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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

PRACTICE advisories are systematically developed reports that are intended to assist decision-making in areas of patient care where scientific evidence is insufficient. Advisories provide a synthesis and analysis of expert opinion, clinical feasibility data, open forum commentary, and consensus surveys. Advisories 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 report the state of the literature and opinions derived from a synthesis of task force members, expert consultants, open forums

and public commentary. Scientific literature and other documentation are summarized in practice advisories to provide an additional source of guidance. 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.

A. Purposes of the Advisory for the Prevention of Perioperative Peripheral Neuropathies

The purposes of this advisory are to 1) educate American Society of Anesthesiologists (ASA) members, (2) provide a reference framework for individual 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.

B. 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

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Please see this issue of ANESTHESIOLOGY, page 5A.

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Readers with special interest in the literature synthesis and consensus statistics used in establishing this Advisory can receive further information by writing to the American Society of Anesthesiologists.

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limited to, operating rooms and other anesthetizing locations, recovery rooms, intensive care units, outpatient procedural units, and office-based practices.

C. Application

This 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 health care professionals.

D. Task Force Members and Consultants

The ASA appointed a task force of 10 members to (1) review the published evidence, (2) obtain consultant opinion from a representative body of anesthesiologists, nurse anesthetists, anesthesiology assistants, perioperative nurses, surgeons, and emergency medicine physicians, and (3) build consensus within the task force. The task force members consisted of anesthesiologists in both private and academic practices from various geographic areas of the United States and methodologists from the ASA Committee on Practice Parameters. The task force identified a group of 150 consultants from both the national and the international anesthesia communities who have expertise or interest in perioperative peripheral neuropathies.

The task force met its objective in a five-step process. First, original published research studies relevant to these issues were reviewed. Second, consultants who practice or work in various settings (*e.g.*, academic and private practice) were asked to (1) participate in surveys of their opinions of the effectiveness of various positioning and protective strategies to prevent perioperative peripheral neuropathies and (2) review and comment on the initial draft report of the task force. Third, a random sample of anesthesiologists ($n = 1,500$) from the ASA Directory of Members (active members only) was surveyed regarding their impressions of various elements of the advisory. Fourth, the task force held an open forum at a major national anesthesia meeting to solicit input on its draft advisory from attendees of the meeting. Fifth, all available information was used to build consensus within the task force on the advisory.

A summary of the consensus of the task force on all key issues pertinent to this advisory is presented in table 1.

E. Availability and Strength of Evidence

Practice advisories are developed by a systematic consensus-based process. Although they do not have the

Table 1. Summary of Task Force Consensus

Preoperative assessment
<ul style="list-style-type: none"> When judged appropriate, it is helpful to ascertain that patients can comfortably tolerate the anticipated operative position
Upper extremity positioning
<ul style="list-style-type: none"> Arm abduction should be limited to 90° in supine patients; patients who are positioned prone may comfortably tolerate arm abduction greater than 90° Arms should be positioned to decrease pressure on the postcondylar groove of the humerus (ulnar groove). When arms are tucked at the side, a neutral forearm position is recommended. When arms are abducted on armboards, either supination or a neutral forearm position is acceptable Prolonged pressure on the radial nerve in the spiral groove of the humerus should be avoided Extension of the elbow beyond a comfortable range may stretch the median nerve
Lower extremity positioning
<ul style="list-style-type: none"> Lithotomy positions that stretch the hamstring muscle group beyond a comfortable range may stretch the sciatic nerve Prolonged pressure on the peroneal nerve at the fibular head should be avoided Neither extension nor flexion of the hip increases the risk of femoral neuropathy
Protective padding
<ul style="list-style-type: none"> Padded armboards may decrease the risk of upper extremity neuropathy The use of chest rolls in laterally positioned patients may decrease the risk of upper extremity neuropathies Padding at the elbow and at the fibular head may decrease the risk of upper and lower extremity neuropathies, respectively
Equipment
<ul style="list-style-type: none"> Properly functioning automated blood pressure cuffs on the upper arms do not affect the risk of upper extremity neuropathies Shoulder braces in steep head-down positions may increase the risk of brachial plexus neuropathies
Postoperative assessment
<ul style="list-style-type: none"> A simple postoperative assessment of extremity nerve function may lead to early recognition of peripheral neuropathies
Documentation
<ul style="list-style-type: none"> Charting specific positioning actions during the care of patients may result in improvements of care by (1) helping practitioners focus attention on relevant aspects of patient positioning; and (2) providing information that continuous improvement processes can use to lead to refinements in patient care

