Practice Advisory for Perioperative Visual Loss Associated with Spine Surgery 2019

*An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Visual Loss, the North American Neuro-Ophthalmology Society, and the Society for Neuroscience in Anesthesiology and Critical Care**

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

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

This document updates the "Practice Advisory for Perioperative Visual Loss Associated with Spine Surgery: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Visual Loss," adopted by the ASA in 2011 and published in 2012.[1]

Methodology

Definition of Perioperative Visual Loss

Perioperative visual loss after spine surgery is a rare and disabling complication.[2–4] For this Advisory, "perioperative visual loss" refers to permanent impairment or total loss of sight associated with a spine procedure during which general anesthesia is administered. The perioperative period includes the time from the immediate preoperative assessment through discharge from the acute healthcare facility. Conditions addressed in this Advisory include posterior ischemic optic neuropathy, anterior ischemic optic neuropathy, central and branch retinal artery occlusion, cerebral visual loss, and posterior reversible encephalopathy syndrome. Anterior ischemic optic neuropathy damages the front of the optic nerve (the optic nerve head or optic disc), whereas posterior ischemic optic neuropathy injures the portion of the optic nerve behind the eye.[5] "High-risk patients" are defined for

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A complete bibliography used to develop this updated Advisory, arranged alphabetically by author, is available as Supplemental Digital Content 1 (http://links.lww.com/ALN/B810).

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this Advisory as those who undergo spine procedures while positioned prone and who have prolonged procedures, experience substantial blood loss, or both.[†]

Purpose of the Advisory

The purpose of this Advisory is to enhance awareness and reduce the frequency of perioperative visual loss during and after spine surgery.

Focus of the Advisory

This Advisory focuses on the perioperative management of patients who are undergoing spine procedures while they are positioned prone and receiving general anesthesia. This Advisory does not address the perioperative management of patients who receive regional anesthesia or sedation. This Advisory also does not include other causes of visual loss. It does not include nonspine surgical procedures (*e.g.*, cardiac surgery, radical neck dissection). In addition, this Advisory does not apply to spine surgery patients younger than 12 yr of age.

Application of the Advisory

This Advisory is intended for use by anesthesiologists, neurosurgeons, neuro-ophthalmologists, and all other individuals who deliver or who are responsible for anesthesia or perioperative care. These individuals may include orthopedic surgeons, neurosurgeons, ophthalmologists, neuro-ophthalmologists, neurologists, nurse anesthetists, perioperative nurses, operating room nurses, and anesthesiology assistants. The Advisory also may serve as a resource for other physicians, nurses, and healthcare professionals who manage anesthetized patients.

Task Force Members and Consultants

In 2017, the ASA Committee on Standards and Practice Parameters requested that this Advisory be updated. This Advisory update is a revision developed by an ASA-appointed task force of 16 members from various geographic areas of the United States, consisting of six anesthesiologists, four neuro-ophthalmologists, two neurosurgery and two orthopedic spine surgeons, and two methodologists. Seven physicians served as official liaisons from national organizations including the North American Neuro-Ophthalmology Society (NANOS), North American Spine Society (NASS), Society for Neuroscience in Anesthesiology and Critical Care (SNACC), and the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS) Joint Section on Disorders of the Spine and Peripheral Nerves. Conflict of interest documentation regarding current or potential financial and other interests pertinent to the practice guideline were disclosed by all task force members and managed.

The task force developed this Advisory by means of a six-step process. First, criteria for evidence associated with perioperative visual loss were established. Second, original published research studies relevant to perioperative visual loss were reviewed and evaluated. Third, a panel of expert consultants was asked to (1) participate in opinion surveys concerning the effectiveness and safety of various methods and interventions that might be used for prevention of perioperative visual loss, and (2) review and comment on a draft of the Advisory developed by the task force. Fourth, survey opinions about the Advisory recommendations were solicited from a random sample of active ASA members and participating medical specialty societies. Fifth, the consultants were surveyed to assess their opinions on the feasibility of implementing the advisory. Sixth, all available information was used to build consensus within the task force to finalize the advisory. A summary of recommendations may be found in appendix 1.

Availability and Strength of Evidence

Preparation of this updated advisory followed a rigorous methodologic process. Evidence was obtained from two principal sources: scientific evidence and opinion-based evidence.

