologic symptoms, diabetes mellitus, peripheral vascular disease, alcohol dependency, and arthritis.

Eighty-eight percent of the responding consultants agree that a focused preoperative physical assessment may identify patients with an increased risk for the development of peripheral neuropathies during the perioperative period. Eighty percent of the ASA membership respondents agree with the above statement.

Advisory Recommendations for Preoperative History and Physical Assessment.

- Review a patient's preoperative history and perform a physical examination to identify: body habitus, preexisting neurologic symptoms, diabetes mellitus, peripheral vascular disease, alcohol dependency, arthritis, and sex (*e.g.*, male sex and its association with ulnar neuropathy).
- When judged appropriate, ascertain whether patients can comfortably tolerate the anticipated operative position.

Positioning Strategies for the Upper Extremities

Literature Findings.

Brachial Plexus Neuropathy: Supine Position. One RCT reports equivocal findings for brachial plexus neuropathy when arm abduction is greater than or equal to 90° with hands up is compared to arms positioned at the side (*Category A3-E evidence*).[11] Two nonrandomized comparative studies also report equivocal findings when arm abduction of 90° is compared with arms positioned at the side (*Category B1-E evidence*).[12,13] Four observational studies report brachial plexus injuries occurring when arm abduction is greater than or equal to 90° (*Category B3-H evidence*).[14–16] Two case reports describe brachial plexus injuries occurring when arm abduction is greater than or equal to 90° in the supine position (*Category B4-H evidence*).[17,18]

Brachial Plexus Neuropathy: Prone Position. One case report indicated that a brachial plexus injury occurred when the patient was placed in a prone position with arms and shoulder abducted greater than or equal to 90° (*Category B4-H evidence*).[19]

Brachial Plexus Neuropathy: Other Positions. Case reports describe brachial plexus injuries occurring with patient's arm abduction greater than or equal to 90° in the lithotomy, Trendelenburg, and barber chair positions (*Category B4-H evidence*).[20–22] Two case reports also describe brachial plexus injuries occurring with arm abduction of 80° in other body positions (*Category B4-H evidence*).[23,24]

Ulnar Neuropathy. One nonrandomized comparative study comparing a tilted body position of 15 to 20° with nontilted body positions reports a reduced frequency of ulnar neuropathy (*Category B1-B evidence*).[25] One nonrandomized comparative study comparing forearms placed above the head with hands in the prone position reports equivocal findings for ulnar nerve injury (*Category B1-E evidence*).[26] The literature is insufficient to evaluate the impact of forearm positioning on an armboard on the occurrence of ulnar neuropathy in supine patients. The literature is insufficient to evaluate the impact of arms being tucked at the side on the occurrence of ulnar neuropathy in supine patients. The literature is insufficient to evaluate the impact of elbow flexion on ulnar neuropathy.

Radial Neuropathy. The literature is insufficient to evaluate perioperative positioning strategies intended to reduce the occurrence of radial neuropathy.

Median Neuropathy. One case series describes median neuropathy occurring when patient elbows were fully extended in either the supine or lateral body position (*Category B4-H evidence*).[27]

Periodic Assessment of Upper Extremity Position during Procedures. The literature is insufficient to evaluate the efficacy of periodic assessment of patient position during a procedure in reducing the risk of upper extremity peripheral neuropathies.

Survey Findings.

Brachial Plexus Neuropathy. Ninety-two percent of the consultants and 96% of the ASA members agree that limiting abduction of the arm(s) in a supine patient may decrease the risk of brachial plexus neuropathy. Of those agreeing, 93% of the consultants and 84% of the ASA members indicate that the upper limit of abduction should be 90°. Seven percent of the consultants and 17% of the ASA members indicate an upper abduction limit of 60°.

Eighty-eight percent of the consultants and 91% of the ASA members agree that limiting abduction of the arm or arms in a prone patient may decrease the risk of brachial plexus neuropathy. Of those agreeing, 67% of the consultants and 57% of the ASA members agree that the upper limit of abduction should be 90°.

Ulnar Neuropathy. Fifty-two percent of the consultants and 42% of the ASA members agree that flexion of the elbow may increase the risk of ulnar neuropathy. Of those agreeing, 72% of the consultants and 66% of the ASA members indicate that elbow flexion of greater than 90° may increase the risk of ulnar neuropathy.

Seventy-four percent of the consultants and 75% of the ASA members agree that specific forearm positions in a supine patient with an arm or arms abducted on an armboard may decrease the risk of ulnar neuropathy. Of those agreeing, 85% of the consultants and 87% of the ASA members selected the supinated and neutral forearm positions.

Seventy-two percent of the consultants and 75% of the ASA members agree that specific forearm positions in a supine patient with an arm or arms tucked at the side may decrease the risk of ulnar neuropathy. Of those agreeing, 64% of the consultants and 63% of the ASA members selected the neutral forearm position.

Radial Neuropathy. Eighty-nine percent of the consultants and 86% of the ASA members agree that pressure in the spiral groove of the humerus from prolonged contact with a hard surface may increase the risk of radial neuropathy.

Median Neuropathy. Fifty-nine percent of the consultants and 62% of the ASA members agree that extension of the elbow in an anesthetized, supine patient beyond the normal range of extension that is comfortable during the preoperative examination may increase the risk of median neuropathy.