support of sufficient numbers of scientific studies, a source of guidance is provided by the summarization of scientific studies, case reports, descriptive literature, and other documentation. Consensus findings from consultant and ASA membership surveys are summarized and included in advisories in addition to task force opinion, open forum opinion, and public commentary.

Advisory Statements

I. Preoperative History and Physical Assessment

Certain patient characteristics have been reported to be associated with perioperative neuropathies. Although this advisory found no studies examining the relationship between the performance of a preoperative history or physical assessment and the prevention of perioperative peripheral neuropathies, 25 studies reported postoperative peripheral neuropathies occurring in patients with specific preexisting conditions (e.g., smoking, diabetes, vascular disease, and extremes of body weight, and age).¹⁻²⁵ Such conditions often are noted in a patient's medical history or found during a physical assessment. These studies are not acceptable evidence of causation.

Advisory

Consultants and ASA Members. Ninety-three percent of the consultants who responded (n = 78/84) 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 (n = 382/433) 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 (n = 72/82) 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 (n = 344/429) agree with the above statement.

Task Force and Others. The task force consensus is that body habitus, preexisting neurologic symptoms, diabetes mellitus, peripheral vascular disease, alcohol dependency, arthritis, and gender (e.g., male gender and its association with ulnar neuropathy) are important elements of a preoperative history. The task force consensus also indicates that, when judged appropriate, it would be helpful during a preoperative assessment to ascertain that patients can comfortably tolerate the anticipated operative position. Public commentary from an open forum and from Internet correspondence corroborates the task force opinions.

II. Specific Positioning Strategies for the Upper Extremities

A. Positioning Strategies to Reduce the Frequency of Perioperative Brachial Plexus Neuropathy

Nineteen articles were found that reported brachial plexus injuries.²⁶⁻⁴⁴ Fifteen were case reports or studies with descriptive information only.²⁶⁻⁴⁰ Six of the 15 articles reported brachial plexus neuropathies occurring with arm abduction greater than 90°,²⁶⁻³¹ and four of the 15 reported brachial plexus neuropathies occurring with arm abduction equal to 90°.³²⁻³⁵ Four articles reported statistical comparisons,⁴¹⁻⁴⁴ only one of which was a randomized clinical trial.⁴⁴ Three of these four articles compared arm abduction less than or equal to 90° *versus* arms at side in supine patients.⁴¹⁻⁴³ One article compared arm abduction less than 90° *versus* arm abduction equal to 90°.⁴⁴ These articles do not provide sufficient data to identify a causal relationship between perioperative conditions and brachial plexus neuropathies.

Advisory

Arm Abduction in a Supine Patient

Consultants and ASA Members. Ninety-two percent of the consultants (n = 75/82), and 96% of the ASA members (n = 411/431) 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 (n = 67/72) and 84% of the ASA members (n = 342/405) indicate that the upper limit of abduction should be 90°. Seven percent of the consultants (n = 5/72) and 17% of the ASA members (n = 63/405) indicate an upper abduction limit of 60°.

Task Force and Others. The task force consensus is that arm abduction should be limited to 90°. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Arm Abduction in a Prone Patient

Consultants and ASA members. Eighty-eight percent of the consultants (n = 71/81) and 91% of the ASA members (n = 392/432) 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 (n = 47/70) and 57% of the ASA members (n = 222/387) agree that the upper limit of abduction should be 90°.

Task Force and Others. The task force notes that the prone position affects shoulder and brachial plexus mobility differently than does the supine position. These differences may allow patients to comfortably tolerate abduction of their arms greater than 90° when posi-

tioned prone. Public commentary from an open forum and from Internet correspondence corroborates the task force commentary.

