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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**

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

8 Practice advisories summarize the state of the literature and report opinions obtained from
9 expert consultants and ASA members. They are not supported by scientific literature to the
10 same degree as standards or guidelines because of the lack of sufficient numbers of adequately
11 controlled studies. Practice advisories are subject to periodic revision as warranted by the
12 evolution of medical knowledge, technology, and practice.

13 This document updates the "Practice Advisory for the Prevention of Perioperative Peripheral
14 Neuropathies: an Updated Report," adopted by the ASA in 2010 and published in 2011.[†]

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Address correspondence to the American Society of Anesthesiologists: 1060 American Lane, Schaumburg, Illinois 60173. This Practice Advisory, as well as all ASA Practice Parameters, may be obtained at no cost through the Journal Web site, www.anesthesiology.org.

[†] 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 Prevention of Perioperative Peripheral Neuropathies. *ANESTHESIOLOGY* 2011; 114: 741–54

Methodology

15 ***Definition of Peripheral Neuropathy***

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

20 ***Purposes of the Advisory***

21 The purposes of the Advisory are to 1) educate American Society of Anesthesiologists
22 (ASA) members, (2) provide a reference framework for individual practices, and (3) stimulate
23 the pursuit and evaluation of strategies that may prevent or reduce the frequency of occurrence or
24 minimize the severity of peripheral neuropathies that may be related to perioperative positioning
25 of patients.

26 ***Focus***

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

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

36 ***Application***

37 The updated Advisory is intended for use by anesthesiologists or other providers working

38 under the direction of anesthesiologists. It also may serve as a resource for other health care
39 professionals.

40 ***Task Force Members and Consultants***

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

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

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

59 ***Availability and Strength of Evidence***

60 Preparation of this update used the same methodological process as was used in the original

[‡] Society for Ambulatory Anesthesia 14th Annual Meeting, Seattle, WA, 1999.

61 Advisory to obtain new scientific evidence. Opinion-based evidence obtained from the original
62 Advisory is reported in this update. The protocol for reporting each source of evidence is
63 described below.

64 **Scientific Evidence.** Scientific evidence used in the development of this Advisory is based
65 on cumulative findings from literature published in peer-reviewed journals. Literature citations
66 are obtained from healthcare databases, direct internet searches, Task Force members, liaisons
67 with other organizations, and manual searches of references located in reviewed articles.
68 Findings from the aggregated literature are reported in the text of this Advisory by evidence
69 category, level, and direction and in appendix 2. Evidence categories refer specifically to the
70 strength and quality of the *research design* of the studies. Category A evidence represents results
71 obtained from randomized controlled trials (RCTs) and Category B evidence represents
72 observational results obtained from nonrandomized study designs or RCTs without pertinent
73 comparison groups. When available, Category A evidence is given precedence over Category B
74 evidence for any particular outcome. These evidence categories are further divided into evidence
75 levels. Evidence levels refer specifically to the strength and quality of the summarized study
76 *findings* (*i.e.*, statistical findings, type of data, and the number of studies reporting/replicating the
77 findings). In this document, only the highest level of evidence is included in the summary report
78 for each intervention-outcome pair, including a directional designation of benefit, harm, or
79 equivocalty.

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

83 Level 1: The literature contains a sufficient number of RCTs to conduct meta-analysis,[§] and
84 meta-analytic findings from these aggregated studies are reported as evidence.

85 Level 2: The literature contains multiple RCTs, but the number of RCTs is not sufficient to
86 conduct a viable meta-analysis for the purpose of this Advisory. Findings from
87 these RCTs are reported separately as evidence.

88 Level 3: The literature contains a single RCT, and findings from this study are reported as
89 evidence.

90 **Category B.** Observational studies or RCTs without pertinent comparison groups may
91 permit *inference* of beneficial or harmful relationships among clinical interventions and clinical
92 outcomes. Inferred findings are given a directional designation of beneficial (B), harmful (H) or
93 equivocal (E). For studies that report statistical findings, the threshold for significance is $p <$
94 0.01.