Periodic Assessment of Upper Extremity Position during Procedures. Ninety-two percent of the consultants and 97% of the ASA members agree that upper extremity position should be periodically assessed during procedures.

Advisory Recommendations for Positioning of the Upper Extremities.

Positioning Strategies to Reduce Perioperative Brachial Plexus Neuropathy.

- When possible, limit arm abduction in a supine patient to 90°.
  - The prone position may allow patients to comfortably tolerate abduction of their arms to greater than 90°.**

** The task force notes that the prone position affects shoulder and brachial plexus mobility differently than does the supine position.

Positioning Strategies to Reduce Perioperative Ulnar Neuropathy.

- *Supine Patient with Arm on an Armboard:* Position the upper extremity to decrease pressure on the postcondylar groove of the humerus (ulnar groove).
  - Either supination or the neutral forearm positions may be used to facilitate this action.
- *Supine Patient with Arms Tucked at Side:* Place the forearm in a neutral position.
- *Flexion of the Elbow:* When possible, avoid flexion of the elbow to decrease the risk of ulnar neuropathy.††

Positioning Strategies to Reduce Perioperative Radial Neuropathy.

- Avoid prolonged pressure on the radial nerve in the spiral groove of the humerus.

Positioning Strategies to Reduce Perioperative Median Neuropathy.

- Avoid extension of the elbow beyond the range that is comfortable during the preoperative assessment to prevent stretching of the median nerve.

Periodic Assessment of Upper Extremity Position during Procedures.

- Periodic perioperative assessments may be performed to ensure maintenance of the desired position.

Positioning Strategies for the Lower Extremities

Literature Findings.

Sciatic Neuropathy. One observational study reports sciatic nerve deficits of 1.0% occurring when patient legs were overextended and divaricated by 30° in the supine position (*Category B3-H evidence*).[28] One case report notes sciatic neuropathy after vertical leg extension and maximum external rotation of the thighs in a lithotomy position,[29] and a second case report notes sciatic neuropathy after hip flexion of 90° in a sitting position (*Category B4-H evidence*).[30] Two additional case reports note sciatic neuropathies occurring in patients in the supine position with the right hip elevated (*Category B4-H evidence*).[31,32] The literature is insufficient to evaluate whether limiting stretching of the hamstring muscle group or limiting hip flexion are effective strategies in reducing the incidence of sciatic neuropathy.

Femoral Neuropathy. One observational study reports neuropathies occurring (femoral nerve = 1.0%, obturator nerve = 0.3% of patients) when patients are placed on a split-leg table with hyperextended legs in the Trendelenburg position (*Category B3-H evidence*).[33] Four case reports describe femoral neuropathy occurring in patients with excessive hip or thigh abduction in the lithotomy body position (*Category B4-H evidence*).[34–37]

Peroneal (Fibular) Neuropathy. Case reports indicate peroneal neuropathy occurring after compression on the peroneal nerve secondary to placement of patients in a lithotomy position (*Category B4-H evidence*).[29,38–40]

†† There is no consensus on an acceptable degree of flexion during the perioperative period.

Survey Findings. Sciatic Neuropathy. Forty-eight percent of the consultants and 57% of the ASA members agree that stretching of the hamstring muscle group (*e.g.*, biceps femoris muscle) beyond the normal range of motion that is comfortable during the preoperative assessment may increase the risk of sciatic neuropathy. Fifty percent of the consultants and 52% of the ASA members agree that the risk of sciatic neuropathy in a patient who is positioned in a lithotomy position may be reduced if the degree of hip flexion is limited to 90°.

Femoral Neuropathy. Forty percent of the consultants and 49% of the ASA members agree that extension of the hip in an anesthetized, supine patient beyond the normal range of extension that is comfortable during the preoperative examination (*e.g.*, hyperlordosis) may increase the risk of femoral neuropathy. Fifty-one percent of the consultants and 44% of the ASA members were undecided.

Forty percent of the consultants and 43% of the ASA members agree that the risk of femoral neuropathy may be reduced if the degree of hip flexion is limited to 90°. Forty-four percent of the consultants and 29% of the ASA members agree that the risk of femoral neuropathy in a patient placed in a lithotomy position is not increased with any degree of hip flexion.

Peroneal (Fibular) Neuropathy. Ninety-two percent of the consultants and 95% of the ASA members agree that pressure near the fibular head from contact with a hard surface or a rigid support may increase the risk of peroneal neuropathy.

Advisory Recommendations for Positioning of the Lower Extremities.

Positioning Strategies to Reduce Perioperative Sciatic Neuropathy.

- *Stretching of the Hamstring Muscle Group:* Positions that stretch the hamstring muscle group beyond the range that is comfortable during the preoperative assessment may be avoided to prevent stretching of the sciatic nerve.
- *Limiting Hip Flexion:* Since the sciatic nerve or its branches cross both the hip and the knee joints, assess extension and flexion of these joints when determining the degree of hip flexion.

Positioning Strategies to Reduce Perioperative Femoral Neuropathy.

- When possible, avoid extension or flexion of the hip to decrease the risk of femoral neuropathy.

Positioning Strategies to Reduce Perioperative Peroneal Neuropathy.

- Avoid prolonged pressure on the peroneal nerve at the fibular head.