B. Positioning Strategies to Reduce the Frequency of Perioperative Ulnar Neuropathy

Five articles were found that reported ulnar neuropathies.^{20,25,45-47} Three articles were case reports,^{25,45,46} one was a retrospective comparison of forearm supination and pronation,²⁰ and one was a nonrandomized comparison of supination and pronation.⁴⁷ These articles do not contain sufficient data to identify a relationship between positioning strategies and ulnar neuropathies.

Advisory

Supine Patient with Arm on an Armboard

Consultants and ASA Members. Seventy-four percent of the consultants (n = 61/83) and 75% of the ASA members (n = 318/426) 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 (n = 51/60), and 87% of the ASA members (n = 274/315) selected the supinated and neutral forearm positions.

Task Force and Others. The task force consensus is that the forearm should be positioned to decrease pressure on the postcondylar groove of the humerus (ulnar groove). Either supination or the neutral forearm position meets this goal. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Supine Patient with Arms Tucked at Side

Consultants and ASA Members. Seventy-two percent of the consultants (n = 60/83) and 75% of the ASA members (n = 318/424) 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 (n = 38/59) and 63% of the ASA members (n = 196/312) selected the neutral forearm position.

Task Force and Others. The task force consensus is that the forearm should be in a neutral position. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Flexion of the Elbow

Consultants and ASA Members. Fifty-two percent of the consultants (n = 42/81) and 42% of the ASA members (n = 180/426) agree that *flexion of the elbow may increase the risk of ulnar neuropathy*. Of those agreeing, 72% of the consultants (n = 29/40) and 66% of the

ASA members (n = 114/174) indicate that elbow flexion of greater than 90° may increase the risk of ulnar neuropathy.

Task Force and Others. The task force consensus is that flexion of the elbow may increase the risk of ulnar neuropathy, but there is no consensus on an acceptable degree of flexion during the perioperative period. Public commentary from an open forum and from Internet correspondence corroborates the consultant and ASA membership survey results.

C. Positioning Strategies to Reduce the Frequency of Perioperative Radial Neuropathy

No case reports or studies were found addressing perioperative positioning strategies to protect the radial nerve.

Advisory

Consultants and ASA Members. Eighty-nine percent of the consultants (n = 73/82) and 86% of the ASA members (n = 364/425) agree that *pressure in the spiral groove of the humerus from prolonged contact with a hard surface may increase the risk of radial neuropathy*.

Task Force and Others. The task force consensus is that prolonged pressure on the radial nerve in the spiral groove of the humerus should be avoided. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

D. Positioning Strategies to Reduce the Frequency of Perioperative Median Neuropathy

No case reports or studies were found addressing perioperative positioning strategies to protect the median nerve.

Advisory

Consultants and ASA Members. Fifty-nine percent of the consultants (n = 48/82) and 62% of the ASA members (n = 264/424) 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*.

Task Force and Others. The task force consensus is that extension of the elbow beyond the range that is comfortable during the preoperative assessment may stretch the median nerve. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

E. Periodic Assessment of Position During Procedures

No case reports or studies were found addressing assessment of patient position perioperatively to protect the upper extremities.

Advisory

Consultants and ASA Members. Ninety-two percent of the consultants (n = 76/83) and 97% of the ASA members (n = 413/425) agree that *upper extremity position should be periodically assessed during procedures.*

Task Force and Others. The task force consensus is that periodic perioperative assessments may ensure maintenance of the desired position. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

III. Specific Positioning Strategies for the Lower Extremities

A. Positioning Strategies to Reduce the Frequency of Perioperative Sciatic Neuropathy

Two case reports of postoperative sciatic neuropathy were found.^{48,49} One report noted hip flexion of 90° in a sitting position,⁴⁸ and the other reported perioperative vertical leg extension and maximum external rotation of thighs in a lithotomy position.⁴⁹ Case reports are not acceptable evidence to indicate causation.