95 Level 1: The literature contains observational comparisons (*e.g.*, cohort, case-control
96 research designs) with comparative statistics between clinical interventions for a
97 specified clinical outcome.

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

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

102 Level 4: The literature contains case reports.

103 **Insufficient Literature.** The *lack* of sufficient scientific evidence in the literature may occur
104 when the evidence is either unavailable (*i.e.*, no pertinent studies found) or inadequate.

[§] 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 5 independent RCTs are required for meta-analysis, meta-analyses were not conducted for this practice advisory.

105 Inadequate literature cannot be used to assess relationships among clinical interventions and
106 outcomes because a clear interpretation of findings is not obtained due to methodological
107 concerns (*e.g.*, confounding of study design or implementation) or the study does not meet the
108 criteria for content as defined in the “Focus” of the Advisory.

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

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

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

119 **Membership Opinion.** Survey responses from active ASA members are reported in summary
120 form in the text, with a complete listing of ASA member survey responses reported in appendix
121 2.

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

** American Society of Anesthesiologists: Practice Advisory for the Prevention of Perioperative Peripheral Neuropathies. *ANESTHESIOLOGY* 2000; 92:1168-1182

Advisories126 ***Preoperative History and Physical Assessment***

127 **Literature Findings.** Certain patient characteristics have been reported to be associated
128 with perioperative neuropathies. Although the literature is insufficient to examine the
129 relationship between the performance of a preoperative history or physical assessment and the
130 prevention of perioperative peripheral neuropathies, observational studies have reported an
131 association of preoperative patient conditions (*i.e.*, obesity diabetes, vascular disease, age and
132 low body mass index) with both upper and lower extremity neuropathies (*Category B2-H*
133 *evidence*).¹⁻³ Descriptive observational studies report brachial and ulnar neuropathies occurring
134 in patients with specific preexisting conditions such as diabetes, vascular disease, alcoholism,
135 gender and extremes of body weight (*Category B3 evidence*).⁴⁻⁷ Case reports indicate that both
136 upper and lower neuropathies occur with diabetes, preexisting paresthesias, heavy alcohol use,
137 and smoking history (*Category B4 evidence*).⁸⁻¹⁰ Such conditions often are noted in a patient's
138 medical history or found during a physical assessment.

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

146 Eighty-eight percent of the responding consultants agree that a focused preoperative physical
147 assessment may identify patients with an increased risk for the development of peripheral

148 neuropathies during the perioperative period. Eighty percent of the ASA membership
149 respondents agree with the above statement.

150 **Advisory Recommendations for Preoperative History and Physical Assessment.**

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

158 ***Positioning Strategies for the Upper Extremities***

159 **Literature Findings.**

160 ***Brachial Plexus Neuropathy: Supine Position.*** One randomized controlled trial (RCT)
161 reports equivocal findings for brachial plexus neuropathy when arm abduction $\geq 90^\circ$ with hands
162 up is compared to arms positioned at the side (*Category A3-E evidence*).¹¹ Two nonrandomized
163 comparative studies also report equivocal findings when arm abduction of 90% is compared with
164 arms positioned at the side (*Category B1-E evidence*).¹²⁻¹³ Four observational studies report
165 brachial plexus injuries occurring when arm abduction $\geq 90^\circ$ (*Category B3-H evidence*).¹⁴⁻¹⁶
166 Two case reports describe brachial plexus injuries occurring when arm abduction is $\geq 90^\circ$ in the
167 supine position (*Category B4-H evidence*).^{17,18}

168 ***Brachial Plexus Neuropathy: Prone Position.*** One case report indicated that a brachial
169 plexus injury occurred when the patient was placed in a prone position with arms and shoulder
170 abducted $\geq 90^\circ$ (*Category B4-H evidence*).¹⁹