Protective Padding

Literature Findings. Protective padding is intended to protect the patient from perioperative neuropathies. One prospective observational study reports brachial plexus injury in 4.6% of patients when foam elbow pads in the supine body position are used with patient arms tucked against the body in a thumbs-up position (*Category B2-H evidence*).[41] One retrospective

observational study of the placement of towels under the scapula during median sternotomy reports brachial plexus injury in 0.4% of patients (*Category B2-H evidence*).[42] One retrospective observational study reports ulnar neuropathy occurring in 0.1% of patients when the ipsilateral upper limb is placed on a padded armboard, and the contralateral arm is flexed and rested on the bed in the lateral decubitus body position (*Category B2-H evidence*).[43] Case reports describe brachial plexus, ulnar, and median nerve neuropathies occurring when various types of padding are used (*e.g.*, arm padding, elbow cushions, shoulder padding, armboards) in the supine, lithotomy, or lateral body positions (*Category B4-H evidence*).[21,25,24–51] However, these case reports do not imply that protective padding was a cause of peripheral neuropathies, nor do they imply that the padding was used inappropriately. No studies were found that address the use of chest ("axillary") rolls to reduce perioperative peripheral neuropathies. One retrospective comparison of gel pads *versus* nongel pads placed under the knees reported equivocal results for the frequency of peroneal neuropathy (*Category B1-E evidence*).[52]

Survey Findings. Eighty-nine percent of the consultants and 89% of the ASA members agree that padded armboards may decrease the risk of upper extremity neuropathies. Seventy-eight percent of the consultants and 87% of the ASA members agree that the use of a chest roll placed under the "downside" (dependent) lateral thorax in a patient who is positioned laterally may decrease the risk of brachial plexus neuropathy in the down arm. Sixty-eight percent of the consultants and 78% of the ASA members agree that the use of specific padding (*e.g.*, foam or gel pads) at the elbow may decrease the risk of ulnar neuropathy. Ninety-four percent of the consultants and 91% of the ASA members agree that the use of specific padding to prevent contact of the peroneal nerve (at the fibular head) with a hard surface may decrease the risk of peroneal neuropathy. Sixty-eight percent of the consultants and 60% of the ASA members agree that, in some circumstances, the use of padding may increase the risk of peripheral neuropathies.

Advisory Recommendations for Protective Padding.

- Padded armboards may be used to decrease the risk of upper extremity neuropathy.
- Chest rolls in the laterally positioned patient may be used to decrease the risk of upper extremity neuropathy.
- Padding at the elbow may be used to decrease the risk of upper extremity neuropathy.
- Specific padding to prevent pressure of a hard surface against the peroneal nerve at the fibular head may be used to decrease the risk of peroneal neuropathy.
- Avoid the inappropriate use of padding (*e.g.*, padding too tight) to decrease the risk of perioperative neuropathy.

Equipment

Literature Findings. One case series described brachial plexus injuries occurring when patients' arms were restrained on an armboard in a modified lithotomy body position (*Category B4-H evidence*).[53] Three case series describe ulnar neuropathies occurring when automated blood pressure cuffs were placed on the upper arm in the supine body position (*Category B4-H evidence*).[54–56] One case report describes an ulnar neuropathy of the hand occurring when a padded sling was used in the beach chair body position (*Category B4-H evidence*).[57] Three case reports describe median neuropathies occurring when equipment was placed on the forearm (*i.e.*, blood pressure cuff, wrist attachment for catheter, and tape to affix arms to an armboard; *Category B4-H evidence*).[58–60] Four case reports describe radial neuropathies occurring when automated blood pressure cuffs were placed on the upper arm (*Category B4-H evidence*).[60–63] One case report described a radial nerve injury occurring in a supine patient when a self-retaining sternal retractor was used to elevate the sternum for surgical exposure of the internal mammary artery (*Category B4-H evidence*).[64]

One nonrandomized study reports femoral neuropathies occurring at a lower rate during a time period when the use of self-retaining retractors was not used compared to an earlier time period when self-retaining retractors were used (*Category B1-H evidence*).[65] One nonrandomized study comparing leg wrapping with no wrapping in the lithotomy body position reports equivocal findings for lower extremity neuropathies (*Category B1-E evidence*).[66] One observational study reports various lower extremity neuropathies (*i.e.*, tibial sural, peroneal, and deep peroneal nerves) occurring when thigh or ankle tourniquets are used (*Category B3-H evidence*).[67] Case reports described femoral or peroneal neuropathies occurring with the use of leg holders, stirrups, surgical stockings, pneumatic compression devices, retractors, and thigh tourniquets (*Category B3 evidence*).[68–75]

Survey Findings. Thirty-nine percent of the consultants and 30% of the ASA members agree that the use of an automated blood pressure cuff on the arm may *increase* the risk of ulnar neuropathy. Thirty-nine consultants and 30% of the ASA members agree that the use of an automated blood pressure cuff on the arm may *increase* the risk of radial neuropathy. Twenty-nine percent of the consultants and 20% of the ASA members agree that the use of an automated blood pressure cuff on the arm may *increase* the risk of median neuropathy.

Sixty-six percent of the consultants and 66% of the ASA members agree that shoulder braces (commonly placed over the acromioclavicular joint) to prevent a patient from sliding cephalad when placed in a steep head-down position may *increase* the risk of brachial plexus neuropathy.

Advisory Recommendations for Equipment.

- When possible, avoid the improper use of automated blood pressure cuffs on the arm (*i.e.*, placed below the antecubital fossa) to reduce the risk of upper extremity neuropathy.
- When possible, avoid the use of shoulder braces in a steep head-down position to *decrease* the risk of perioperative neuropathies.