Advisory

Stretching of the Hamstring Muscle Group

Consultants and ASA Members. Forty-eight percent of the consultants (n = 39/81) and 57% of the ASA members (n = 241/423) 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.*

Task Force and Others. The task force consensus is that positions that stretch the hamstring muscle group beyond the range that is comfortable during the preoperative assessment may stretch the sciatic nerve. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Limiting Hip Flexion

Consultants and ASA Members. Fifty percent of the consultants (n = 34/68) and 52% of the ASA members (n = 181/346) 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°.

Task Force and Others. The task force consensus is that since the sciatic nerve or its branches cross both the hip and the knee joints, flexion and extension of both of these joints should be considered when determining the degree of hip flexion. Public commentary from an open

forum and from Internet correspondence corroborates the task force opinion.

B. Positioning Strategies to Reduce the Frequency of Perioperative Femoral Neuropathy

Two case reports of postoperative femoral neuropathy were found.^{50,51} One report found femoral neuropathy to occur in five patients who were placed in a lithotomy position,⁵⁰ and the other reported a patient with postoperative neuropathy after placement in a lithotomy position with exaggerated hip flexion and "candy cane" stirrups.⁵¹ Case reports are not acceptable evidence to indicate causation.

Advisory

Consultants and ASA Members. Forty percent of the consultants (n = 33/83) and 49% of the ASA members (n = 209/424) 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 (n = 42/83) and 44% of the ASA members (n = 186/424) were undecided.

Forty percent of the consultants (n = 25/62) and 43% of the ASA members (n = 141/327) 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 (n = 27/62) and 29% of the ASA members (n = 95/327) agree that *the risk of femoral neuropathy in a patient placed in a lithotomy position is not increased with any degree of hip flexion.*

Task Force and Others. The task force consensus is that neither extension nor flexion of the hip changes the risk for femoral neuropathy. Public commentary from an open forum and from Internet correspondence is equivocal regarding the risk of femoral neuropathy related to hip extension or flexion.

C. Positioning Strategies to Reduce the Frequency of Perioperative Peroneal (Fibular) Neuropathy

One case report of postoperative peroneal nerve palsy in a patient placed in a sitting position, producing sciatic nerve pressure and stretching, was found.⁷ Case reports are not acceptable evidence to indicate causation.

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Consultants and ASA Members. Ninety-two percent of the consultants (n = 76/83) and 95% of the ASA members (n = 409/429) agree that *pressure near the fibular head from contact with a hard surface or a rigid support may increase the risk of peroneal neuropathy.*

Task Force and Others. The task force consensus is that prolonged pressure on the peroneal nerve at the

fibular head should be avoided. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

IV. Protective Padding

Protective padding is intended to protect the patient from perioperative neuropathies. Eight articles were found that reported peripheral neuropathies occurring when upper extremity protective padding was used.^{4,36,45,46,52-55} Four of these eight reported cases of brachial plexopathy,^{4,36,52,53} and the other four reported cases of ulnar neuropathy.^{45,46,54,55} These articles do not attribute padding as a cause of the neuropathies. All of these articles were case reports except for one retrospective descriptive study.⁵² These articles are not acceptable evidence of causation. No studies were found addressing the relationship between the use of chest ("axillary") rolls and the occurrence of peripheral neuropathies. No studies were found addressing the occurrence of peripheral neuropathies when lower extremity protective padding was used.

Advisory

Padded Armboards

Consultants and ASA Members. Eighty-nine percent of the consultants (n = 74/83), and 89% of the ASA members (n = 382/428) agree that *padded armboards may decrease the risk of upper extremity neuropathies*.

Task Force and Others. The task force consensus is that padded armboards may decrease the risk of upper extremity neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Chest Rolls

Consultants and ASA Members. Seventy-eight percent of the consultants (n = 64/83) and 87% of the ASA members (n = 370/427) 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*.

Task Force and Others. The task force consensus is that the use of chest rolls in the laterally positioned patient may decrease the risk of upper extremity neuropathy. Public commentary from an open forum offers divergent opinions. Internet correspondence corroborates the task force opinion.