171 ***Brachial Plexus Neuropathy: Other Positions.*** Case reports describe brachial plexus
172 injuries occurring with patient's arm abduction $\geq 90^\circ$ in Lithotomy, Trendelenburg, and Barber
173 Chair positions (*Category B4-H evidence*).²⁰⁻²² Two case reports also describe brachial plexus
174 injuries occurring with arm abduction of 80° in other body positions (*Category B4-H evidence*).
175 ^{23,24}

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

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

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

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

193 **Survey Findings.**

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

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

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

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

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

215 **Radial Neuropathy.** Eighty-nine percent of the consultants and 86% of the ASA members
216 agree that pressure in the spiral groove of the humerus from prolonged contact with a hard

217 surface may increase the risk of radial neuropathy.

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

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

225 **Advisory Recommendations for Positioning of the Upper Extremities.**

226 ***Positioning Strategies to Reduce Perioperative Brachial Plexus Neuropathy.***

- 227 • When possible, limit arm abduction in a supine patient to 90°.
- 228 ○ The prone position may allow patients to comfortably tolerate abduction of
229 their arms to greater than 90°^{††}

230 ***Positioning Strategies to Reduce Perioperative Ulnar Neuropathy.***

- 231 • *Supine Patient with Arm on an Armboard:* Position the upper extremity to decrease
232 pressure on the postcondylar groove of the humerus (ulnar groove).
- 233 ○ Either supination or the neutral forearm positions may be used to facilitate this
234 action.
- 235 • *Supine Patient with Arms Tucked at Side:* Place the forearm in a neutral position.
- 236 • *Flexion of the Elbow:* When possible, avoid flexion of the elbow to decrease the risk
237 of ulnar neuropathy.^{‡‡}

^{††} 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.

238 ***Positioning Strategies to Reduce Perioperative Radial Neuropathy.***

- 239
 - Avoid prolonged pressure on the radial nerve in the spiral groove of the humerus.

240 ***Positioning Strategies to Reduce Perioperative Median Neuropathy.***

- 241
 - Avoid extension of the elbow beyond the range that is comfortable during the

242 preoperative assessment to prevent stretching of the median nerve.

243 ***Periodic Assessment of Upper Extremity Position during Procedures.***

- 244
 - Periodic perioperative assessments may be performed to ensure maintenance of the

245 desired position.

246 ***Positioning Strategies for the Lower Extremities***

247 **Literature Findings.**

248 ***Sciatic Neuropathy.*** One observational study reports sciatic nerve deficits of 1.0% occurring
249 when patient legs were overextended and divaricated by 30° in the supine position (*Category B3-*
250 *H evidence*).²⁸ One case report notes sciatic neuropathy following vertical leg extension and
251 maximum external rotation of the thighs in a lithotomy position.,²⁹ and a second case report
252 notes sciatic neuropathy following hip flexion of 90° in a sitting position (*Category B4-H*
253 *evidence*).³⁰ Two additional case reports note sciatic neuropathies occurring in patients in the
254 supine position with the right hip elevated (*Category B4-H evidence*).^{31,32}

255 The literature is insufficient to evaluate whether limiting stretching of the hamstring muscle
256 group or limiting hip flexion are effective strategies in reducing the incidence of sciatic
257 neuropathy.

258 ***Femoral Neuropathy.*** One observational study reports neuropathies occurring (femoral
259 nerve = 1.0%, obturator nerve = 0.3% of patients) when patients are placed on a split-leg table
260 with hyperextended legs in the Trendelenburg position (*Category B3-H evidence*).³³ Four case

261 reports describe femoral neuropathy occurring in patients with excessive hip or thigh abduction
262 in the lithotomy body position (*Category B4-H evidence*).³⁴⁻³⁷

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

266 **Survey Findings.**

267 ***Sciatic Neuropathy.*** Forty-eight percent of the consultants and 57% of the ASA members
268 agree that stretching of the hamstring muscle group (*e.g.*, biceps femoris muscle) beyond the
269 normal range of motion that is comfortable during the preoperative assessment may increase the
270 risk of sciatic neuropathy.