Scientific Evidence

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

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

[†] For this Advisory, prolonged procedures are defined as spine procedures greater than 4 h. Substantial blood loss is defined as blood loss greater than 800 ml.

each intervention–outcome pair, including a directional designation of benefit, harm, or equivocality.

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

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

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

Level 1: The literature contains nonrandomized comparisons (*e.g.*, quasiexperimental, cohort [prospective or retrospective], or case–control research designs) with comparative statistics among clinical interventions for a specified clinical outcome.
Level 2: The literature contains noncomparative observational studies with associative statistics (*e.g.*, correlation, sensitivity, and specificity).
Level 3: The literature contains noncomparative observational studies with descriptive statistics (*e.g.*, frequencies, percentages).
Level 4: The literature contains case reports.

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

‡ No relevant studies were found for this Advisory that met the criteria for category A evidence.

Opinion-based Evidence

All opinion-based evidence (*e.g.*, survey data, open forum testimony [from original advisory], internet-based comments, letters, and editorials) relevant to each topic was considered in the development of these guidelines. However, only the findings obtained from formal surveys are reported in the document. Opinion surveys were developed by the task force to address each clinical intervention identified in the document. Identical surveys were distributed to expert consultants and a random sample of members of the participating organizations.

Expert and Participating Membership Opinion Surveys. Survey findings from task force–appointed expert consultants, a random sample of the ASA membership, and membership samples from NANOS, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves are fully reported in this document. Survey responses were recorded using a five-point scale and summarized based on median values.

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

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

Advisory Evidence and Recommendations

Preoperative Patient Evaluation and Preparation

Literature Findings. Comparative studies are insufficient to evaluate the impact of conducting an ophthalmic examination. Studies with observational findings indicate that certain conditions, including preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use, among

other preoperative characteristics (*e.g.*, age, male sex, and diabetic retinopathy), may be associated with perioperative visual loss (Category B2-H evidence).[3,6–10]§ Two retrospective descriptive studies also indicate that perioperative visual loss may occur in patients with the above conditions (Category B3-H evidence).[4,11] Case reports indicate that perioperative visual loss may occur in patients whose medical history includes the listed preoperative conditions listed above (Category B4-H evidence).[12–34]‖ Although a small cup-to-disc ratio may render the axons of the optic nerve more susceptible to injury, the literature is insufficient to evaluate the role of optic nerve head anatomy as a risk factor for perioperative anterior ischemic optic neuropathy or support routinely conducting a preoperative examination of the cup-to-disc in spine surgery patients.[5,35] One observational study reported that 86% of patients undergoing spine surgery in the prone position prefer to be informed of the risk of visual loss (Category B3-B evidence).[36] The literature is insufficient to evaluate whether or not glaucoma is a risk factor for perioperative visual loss.

Survey Findings. The consultants and members of ASA, NANOS, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree with the recommendation to review a patient's preoperative history and perform an appropriate examination to identify patients with preoperative conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use. Consultants and members of the participating organizations agree with the recommendation to inform patients that certain preoperative conditions may increase their risk of perioperative visual loss in spine surgery. The consultants and members of ASA and NANOS strongly agree, and members of SNACC and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of perioperative visual loss. Finally, consultants and members of ASA, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to determine on a case-by-case basis whether or not to inform patients who are *not* anticipated to be "high-risk" for visual loss; members of NANOS were equivocal.

Advisory Recommendations for Preoperative Patient Evaluation and Preparation

- Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis, tobacco use), and obesity.
- Inform patients that certain preoperative conditions may increase their risk of perioperative visual loss in spine surgery. These include, but are not limited to, those who are male, obese, or have vascular disease risk factors such as hypertension and peripheral vascular disease.
- Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of perioperative visual loss.#
  - Determine on a case-by-case basis whether or not to inform patients who are *not* anticipated to be "high-risk" for visual loss.

Intraoperative Management

Intraoperative management topics consist of (1) blood pressure management, (2) management of blood loss and administration of fluids, (3) use of vasopressors, (4) patient and head positioning, and (5) staging of surgical procedures.