Padding at the Elbow

Consultants and ASA Members. Sixty-eight percent of the consultants (n = 56/83) and 78% of the ASA members (n = 335/429) agree that *the use of specific padding (e.g., foam or gel pads) at the elbow may decrease the risk of ulnar neuropathy*.

Task Force and Others. The task force consensus is that padding at the elbow may decrease the risk of upper extremity neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Padding to Protect the Peroneal (Fibular) Nerve

Consultants and ASA Members. Ninety-four percent of the consultants (n = 77/82) and 91% of the ASA members (n = 392/429) 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*.

Task Force and Others. The task force consensus is that the use of specific padding to prevent pressure of a hard surface against the peroneal nerve at the fibular head may decrease the risk of peroneal neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Complications from the Use of Padding

Consultants and ASA Members. Sixty-eight percent of the consultants (n = 55/81) and 60% of the ASA members (n = 256/427) agree that, *in some circumstances, the use of padding may increase the risk of peripheral neuropathies*.

Task Force and Others. The task force consensus is that the inappropriate use of padding (e.g., padding too tight) may increase the risk of perioperative neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

V. Equipment

No articles were found that prospectively examined the impact of equipment or supports as a direct cause of perioperative peripheral neuropathies. Regarding upper extremity neuropathies, eleven articles were found that retrospectively reported peripheral neuropathies occurring when upper extremity contact was made with equipment or supports.^{25,35,43,56-63} Six case reports described radial or ulnar nerve damage occurring when a blood pressure monitoring device was used intraoperatively.^{25,56-60} Two case reports described brachial plexus neuropathies occurring when shoulder braces or

rests were used.^{35,61} One case report described isolated radial nerve palsy occurring in a prone patient with an arm abducted over a Foster frame,⁶² and one case report described radial neuropathy occurring in a supine patient undergoing coronary artery bypass grafting with an arm compressed by a retractor.⁶³ Case reports are not acceptable evidence to indicate causation. One nonrandomized comparison study examined use *versus* no use of a shoulder brace when patients were in a supine position for laparotomy, and found a lower frequency of brachial plexus neuropathy when a shoulder brace was not used.⁴³ However, the research design of the study does not provide acceptable evidence of causation.

Sixteen articles were found that reported peripheral neuropathies occurring when lower extremity contact was made with equipment or supports.^{12,51,64-77} Fourteen case reports described femoral or peroneal neuropathies occurring with the use of leg holders,⁶⁴ stirrups,^{51,65,66} surgical stockings,⁶⁷ pneumatic compression devices,⁶⁸ and retractors.^{12,69-74} One article reported a case of lateral popliteal nerve palsy as a complication of the use of a continuous passive motion knee machine.⁷⁵ On article retrospectively compared parturients in a lithotomy position with stirrups *versus* without stirrups.⁷⁶ These articles are not acceptable evidence of causation. One nonrandomized comparison study of femoral neuropathy examined the use of self-retaining retractors *versus* hand-held retractors for hysterectomy.⁷⁷ The research design of the study does not provide acceptable evidence of causation.

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Automated Blood Pressure Cuff

Consultants and ASA Members.

Effects on Ulnar Neuropathy: Twenty-six percent of the consultants (n = 21/82) disagree, 39% agree (n = 32/82), and 35% are uncertain (n = 29/82) that *use of an automated blood pressure cuff on the arm may increase the risk of ulnar neuropathy*. Thirty-six percent of the ASA members (n = 155/428) disagree, 30% agree (n = 126/428), and 34% are uncertain (n = 147/428) that the use of an automated blood pressure cuff on the arm may *increase* the risk of ulnar neuropathy.

Effects on Radial Neuropathy: Twenty percent of the consultants (n = 17/83) disagree, 39% agree (n = 32/83), and 41% are uncertain (n = 34/83) that *use of an automated blood pressure cuff on the arm may increase the risk of radial neuropathy*. Thirty-one percent of the ASA members (n = 133/428) disagree, 30% agree (n = 128/428), and 39% are uncertain (n = 167/428)

that *the use of an automated blood pressure cuff on the arm may increase the risk of radial neuropathy*.