Postoperative Physical Assessment

Literature Findings. The literature is insufficient to evaluate whether performing an early postoperative physical assessment reduces the severity of complications associated with perioperative peripheral neuropathies. However, one observational study reports postoperative assessment within 24 h postoperatively detected upper limb neuropathies (*Category B3-B evidence*).[76] One observational study reports the detection of peripheral nerve complications, in addition to other postoperative complications, when a daily postoperative examination was performed (*Category B3-B evidence*).[77]

Survey Findings. Seventy-two percent of the consultants and 67% of the ASA members agree that examining the patient in the postanesthesia care unit (PACU) may lead to early recognition of peripheral neuropathy.

Advisory Recommendations for Postoperative Physical Assessment.

- Perform a simple postoperative assessment of extremity nerve function for early recognition of peripheral neuropathies.

Documentation

Literature Findings. The literature is insufficient to evaluate the impact of documentation of specific perioperative positioning actions as they may relate to peripheral neuropathies.

Survey Findings. Eighty-eight percent of the consultants and 93% of the ASA members agree that documentation on an anesthetic record of specific positioning actions during the care of a patient is important. Agreement of the majority of consultants and ASA members with the above statement indicates that, when appropriate, it is important to document the following: (1) overall patient position (*e.g.*, supine, prone, lateral, or lithotomy); (2) position of arms; (3) position of lower extremities; (4) use of specific padding at the elbow or over the fibular head; (5) specific positioning action or actions taken or used during the procedures as indicated by findings on the preoperative assessment; and (6) presence or absence of signs or symptoms of peripheral neuropathy in the PACU.

Advisory Recommendations for Documentation.

- Document specific perioperative positioning actions that may be useful for continuous improvement processes.‡‡

Appendix 1: Summary of Advisory Recommendations

Preoperative History and Physical Assessment

- Review a patient's preoperative history and perform a physical examination to identify: body habitus, preexisting neurologic symptoms, diabetes mellitus, peripheral vascular disease, alcohol dependency, arthritis, and sex (*e.g.*, male sex and its association with ulnar neuropathy).
- When judged appropriate, ascertain whether patients can comfortably tolerate the anticipated operative position.

Positioning Strategies for the Upper Extremities

Positioning Strategies to Reduce Perioperative Brachial Plexus Neuropathy

- When possible, limit arm abduction in a supine patient to 90°.
  - The prone position may allow patients to comfortably tolerate abduction of their arms to greater than 90°.*

Positioning Strategies to Reduce Perioperative Ulnar Neuropathy

- *Supine Patient with Arm on an Armboard:* Position the upper extremity to decrease pressure on the postcondylar groove of the humerus (ulnar groove).
  - Use of either supination or the neutral forearm positions may be used to facilitate this action.
- *Supine Patient with Arms Tucked at Side:* Place the forearm in a neutral position.
- *Flexion of the Elbow:* When possible, avoid flexion of the elbow to decrease the risk of ulnar neuropathy.†

Positioning Strategies to Reduce Perioperative Radial Neuropathy

- Avoid prolonged pressure on the radial nerve in the spiral groove of the humerus.

Positioning Strategies to Reduce Perioperative Median Neuropathy

- Avoid extension of the elbow beyond the range that is comfortable during the preoperative assessment to prevent stretching of the median nerve.

Periodic Assessment of Upper Extremity Position during Procedures

- Periodic perioperative assessments may be performed to ensure maintenance of the desired position.

Positioning Strategies for the Lower Extremities

Positioning Strategies to Reduce Perioperative Sciatic Neuropathy

- *Stretching of the Hamstring Muscle Group:* Positions that stretch the hamstring muscle group beyond the range that is comfortable during the preoperative assessment may be avoided to prevent stretching of the sciatic nerve.

‡‡ Documentation may result in improvements by helping practitioners focus attention on relevant aspects of patient positioning and providing information on positioning strategies that may eventually lead to improvements in patient care.

* The Task Force notes that the prone position affects shoulder and brachial plexus mobility differently than does the supine position.

† There is no consensus on an acceptable degree of flexion during the perioperative period.

- *Limiting Hip Flexion:* Since the sciatic nerve or its branches cross both the hip and the knee joints, assess extension and flexion of these joints when determining the degree of hip flexion.

Positioning Strategies to Reduce Perioperative Femoral Neuropathy

- When possible, avoid extension or flexion of the hip to decrease the risk of femoral neuropathy.

Positioning Strategies to Reduce Perioperative Peroneal Neuropathy

- Avoid prolonged pressure on the peroneal nerve at the fibular head.

Protective Padding

- Padded armboards may be used to decrease the risk of upper extremity neuropathy.
- Chest rolls in the laterally positioned patient may be used to decrease the risk of upper extremity neuropathy.
- Padding at the elbow may be used to decrease the risk of upper extremity neuropathy.
- Specific padding to prevent pressure of a hard surface against the peroneal nerve at the fibular head may be used to decrease the risk of peroneal neuropathy.
- Avoid the inappropriate use of padding (*e.g.*, padding too tight) to decrease the risk of perioperative neuropathy.

Equipment

- When possible, avoid the improper use of automated blood pressure cuffs on the arm (*i.e.*, placed below the antecubital fossa) to reduce the risk of upper extremity neuropathy.
- When possible, avoid the use of shoulder braces in a steep head-down position to *decrease* the risk of perioperative neuropathies.