271 Fifty percent of the consultants and 52% of the ASA members agree that the risk of sciatic
272 neuropathy in a patient who is positioned in a lithotomy position may be reduced if the degree of
273 hip flexion is limited to 90°.

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

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

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

286 **Advisory Recommendations for Positioning of the Lower Extremities.**

287 ***Positioning Strategies to Reduce Perioperative Sciatic Neuropathy.***

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

294 ***Positioning Strategies to Reduce Perioperative Femoral Neuropathy.***

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

297 ***Positioning Strategies to Reduce Perioperative Peroneal Neuropathy.***

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

299 ***Protective Padding***

300 **Literature Findings.** Protective padding is intended to protect the patient from
301 perioperative neuropathies. One prospective observational study reports brachial plexus injury in
302 4.6% of patients when foam elbow pads in the supine body position are used with patient arms
303 tucked against the body in a thumbs-up position (*Category B2-H evidence*).⁴¹ One retrospective
304 observational study of the placement of towels under the scapula during median sternotomy
305 reports brachial plexus injury in 0.4% of patients (*Category B2-H evidence*).⁴² One

306 retrospective observational study reports ulnar neuropathy occurring in 0.1% of patients when
307 the ipsilateral upper limb is placed on a padded arm board and the contralateral arm is flexed and
308 rested on the bed in the lateral decubitus body position (*Category B2-H evidence*).⁴³ Case
309 reports describe brachial plexus, ulnar and median nerve neuropathies occurring when various
310 types of padding are used (*e.g.*, arm padding, elbow cushions, shoulder padding, armboards) in
311 the supine, lithotomy or lateral body positions (*Category B4-H evidence*).⁴⁴⁻⁵³ However, these
312 case reports do not imply that protective padding was a cause of peripheral neuropathies, nor do
313 they imply that the padding was used inappropriately. No studies were found that address the
314 use of chest (“axillary”) rolls to reduce perioperative peripheral neuropathies. One retrospective
315 comparison of gel pads versus non gel-pads placed under the knees reported equivocal results for
316 the frequency of peroneal neuropathy (*Category B1-E evidence*).⁵⁴

317 **Survey Findings.** Eighty-nine percent of the consultants and 89% of the ASA members
318 agree that padded armboards may decrease the risk of upper extremity neuropathies.

319 Seventy-eight percent of the consultants and 87% of the ASA members agree that the use of
320 a chest roll placed under the "downside" (dependent) lateral thorax in a patient who is positioned
321 laterally may decrease the risk of brachial plexus neuropathy in the down arm.

322 Sixty-eight percent of the consultants and 78% of the ASA members agree that the use of
323 specific padding (*e.g.*, foam or gel pads) at the elbow may decrease the risk of ulnar neuropathy.

324 Ninety-four percent of the consultants and 91% of the ASA members agree that the use of
325 specific padding to prevent contact of the peroneal nerve (at the fibular head) with a hard surface
326 may decrease the risk of peroneal neuropathy.

327 Sixty-eight percent of the consultants and 60% of the ASA members agree that, in some
328 circumstances, the use of padding may increase the risk of peripheral neuropathies.

329 **Advisory Recommendations for Protective Padding.**

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

338 ***Equipment***

339 **Literature Findings.** One case series described brachial plexus injuries occurring when

340 patients' arms were restrained on an armboard in a modified lithotomy body position (*Category*

341 *B4-H evidence*).⁵⁵ Three case series describe ulnar neuropathies occurring when automated

342 blood pressure cuffs were placed on the upper arm in the supine body position (*Category B4-H*

343 *evidence*).⁵⁶⁻⁵⁸ One case report describes an ulnar neuropathy of the hand occurring when a

344 padded sling was used in the beach chair body position (*Category B4-H evidence*).⁵⁹ Three case

345 reports describe median neuropathies occurring when equipment was placed on the forearm (*i.e.*,