Effects on Median Neuropathy: Twenty-nine percent of the consultants (n = 24/82) disagree, 29% agree (n = 24/82), and 42% are uncertain (n = 34/82) that use of an automated blood pressure cuff on the arm may increase the risk of median neuropathy. Thirty-nine percent of the ASA members (n = 167/429) disagree, 20% agree (n = 87/429), and 41% are uncertain (n = 175/429) that the use of an automated blood pressure cuff on the arm may increase the risk of median neuropathy.

Task Force and Others. The task force consensus is that the use of properly functioning automated blood pressure cuffs on the arm (*i.e.*, placed above the antecubital fossa) does not change the risk of upper extremity neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

Shoulder Braces

Consultants and ASA Members. Sixty-six percent of the consultants (n = 55/83) and 66% of the ASA members (n = 280/422) 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*.

Task Force and Others. The task force consensus is that use of shoulder braces in a steep head-down position may *increase* the risk of perioperative neuropathies. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

VI. Postoperative Physical Assessment

No articles were found that examined the relationship between the performance of a physical assessment in the postanesthesia care unit (PACU) and the prevention of perioperative peripheral neuropathies. However, four case reports,^{14,54,78,79} and four descriptive studies described the detection of a peripheral neuropathy during postoperative assessment.^{76,80-82} Case reports and descriptive studies do not provide acceptable evidence to indicate causation. No comparative studies were found.

Advisory

Consultants and ASA Members. Seventy-two percent of the consultants (n = 60/83) and 67% of the ASA members (n = 282/424) agree that *examining the patient in the PACU may lead to early recognition of peripheral neuropathy*.

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Task Force and Others. The task force consensus is that a simple postoperative assessment of extremity nerve function may lead to early recognition of peripheral neuropathy. Public commentary from an open forum and from Internet correspondence corroborates the task force opinion.

VII. Documentation

No studies were found addressing the issue of documentation of specific perioperative positioning actions related to peripheral neuropathies.

Advisory

Consultants and ASA Members. Eighty-eight percent of the consultants ($n = 74/84$), and 93% of the ASA members ($n = 393/424$) 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.

Task Force and Others. The task force consensus is that this documentation may be useful for continuous improvement processes. Documentation may result in improvements by (1) helping the practitioner focus attention on relevant aspects of patient positioning and (2) providing knowledge of positioning strategies that eventually leads to changes in anesthesia practice. Public commentary from an open forum and from the Internet corroborates the task force opinion.

Appendix: Literature Review and Consensus-Based Evidence

For this Advisory, a literature review was used in combination with consensus opinion to provide guidance to practitioners regarding positioning strategies and perioperative peripheral neuropathies. Both the literature review and consensus data were based on the following statements, or evidence linkages. These linkages represent directional statements about relationships between

intraoperative patient positioning and perioperative peripheral neuropathies. Evidence linkages are listed below:

- I. A focused preoperative history and physical assessment reduces the occurrence of perioperative peripheral neuropathies
- II. Specific positioning strategies for the upper extremities reduce the occurrence of perioperative peripheral neuropathies.
 - A. Brachial plexus neuropathy:
 1. Abduction equal to or less than 90° *versus* abduction greater than 90°
 2. Supination of forearm *versus* pronation (and its subsequent effect on rotation of the humerus)
 - B. Ulnar neuropathy at the elbow:
 1. Flexion/extension of elbow less than or equal to 90° *versus* greater than 90°
 2. Patient in supine position:
 - a. Forearm on an armboard—supination *versus* pronation of the forearm
 - b. Arms tucked at side—supination *versus* pronation of the forearm
 - C. Radial neuropathy in the arm:
 1. Avoidance of pressure on arm from contact with hard surfaces
 - D. Median neuropathy at the elbow:
 1. Patient in supine position
 - a. Flexion/extension of elbow less than or equal to 90° *versus* greater than 90°
- III. Specific positioning strategies for the lower extremities reduce the occurrence of perioperative peripheral neuropathies.
 - A. Sciatic neuropathy
 1. Patient in lithotomy position
 - a. Stretching of hamstring muscle (e.g., biceps femorous muscle) beyond comfortable range of motion
 - b. Hip flexion less than or equal to 120° *versus* greater than 120°
 2. Patient in lateral position
 - a. Stretching of hamstring muscle (e.g., biceps femorous muscle) beyond comfortable range of motion
 - b. Hip flexion less than or equal to 120° *versus* greater than 120°
 - B. Femoral neuropathy:
 1. Patient in supine position
 - a. Hip flexion less than or equal to 90°