Postoperative Physical Assessment

- Perform a simple postoperative assessment of extremity nerve function for early recognition of peripheral neuropathies.

Documentation

- Document specific perioperative positioning actions that may be useful for continuous improvement processes.‡

‡ Documentation may result in improvements by helping practitioners focus attention on relevant aspects of patient positioning and providing information on positioning strategies that may eventually lead to improvements in patient care.

Appendix 2: Methods and Analyses

For this Advisory, a systematic search and review of peer-reviewed published literature was conducted, with scientific findings summarized and reported below and in the document. Assessment of conceptual issues, practicality, and feasibility of the Advisory recommendations was also conducted, with opinion data collected from surveys by the original Advisory and from other sources. Both the systematic literature review and opinion data are based on *evidence linkages*, or statements regarding potential relationships between interventions and outcomes associated with peripheral neuropathies. The evidence model below guided the search, providing inclusion and exclusion information regarding patients, procedures, practice settings, providers, clinical interventions, and outcomes.

Evidence Model

Patients

Inclusion criteria:

- Adult patients
- Sedated patients
- Anesthetized patients

Exclusion criteria:

- Children, neonates, and infants

Procedures

Inclusion criteria:

- Inpatient procedures
- Outpatient procedures

Exclusion criteria:

- Procedures where anesthetic care is not provided

Practice Settings

Inclusion criteria:

- Operating rooms
- Other anesthetizing locations
- Recovery rooms
- Intensive care units
- Outpatient procedural units
- Office-based practices

Exclusion criteria:

- Nonperioperative settings

Providers

Inclusion criteria:

- Anesthesia care providers
  - Anesthesiologists
  - Providers working under the direction of anesthesiologists

Exclusion criteria:

- Individuals who do not deliver or are responsible for anesthesia care

Interventions

Inclusion criteria:

- Patient evaluation
  - Conduct a preoperative history and physical assessment
  - Include assessment of body habitus, preexisting neurologic symptoms, diabetes, peripheral vascular disease, alcohol dependence, arthritis, and sex (e.g., male sex and its association with ulnar neuropathy)
- Ascertain that patients can comfortably tolerate the anticipated operative position
- Positioning strategies for the upper extremities
  - Positioning strategies to protect the brachial plexus
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Position of extremities
      - Arm/shoulder abduction less than or equal to 90° *versus* more than 90°
      - Hands up
      - Arms elevated
      - Head/neck rotation
      - Head in neutral position
  - Positioning strategies to protect the ulnar nerve at the elbow
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Tilted position (15° to 20°)
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Position of extremities
      - Arm/shoulder abduction less than or equal to 90° *versus* more than 90°
      - Forearm positions on armboard
      - Arms tucked at side
      - Flexion of elbow
      - Hands up
  - Positioning strategies to protect the radial nerve in the arm
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Avoidance of prolonged pressure from a hard surface on the radial nerve in the spiral groove
  - Positioning strategies to protect the median nerve at the elbow
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Avoidance of elbow extension beyond the normal range of extension that is comfortable
  - Periodic assessment of upper extremity position during procedures
- Positioning strategies for the lower extremities
  - Positioning strategies to protect the sciatic nerve
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Avoidance of hamstring muscle stretching beyond the normal range of extension that is comfortable
    - Limiting extension of the hip and knee joints
  - Positioning strategies to protect the femoral nerve
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Limiting extension/flexion/rotation of the hip beyond the normal range of extension that is comfortable
  - Positioning strategies to protect the peroneal (fibular) nerve
    - Overall patient body position
      - Prone
      - Supine
      - Sitting
      - Other positions (*e.g.*, lithotomy, Trendelenburg)
    - Avoidance of prolonged pressure from a hard surface or rigid support on the fibular head
- Equipment/padding
  - Upper extremity padding/equipment
    - Padded armboards

- Chest rolls
- Padding at the elbow
- Brachial plexus
  - Shoulder roll
  - Padded armboard
  - Rigid shoulder rests
  - Other upper extremity protective padding
- Ulnar nerve at the elbow
  - Elbow cushions/pads
  - Wrist tied to armboard
  - Other upper extremity protective padding
- Radial nerve in the arm
  - Protective padding
- Median nerve at the elbow
  - Protective padding
- Lower extremity padding/equipment
  - Peroneal (fibular) nerve
    - Specific padding to prevent pressure of a hard surface against the peroneal nerve at the fibular head

- Equipment
  - Equipment placed on upper extremities
    - Blood pressure cuff placement on the arm (placed above the antecubital fossa)
    - Shoulder braces (*e.g.*, patient placed in a steep head-down position)
    - Retractors (*e.g.*, sternal retractors)
    - Equipment placed on lower extremities
    - Leg holders
    - Leg wraps
    - Padded slings
    - Stirrups
    - Pneumatic compression devices
    - Retractors
- Postoperative physical assessment
  - Postoperative assessment of extremity nerve function
- Documentation on anesthetic record
  - Documentation of specific perioperative positioning actions
    - Overall patient body position (*e.g.*, prone, supine, sitting, or other position)
    - Position of arms
    - Position of lower extremities
    - Use of specific padding (*e.g.*, at the elbow or over the fibular head)
- Documentation of presence or absence of signs/symptoms of peripheral neuropathy in the postanesthetic care unit