346 blood pressure cuff, wrist attachment for catheter, and tape to affix arms to an armboard

347 (*Category B4-H evidence*).⁶⁰⁻⁶² Four case reports describe radial neuropathies occurring when

348 automated blood pressure cuffs were placed on the upper arm (*Category B4-H evidence*).⁶²⁻⁶⁵

349 One case report described a radial nerve injury occurring in a supine patient when a self-

350 retaining sternal retractor was used to elevate the sternum for surgical exposure of the internal

351 mammary artery (*Category B4-H evidence*).⁶⁶

352 One nonrandomized study reports femoral neuropathies occurring at a lower rate during a
353 time period when the use of self-retaining retractors was not used compared to an earlier time
354 period when self-retaining retractors were used (*Category B1-H evidence*).⁶⁷ One
355 nonrandomized study comparing leg wrapping with no wrapping in the lithotomy body position
356 reports equivocal findings for lower extremity neuropathies (*Category B1-E evidence*).⁶⁸ One
357 observational study reports various lower extremity neuropathies (*i.e.*, tibial sural, peroneal and
358 deep peroneal nerves) occurring when thigh or ankle tourniquets are used (*Category B3-H*
359 *evidence*).⁶⁹ Case reports described femoral or peroneal neuropathies occurring with the use of
360 leg holders, stirrups, surgical stockings, pneumatic compression devices, retractors, and thigh
361 tourniquets (*Category B3 evidence*).⁷⁰⁻⁷⁷

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

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

371 **Advisory Recommendations for Equipment:**

- 372 • When possible, avoid the improper use of automated blood pressure cuffs on the arm
373 (*i.e.*, placed below the antecubital fossa) to reduce the risk of upper extremity
374 neuropathy.

- 375 • When possible, avoid the use of shoulder braces in a steep head-down position to
376 *decrease* the risk of perioperative neuropathies.

377 ***Postoperative Physical Assessment***

378 **Literature Findings.** The literature is insufficient to evaluate whether performing an early
379 postoperative physical assessment reduces the severity of complications associated with
380 perioperative peripheral neuropathies. However, one observational study reports postoperative
381 assessment within 24 hours postoperatively detected upper limb neuropathies (*Category B3-B*
382 *evidence*).⁷⁸ One observational study reports the detection of peripheral nerve complications, in
383 addition to other postoperative complications, when a daily postoperative examination was
384 performed (*Category B3-B evidence*).⁷⁹

385 **Survey Findings.** Seventy-two percent of the consultants and 67% of the ASA members
386 agree that examining the patient in the PACU may lead to early recognition of peripheral
387 neuropathy.

388 **Advisory Recommendations for Postoperative Physical Assessment.**

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

391 ***Documentation***

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

394 **Survey Findings.** Eighty-eight percent of the consultants and 93% of the ASA members
395 agree that documentation on an anesthetic record of specific positioning actions during the care
396 of a patient is important. Agreement of the majority of consultants and ASA members with the
397 above statement indicates that, when appropriate, it is important to document the following: (1)

398 overall patient position (*e.g.*, supine, prone, lateral, or lithotomy), (2) position of arms, (3)
399 position of lower extremities, (4) use of specific padding at the elbow or over the fibular head,
400 (5) specific positioning action or actions taken or used during the procedures as indicated by
401 findings on the preoperative assessment, and (6) presence or absence of signs or symptoms of
402 peripheral neuropathy in the PACU.

403 **Advisory Recommendations for Documentation.**

- 404 • Document specific perioperative positioning actions that may be useful for
405 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.

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Appendix I: 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 gender (*e.g.*, male gender 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 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.
- *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.

^{***} 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.