- C. Peroneal (fibular) neuropathy:
 1. Avoidance of contact with hard surfaces or supports that applies direct pressure on the fibular head (to protect the peroneal [fibular] nerve)
 2. Avoidance of contact with hard surfaces or supports that applies direct pressure on the lateral tibia from contact with hard surfaces (to protect the peroneal [fibular] nerve)
- IV. Protective padding reduces the occurrence of perioperative peripheral neuropathies.
 - A. Upper extremity:
 1. Padded armboards
 2. Specific padding (*e.g.*, foam or gel pads) at the elbow
 3. For a patient in lateral position, the use of a chest roll positioned under the chest (*versus* a chest roll placed under the axilla) to protect the brachial plexus
 4. Avoidance of padding that is excessively tight or restrictive (*e.g.*, on elbow)
 - B. Lower extremity:
 1. Specific padding between the outside of the leg below the knee to prevent contact of the peroneal nerve (at the fibular head) with a hard surface
 2. Avoidance of padding that is excessively tight or restrictive
- V. Equipment (*e.g.*, braces, supports).
 - A. Placed on upper extremity:
 1. Use of shoulder braces (commonly placed over the acromioclavicular joint) to prevent a patient from sliding cephalad when placed in a steep head-down position
 2. Blood pressure cuff:
 - a. Automated blood pressure cuff (*versus* manual blood pressure cuff monitoring)
 - b. Blood pressure cuff placed on the arm (*versus* blood pressure cuff placed on the forearm)
 - B. Placed on lower extremity:
 1. Avoidance of contact with hard surfaces or supports that applies direct pressure on the fibular head (to protect the peroneal [fibular] nerve)
 2. Avoidance of contact with hard surfaces or supports that applies direct pressure on the lateral tibia from contact with hard surfaces (to protect the peroneal [fibular] nerve)

VI. A postoperative physical assessment improves the recognition of peripheral neuropathies

VII. Documentation of specific perioperative positioning actions provides information that leads to changes in anesthesiology practice resulting in reduced occurrence of perioperative adverse events/injuries.

A. State of the Literature

For purposes of literature review, potentially relevant clinical studies were identified via electronic and manual searches of the literature. The electronic search covered a 34-year period from 1966 through 1999. The manual search covered a 78-year period of time from 1922 through 1999. Over 1500 citations were initially identified, yielding a total of 509 non-overlapping articles that addressed topics related to the seven evidence linkages. Following review of the articles, 427 studies did not provide direct evidence, and were subsequently eliminated. A total of 82 articles (from 45 journals) contained direct linkage-related evidence. No evidence linkage contained enough studies with well-defined experimental designs and statistical information to conduct formal meta-analyses.

A study or report that appears in the published literature can be included as evidence in the development of an advisory if it meets four essential criteria. Failure to meet one or more of these criteria means that a study had features that did not make it suitable for the analytic process. The four essential criteria are as follows:

1. The study must be related to one of the specified linkage statements
2. The study must report a clinical finding or set of findings that can be tallied or quantified. This criterion eliminates reports that only contain opinion
3. The study must report a clinical finding or set of findings that can be identified as the product of an original investigation or report. This criterion eliminates the repetitive reporting and counting of the same results, as may occur in review articles or follow-up studies that summarize previous findings
4. The study must use sound research methods and analytical approaches that provide a clear test or indication of the relationship between the intervention and outcome of interest.