Outcomes

Inclusion criteria:

- Postoperative signs and symptoms related to peripheral nerve injury (*e.g.*, brachial plexus, sciatic, and femoral)
  - Paresthesia
  - Muscle weakness
  - Tingling in extremities
  - Pain in extremities

Exclusion criteria:

- Compartment syndromes
- Neuropathies associated with anesthetic techniques (*e.g.*, neuraxial anesthesia)

Evidence Collection

Literature inclusion criteria:

- RCTs
- Prospective nonrandomized comparative studies (*e.g.*, quasi-experimental, cohort)
- Retrospective comparative studies (*e.g.*, case control)
- Observational studies (*e.g.*, correlational or descriptive statistics)
- Case reports, case series

Literature exclusion criteria (except to obtain new citations):

- Editorials
- Literature reviews
- Meta-analyses conducted by others
- Abstracts greater than 5 yr old
- Unpublished studies
- Studies in non–peer-reviewed journals
- Newspaper articles

Survey evidence:

- Expert consultant survey
- ASA membership survey
- Other participating organization surveys
- Reliability survey
- Feasibility survey

State of the Literature. For the systematic review, potentially relevant clinical studies were identified *via* electronic and manual searches. Healthcare database searches included PubMed, EMBASE, Web of Science, Google Books, and the Cochrane Central Register of Controlled Trials. The searches covered a 7.5-yr period from January 1, 2010, through July 31, 2017. Accepted studies from the previous updated Advisory were also re-reviewed, covering the period of January 1, 1999, through July 31, 2009. Search terms consisted of the interventions indicated in the evidence model above guided by the appropriate inclusion/exclusion criteria. Only studies containing original findings from peer-reviewed journals were acceptable. Editorials, letters, and other articles without data were excluded. A literature search strategy and Preferred Reporting Items of Systematic reviews and Meta-Analyses (PRISMA) flow diagram are available as Supplemental Digital Content 2, http://links.lww.com/ALN/B568.

Seven hundred and ninety-five new citations were identified and reviewed, with 31 new studies meeting the above stated criteria. These studies were combined with 83 pre-2010 articles used in the previous Advisory, resulting in a total of 114 articles found acceptable as evidence for this Advisory. A complete bibliography of articles used to develop this Advisory, organized by section, is available as Supplemental Digital Content 3, http://links.lww.com/ALN/B554.

Each pertinent outcome reported in a study was classified by evidence category and level and designated as beneficial, harmful, or equivocal. Findings were then summarized for each evidence linkage and reported in the text of the updated Advisory.

Consensus-based Evidence. For the original Advisory, consensus was obtained from multiple sources, including: (1) survey opinion from consultants who were selected based on their knowledge or expertise in perioperative positioning and peripheral neuropathy, (2) survey opinions from a randomly selected sample of active members of the ASA, (3) testimony from attendees of a publicly held open forum at a national convention, (4) internet commentary, and (5) Task Force member opinion and interpretation. The survey rate of return was 56% (N = 84/150) for consultants and 29% (N = 433/1,500) for membership respondents.

The results of the original surveys are reported in tables 1–3 and in the text of the Advisory. The majority of consultants and ASA membership respondents agreed with the following survey items: (1) a focused preoperative history; (2) a focused preoperative examination to identify patients at risk for the development of peripheral neuropathies during the perioperative period; (3) upper extremity position should be periodically assessed during procedures; (4) limiting abduction of the arm(s) in a supine or prone patient may decrease the risk of brachial plexus neuropathy; (5) specific forearm position(s) in a supine patient with an arm(s) tucked at the side may decrease the risk of ulnar neuropathy; (6) specific forearm position(s) in a supine patient with an arm(s) abducted on an armboard may decrease the risk of ulnar neuropathy; (7) pressure in the spiral groove of the humerus from prolonged contact with a hard surface may increase the risk of radial neuropathy; (8) extension of the elbow in an anesthetized, supine patient beyond the normal range of extension that is comfortable during the preoperative exam may increase the risk of median neuropathy; (9) pressure near the fibular head from contact with a hard surface or a rigid support may increase the risk of peroneal neuropathy; (10) padded armboards may decrease the risk of upper extremity neuropathies; (11) a chest roll placed under the "downside" (dependent) lateral thorax in a patient who is positioned laterally may decrease the risk of brachial plexus neuropathy in the down arm; (12) specific padding (*e.g.*, foam or gel pads) at the elbow may decrease the risk of ulnar neuropathy; (13) specific padding to prevent contact of the peroneal nerve (at the fibular head) with a hard surface may decrease the risk of peroneal neuropathy; (14) in some circumstances, the use of padding may increase the risk of peripheral neuropathies; (15) shoulder braces (commonly placed over the acromioclavicluar joint) to prevent a patient from sliding cephalad when placed in a steep head-down position may increase the risk of brachial plexus neuropathy; (16) examining the patient in the PACU may lead to early recognition of peripheral neuropathy; and (17) documentation on an anesthetic record of specific positioning actions during the care of a patient is important. Items where no majority agreement was indicated were: (1) flexion of the elbow may increase the risk of ulnar neuropathy; (2) stretching of the hamstring muscle group (*e.g.*, biceps femoris muscle) beyond the normal range of motion that is comfortable during the preoperative assessment may increase the risk of sciatic neuropathy; (3) extension of the hip in an anesthetized, supine patient beyond the normal range of extension that is comfortable during the preoperative exam (*e.g.*, hyperlordosis) may increase the risk of femoral neuropathy; and (4) the use of an automated blood pressure cuff on the arm may increase the risk of ulnar, radial, or median neuropathy.