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

406 For this Advisory, a systematic search and review of peer-reviewed published literature was
407 conducted, with scientific findings summarized and reported below and in the document. Assessment
408 of conceptual issues, practicality and feasibility of the Advisory statements was also conducted, with
409 opinion data collected from surveys by the original Advisory and from other sources. Both the
410 systematic literature review and opinion data are based on *evidence linkages*, or statements regarding
411 potential relationships between interventions and outcomes associated with peripheral neuropathies.
412 The evidence model below guided the search, providing inclusion and exclusion information
413 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:
 - Non-perioperative 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 gender (*e.g.*, male gender 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 $\leq 90^\circ$ vs $> 90^\circ$
 - 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 $\leq 90^\circ$ vs $> 90^\circ$
 - Forearm positions on arm board
 - 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 arm boards
 - Chest rolls
 - Padding at the elbow
 - Brachial plexus
 - Shoulder roll
 - Padded arm board
 - Rigid shoulder rests
 - Other upper extremity protective padding
 - Ulnar nerve at the elbow
 - Elbow cushions/pads
 - Wrist tied to arm board
 - 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:
 - Randomized controlled trials
 - 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 years 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

414 For the systematic review, potentially relevant clinical studies were identified *via* electronic and
415 manual searches. Healthcare database searches included PubMed, EMBASE, Web of Science,
416 Google Books, and the Cochrane Central Register of Controlled Trials. The searches covered a 7.5-
417 yr period from January 1, 2010 through May 31, 2017. Accepted studies from the previous updated
418 Advisory were also re-reviewed, covering the period of January 1, 1999 through July 31, 2009.
419 Search terms consisted of the interventions indicated in the evidence model above guided by the
420 appropriate inclusion/exclusion criteria. Only studies containing original findings from peer-
421 reviewed journals were acceptable. Editorials, letters, and other articles without data were excluded.

422 Seven hundred ninety-five new citations were identified and reviewed, with 32 new studies
423 meeting the above stated criteria. These studies were combined with 85 pre-2010 articles used in the
424 previous Guidelines, resulting in a total of 117 articles found acceptable as evidence for this
425 Advisory. A complete bibliography of articles used to develop this Advisory, organized by section, is
426 available as Supplemental Digital Content 2, <http://links.lww.com/ALN/.....>

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

Consensus-Based Evidence

430 For the original Advisory, consensus was obtained from multiple sources, including: (1) survey
431 opinion from consultants who were selected based on their knowledge or expertise in perioperative
432

433 positioning and peripheral neuropathy, (2) survey opinions from a randomly selected sample of active
434 members of the American Society of Anesthesiologists, (3) testimony from attendees of a publicly-
435 held open forum at a national convention, (4) internet commentary, and (5) Task Force member
436 opinion and interpretation. The survey rate of return was 56% (N = 84/150) for consultants, and 29%
437 (N=433/1500) for membership respondents.

438 Results of the original surveys are reported in Tables 2-4 and in the text of the Advisory. The
439 majority of consultants and ASA membership respondents agreed with the following survey items: 1)
440 a focused preoperative history and 2) a focused preoperative examination to identify patients at risk
441 for the development of peripheral neuropathies during the perioperative period; 3) upper extremity
442 position should be periodically assessed during procedures; 4) limiting abduction of the arm(s) in a
443 supine or prone patient may decrease the risk of brachial plexus neuropathy; 5) specific forearm
444 position(s) in a supine patient with an arm(s) tucked at the side or 6) abducted on an armboard may
445 decrease the risk of ulnar neuropathy; 7) pressure in the spiral groove of the humerus from prolonged
446 contact with a hard surface may increase the risk of radial neuropathy; 8) extension of the elbow in an
447 anesthetized, supine patient beyond the normal range of extension that is comfortable during the
448 preoperative exam may increase the risk of median neuropathy; 9) pressure near the fibular head from
449 contact with a hard surface or a rigid support may increase the risk of peroneal neuropathy; 10)
450 padded armboards may decrease the risk of upper extremity neuropathies; 11) of a chest roll placed
451 under the "downside" (dependent) lateral thorax in a patient who is positioned laterally may decrease
452 the risk of brachial plexus neuropathy in the down arm; 12) specific padding (e.g., foam or gel pads)
453 at the elbow may decrease the risk of ulnar neuropathy; 13) specific padding to prevent contact of the
454 peroneal nerve (at the fibular head) with a hard surface may decrease the risk of peroneal neuropathy;
455 14) in some circumstances, the use of padding may increase the risk of peripheral neuropathies; 15)