Of the 509 studies reviewed, 82 met the first three criteria. However, only 6 studies exhibited sufficiently acceptable methods and analyses that provided a clear indication of the relationships between interventions

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Table 2. Consultant Survey of Evidence Linkages

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy (Does the use of the intervention impact the risk of neuropathy?)	N	% Agreement		
			Agree	Disagree	Don't Know
Any	A focused preoperative history	84	93	6	1
Any	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 exam	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 range that is comfortable during a preoperative evaluation	81	48	9	43
Femoral	Extension of the hip in a supine patient beyond a range that is comfortable during a preoperative evaluation	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
Brachial plexus	Padding in some circumstances may increase peripheral neuropathy	81	68	14	18
	Shoulder braces to prevent a patient from sliding cephalad when placed in a steep head-down position	83	66	9	25
Ulnar	Automated blood pressure cuff on the arm	82	39	26	35
Radial	Automated blood pressure cuff on the arm	83	39	21	40
Median	Automated blood pressure cuff on the arm	82	29	29	42
Any	Examining a patient in the postanesthesia care unit	83	72	17	11
Any	Documentation on an anesthetic record of specific positioning actions	84	88	8	4

and outcomes of interest.^{41-44,47,77} Because of the small number of qualifying studies, the published literature could not be used as a source of quantitative support.

Future studies should focus on prospective methodologies that utilize traditional hypothesis testing techniques. Use of the following methodological procedures for assessing the impact of positioning techniques on perioperative peripheral neuropathies is recommended: (1) comparison studies [*i.e.*, one technique *versus* another], (2) randomization, and (3) full reporting of test scores and *P* values.

When examining the impact of positioning techniques on perioperative peripheral neuropathies, the researcher must be extremely careful to avoid methodological and interpretive errors. For example, a patient's preoperative condition, type of surgery, duration of sur-

gery, and the perioperative position (e.g., lithotomy, prone) are not under the direct control of the anesthesiologist. These perioperative circumstances may influence perioperative outcomes (*i.e.*, peripheral neuropathies), but are confounding factors when examining the influence of intraoperative positioning techniques (e.g., arm abduction $> 90^\circ$ *versus* $\leq 90^\circ$) on the occurrence of peripheral neuropathies.

In conclusion, the current literature has not been helpful in determining the efficacy of perioperative positioning techniques in reducing the occurrence of peripheral neuropathies. Until additional controlled studies are conducted, evidence from other sources will need to be utilized, such as consensus-driven data and the opinion of practitioners and experts. It is recommended that future research on positioning techniques for the pre-

Table 3. Membership Survey of Evidence Linkages

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy (Does the use of the intervention impact the risk of neuropathy?)	N	% Agreement		
			Agree	Disagree	Don't Know
Any	A focused preoperative history	433	88	5	7
Any	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 exam	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 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
Brachial plexus	Padding in some circumstances may increase peripheral neuropathy	427	60	12	28
	Shoulder braces to prevent a patient from sliding cephalad when placed in a steep head-down position	422	66	8	26
Ulnar	Automated blood pressure cuff on the arm	428	30	36	34
Radial	Automated blood pressure cuff on the arm	428	30	31	39
Median	Automated blood pressure cuff on the arm	429	20	39	41
Any	Examining a patient in the postanesthesia care unit	424	67	19	14
Any	Documentation on an anesthetic record of specific positioning actions	424	93	4	3

vention of peripheral neuropathies focus on improving research design and methods, and concentrate on specific techniques under the direct control of the anesthesiologist during a procedure.

B. Consensus-based Evidence

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 opinion and interpretation. The rate of return was 56% (N = 84/150)

for consultants, and 29% (N = 433/1500) for membership respondents.

Results of the surveys are reported in tables 2 through 4. 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 and (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 or (6) abducted on an armboard may decrease the

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Table 4. Item Responses for Consultants and ASA Members

Survey Item	Consultants		Member	
	N	Percent	N	Percent
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%
Gender	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 exam	74	87%	393	79%
Presence or absence of signs or symptoms of peripheral neuropathy in the postanesthesia care unit	74	58%	393	58%

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) 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; (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 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; (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 exam, 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) gender 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.

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