Consultants and ASA membership respondents who agreed with the above survey items responded to specific item-related topics. The majority of these respondents agreed with the following items: (1) preexisting patient attributes that are important to review during a preoperative history include but are not limited to body habitus, preexisting neurologic symptoms, diabetes mellitus, peripheral vascular disease, alcohol dependency, and arthritis; (2) in a patient examination, it is important to assess limitations to joint range of motion in the elbow and/or shoulder, range of motion of an arthritic neck, range of motion of the hip and knee joints (for placing patients in a lateral or lithotomy position), ability to extend hips (for placing patients in a supine position), and flexibility of the hamstring muscle group (for placing patients in a lateral or lithotomy position); (3) the upper limit of abduction of the arm(s) in a supine or prone patient should be 90°; (4) in a supine patient with an arm(s) tucked at the side, the forearm in the neutral position may decrease the risk of ulnar neuropathy; (5) in a supine patient with an arm(s) abducted on an armboard, the forearm in the supinated position may decrease the risk of ulnar neuropathy; (6) elbow flexion greater than 90° may increase the risk of ulnar neuropathy; (7) the risk of sciatic neuropathy in a patient who is positioned in a lithotomy position may be reduced if the degree of hip flexion is limited to 90°; and (8) it is important to document overall patient position (*e.g.*, supine, prone, lateral, lithotomy), position of arms, position of lower extremities, use of specific padding at the elbow or over the fibular head, specific positioning action(s) taken or used during a procedure as indicated by findings on a preoperative examination, and the presence or absence of signs or symptoms of peripheral neuropathy in the PACU.

A majority was not obtained for the following items: (1) sex as an important attribute to review in a focused preoperative history; (2) flexibility of the hamstring muscle group (for placing patients in a lateral or lithotomy position) as important to assess in a preoperative examination; (3) the degree of hip flexion for reducing the risk of femoral neuropathy in a patient placed in a lithotomy position; and (4) the type of leg holder used for a patient in a lithotomy position as an important attribute to document.

Table 1. Consultant Survey Responses

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy	Agreement			
		N	Agree	Disagree	Don't Know
	A focused preoperative history	84	93%	6%	1%
	A focused preoperative examination	82	88%	5%	7%
Upper extremity	Periodic assessment of upper extremity position during procedures	83	92%	5%	3%
Brachial plexus	Limiting abduction of the arm(s) in a supine patient	82	92%	1%	7%
Brachial plexus	Limiting abduction of the arm(s) in a prone patient	81	88%	5%	7%
Ulnar	Specific forearm position(s) in a supine patient with an arm(s) tucked at the side	83	72%	11%	17%
Ulnar	Specific forearm position(s) in a supine patient who has an arm(s) abducted on an armboard	83	74%	16%	10%
Ulnar	Flexion of the elbow	81	52%	20%	28%
Radial	Pressure in the spiral groove of the humerus from prolonged contact with a hard surface	82	89%	2%	9%
Median	Extension of the elbow in an anesthetized, supine patient beyond the normal range of extension that is comfortable during the preoperative examination	82	59%	7%	34%
Sciatic	In a patient who is positioned in a lateral or lithotomy position, stretching of the hamstring muscle group beyond a comfortable range	81	48%	9%	43%
Femoral	Extension of the hip in a supine patient beyond a comfortable range	83	40%	10%	50%
Peroneal	Pressure near the fibular head from contact with a hard surface or a rigid support	83	92%	0%	8%
Upper extremity	Padded armboards	83	89%	1%	10%
Brachial plexus	A chest roll placed under the "downside" (dependent) lateral thorax in a patient who is positioned laterally	83	78%	7%	15%
Ulnar	Specific padding (*e.g.*, foam or gel pads) at the elbow	83	67%	10%	23%
Peroneal	Specific padding to prevent contact of the peroneal nerve (at the fibular head) with a hard surface	82	94%	1%	5%
Peroneal	Padding in some circumstances may increase peripheral neuropathy	81	68%	14%	18%
Brachial plexus	Shoulder braces to prevent a patient from sliding cephalad when placed in a steep head-down position may increase peripheral neuropathy	83	66%	9%	25%
Ulnar	Automated blood pressure cuff on the arm may increase risk of neuropathy	82	39%	26%	35%
Radial	Automated blood pressure cuff on the arm may increase risk of neuropathy	83	39%	21%	40%
Median	Automated blood pressure cuff on the arm may increase risk of neuropathy	82	29%	29%	42%
	Examining a patient in the PACU may lead to early recognition of neuropathies	83	72%	17%	11%
	Documentation on an anesthetic record of specific positioning actions	84	88%	8%	4%

PACU = postanesthesia care unit.