456 shoulder braces (commonly placed over the acromioclavicular joint) to prevent a patient from sliding
457 cephalad when placed in a steep head-down position may increase the risk of brachial plexus
458 neuropathy; 16) examining the patient in the PACU may lead to early recognition of peripheral
459 neuropathy; and 17) documentation on an anesthetic record of specific positioning actions during the
460 care of a patient is important. Items where no majority agreement was indicated were: 1) flexion of
461 the elbow may increase the risk of ulnar neuropathy; 2) stretching of the hamstring muscle group
462 (e.g., biceps femoris muscle) beyond the normal range of motion that is comfortable during the
463 preoperative assessment may increase the risk of sciatic neuropathy; 3) extension of the hip in an
464 anesthetized, supine patient beyond the normal range of extension that is comfortable during the
465 preoperative exam (e.g., hyperlordosis) may increase the risk of femoral neuropathy; and 4) the use
466 of an automated blood pressure cuff on the arm may increase the risk of ulnar, radial, or median
467 neuropathy.

468 Consultants and ASA membership respondents who agreed with the above survey items
469 responded to specific item-related topics. The majority of these respondents agreed with the
470 following items: 1) preexisting patient attributes that are important to review during a preoperative
471 history include, but are not limited to: body habitus, preexisting neurologic symptoms, diabetes
472 mellitus, peripheral vascular disease, alcohol dependency, and arthritis; 2) in a patient examination,
473 it is important to assess limitations to joint range of motion in the elbow and/or shoulder, range of
474 motion of an arthritic neck, range of motion of the hip and knee joints (for placing patients in a lateral
475 or lithotomy position), ability to extend hips (for placing patients in a supine position), and flexibility
476 of the hamstring muscle group (for placing patients in a lateral or lithotomy position); 3) the upper
477 limit of abduction of the arm(s) in a supine or prone patient should be 90 degrees; 4) in a supine
478 patient with an arm(s) tucked at the side, the forearm in the neutral position may decrease the risk of

479 ulnar neuropathy; 5) in a supine patient with an arm(s) abducted on an armboard, the forearm in the
480 supinated position may decrease the risk of ulnar neuropathy; 6) elbow flexion greater than 90° may
481 increase the risk of ulnar neuropathy; 7) the risk of sciatic neuropathy in a patient who is positioned
482 in a lithotomy position may be reduced if the degree of hip flexion is limited to 90°; and 8) it is
483 important to document overall patient position (e.g., supine, prone, lateral, lithotomy), position of
484 arms, position of lower extremities, use of specific padding at the elbow or over the fibular head,
485 specific positioning action(s) taken or used during a procedure as indicated by findings on a
486 preoperative exam, and the presence or absence of signs or symptoms of peripheral neuropathy in the
487 PACU.

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

Table 1: Consultant Survey Responses

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy	N	Percentage Agreement		
			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 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 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%

Table 2: Membership Survey Responses

Type of Neuropathy	Positioning Intervention to Decrease Risk of Peripheral Neuropathy	N	Percentage Agreement		
			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 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 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%

Table 3: Item Responses for Consultants and ASA Members

Survey Item:	Consultants		Membership	
	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 degrees		7%		16%
90 degrees		93%		84%
4. The upper limit of abduction of the arm(s) in a prone patient should be:	70		387	
60 degrees		33%		43%
90 degrees		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 degrees		15%		14%
90 degrees		13%		20%
> 90 degrees		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 degrees		19%		28%
90 degrees		50%		52%

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120 degrees		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 degrees		7%		20%
90 degrees		40%		43%
120 degrees (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 PACU	74	58%	393	58%