Table 2. Membership Survey Responses

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy	Agreement			
		N	Agree	Disagree	Don't Know
	A focused preoperative history	433	88%	5%	7%
	A focused preoperative examination	429	80%	9%	11%
Upper extremity	Periodic assessment of upper extremity position during procedures	425	97%	1%	2%
Brachial plexus	Limiting abduction of the arm(s) in a supine patient	431	96%	2%	2%
Brachial plexus	Limiting abduction of the arm(s) in a prone patient	432	91%	4%	5%
Ulnar	Specific forearm position(s) in a supine patient with an arm(s) tucked at the side	424	75%	11%	14%
Ulnar	Specific forearm position(s) in a supine patient who has an arm(s) abducted on an armboard	426	75%	11%	14%
Ulnar	Flexion of the elbow	426	42%	28%	30%
Radial	Pressure in the spiral groove of the humerus from prolonged contact with a hard surface	425	86%	3%	11%
Median	Extension of the elbow in a supine patient beyond the normal range of extension that is comfortable during the preoperative examination	424	62%	7%	31%
Sciatic	In a patient who is positioned in a lateral or lithotomy position, stretching of the hamstring muscle group beyond a range that is comfortable during a preoperative examination	423	57%	4%	39%
Femoral	Extension of the hip in a supine patient beyond a range that is comfortable during a preoperative examination	424	49%	7%	44%
Peroneal	Pressure near the fibular head from contact with a hard surface or a rigid support	429	95%	1%	4%
Upper extremity	Padded armboards	428	89%	5%	6%
Brachial plexus	A chest roll placed under the "downside" (dependent) lateral thorax in a patient who is positioned laterally	427	87%	5%	8%
Ulnar	Specific padding (*e.g.*, foam or gel pads) at the elbow	429	78%	10%	12%
Peroneal	Specific padding to prevent contact of the peroneal nerve (at the fibular head) with a hard surface	429	91%	3%	6%
	Padding in some circumstances may increase peripheral neuropathy	427	60%	12%	28%
Brachial plexus	Shoulder braces to prevent a patient from sliding cephalad when placed in a steep head-down position may increase peripheral neuropathy	422	66%	8%	26%
Ulnar	Automated blood pressure cuff on the arm may increase risk of neuropathy	428	30%	36%	34%
Radial	Automated blood pressure cuff on the arm may increase risk of neuropathy	428	30%	31%	39%
Median	Automated blood pressure cuff on the arm may increase risk of neuropathy	429	20%	39%	41%
	Examining a patient in the PACU may lead to early recognition of neuropathies	424	67%	19%	14%
	Documentation on an anesthetic record of specific positioning actions	424	93%	4%	3%

PACU = postanesthesia care unit.

Table 3. Item Responses for Consultants and American Society of Anesthesiologists Members

	Consultants		Membership	
Survey Item	N	% Agree	N	% Agree
1. For a preoperative history, the following attributes are important to review:				
Preexisting neurologic symptoms	78	96%	383	96%
Diabetes	78	90%	383	86%
Body habitus	78	83%	383	88%
Peripheral vascular disease	78	74%	383	77%
Arthritis	78	56%	383	66%
Alcohol dependency	78	56%	383	52%
Sex	78	42%	380	43%
2. In a patient examination, it is important to assess the following:				
Limitations to joint range of motion in the elbow and/or shoulder	74	88%	343	94%
Range of motion of an arthritic neck	73	85%	345	93%
Range of motion of the hip and knee joints (for placing patients in a lateral or lithotomy position)	69	68%	325	73%
Ability to extend hips (for placing patients in a supine position)	67	55%	323	58%
Flexibility of the hamstring muscle group (for placing patients in a lateral or lithotomy position)	67	49%	321	55%
3. The upper limit of abduction of the arm(s) in a supine patient should be:	72		405	
60°		7%		16%
90°		93%		84%
4. The upper limit of abduction of the arm(s) in a prone patient should be:	70		387	
60°		33%		43%
90°		67%		57%
5. Which forearm position (in a supine patient with an arm(s) tucked at the side) do you believe may decrease the risk of ulnar neuropathy?	59		312	
Supinated		27%		26%
Pronated		9%		11%
Neutral		64%		63%
6. Which forearm position (in a supine patient who has an arm(s) abducted on an armboard) do you believe may decrease the risk of ulnar neuropathy?	60		315	
Supinated		62%		59%
Pronated		15%		13%
Neutral		23%		28%
7. What degree of elbow flexion may increase the risk of ulnar neuropathy?	40		171	
45°		15%		14%
90°		13%		20%
> 90°		72%		66%
8. The risk of sciatic neuropathy in a patient who is positioned in a lithotomy position may be reduced if the degree of hip flexion is limited to:	68		346	
60°		19%		28%
90°		50%		52%
120°		13%		12%
Risk is not increased with any degree of hip flexion		18%		8%
9. The risk of femoral neuropathy in a patient placed in a lithotomy position may be reduced if the degree of hip flexion is limited to:	62		327	
60°		7%		20%
90°		40%		43%
120° (*e.g.*, exaggerated lithotomy)		10%		8%
Risk is not increased with any degree of hip flexion		43%		29%
10. The following attributes are important to document:				
Overall patient position (*e.g.*, supine, prone, lateral, lithotomy)	74	100%	392	99%
Position of arms	74	84%	393	81%
Position of lower extremities	74	66%	393	66%
Use of specific padding at the elbow or over the fibular head	74	82%	392	73%
For a patient in a lithotomy position, the type of leg holder used	74	51%	393	39%
Specific positioning action(s) taken or used during a procedure as indicated by findings on a preoperative examination	74	87%	393	79%
Presence or absence of signs or symptoms of peripheral neuropathy in the PACU	74	58%	393	58%

PACU = postanesthesia care unit.

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Competing Interests

The authors declare no competing interests.

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