Blood Pressure Management

Literature Findings. One retrospective descriptive and two retrospective observational studies reported equivocal findings regarding the association of hypotension and perioperative ischemic optic neuropathy (Category B2-E evidence).[8,11,37] Case reports describe visual loss occurring after procedures in which hypotensive episodes occurred intraoperatively (Category B4-H evidence).[20,21,25,27,34,38–40]

Although case reports describe perioperative visual loss occurring after procedures in which intraoperative hypotension was deliberately maintained (*i.e.* deliberate hypotension) for patients without hypertension[18,24,29,41–49] or for patients with well-controlled chronic hypertension[18,26,28,29,50,51] (Category B4-E evidence), the literature is equivocal on whether or not the risk of ischemic optic neuropathy is increased as a result of intraoperative hypotension, either deliberately induced or resulting from the use of preoperative antihypertensive drugs or intraoperative anesthetics (Category B4-E evidence).**

§ Refer to appendix 2 for details of the literature review and data analyses.

‖ Note that perioperative visual loss may still occur in healthy patients without any of the above preoperative conditions.

For the purposes of this Advisory, the Task Force considers such patients (hereafter referred to as "high-risk patients") to have a higher risk for perioperative visual loss than patients who do not undergo prolonged procedures, have substantial blood loss, or both.

** Because deliberate hypotension can only decrease arterial, and not venous bleeding, it may be of relatively limited utility in patients undergoing spine fusion.

Survey Findings. The consultants and members of ASA, NANOS, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree with the recommendation to continually monitor systemic blood pressure in high-risk patients. The consultants and members of ASA and SNACC strongly agree and members of NANOS and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to assess the patient's baseline blood pressure on a case-by-case basis. Consultants and members of the participating organizations agree with the recommendation to determine on a case-by-case basis if deliberate hypotension should be used in high-risk patients. The consultants and members of ASA, NANOS, and SNACC strongly agree, and members of AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.

Consultants and members of ASA, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree and members of NANOS agree with the recommendation to discuss with the surgeon whether deliberate hypotension is necessary. Consultants and members of ASA and SNACC strongly agree and members of NANOS and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs. The consultants and members of the participating organizations agree with the recommendation to use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential, and strongly agree with the recommendation to treat prolonged significant decreases in blood pressure.

Management of Blood Loss and Administration of Fluids

Literature Findings. Two observational studies report that blood loss and duration of surgery are associated with perioperative visual loss (Category B2-H evidence).[8,52] Five descriptive observational studies indicate that perioperative visual loss may occur with substantial blood loss, prolonged procedure, or both (Category B3-H evidence).[4,11,31,37,53] Case reports indicate that perioperative visual loss may occur after prolonged procedures,[12,13,38,43,54–60] substantial intraoperative blood loss,[20,21,26,33,41,42,49,61–64] or both[14–18,23,25,27–29,33,39,40,44,45,47,51,65–70] (Category B4-H evidence).†† One case report indicated that postoperative visual loss still occurred in a spine surgery patient when hematocrit was monitored every 1.5 h throughout the procedure (Category B4-E evidence).[13]

Although comparative studies are insufficient to evaluate the impact on visual loss of the relative percentages of intraoperatively administered crystalloids and colloids on the occurrence of perioperative visual loss, one case–control study reported that the percent of crystalloid in the total volume replacement had no statistically significant effect on developing ischemic optic neuropathy, whereas higher colloid as a percentage of total nonblood replacement was associated with a reduced risk of developing ischemic optic neuropathy (Category B2-E evidence).[8] Case reports indicate that visual loss may still occur when these fluids are used (Category B4-E evidence).[15,17,23,25,27,29,30,34,38,39,42,44,45,47,51,63–69]

Survey Findings. The consultants and members of ASA, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree and members of NANOS agree with the recommendation to periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss. Consultants and members of the participating organizations strongly agree with the recommendation to use transfusions of blood as deemed appropriate. Consultants and members of ASA, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation that crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume; members of NANOS are equivocal.

Use of Vasopressors

Literature Findings. Comparative studies are insufficient to evaluate the impact on perioperative visual loss from perioperative administration of high-dose adrenergic agonists during spine surgery. One retrospective observational study reported equivocal findings for perioperative vasopressors use when patients with perioperative visual loss were compared with patients without perioperative visual loss (Category B2-E evidence).[8] One case report indicated that perioperative visual loss may still occur in spine surgery patients in whom extensive intraoperative hypotension was treated with multiple doses of phenylephrine and ephedrine (Category B4-E evidence).[34]

Survey Findings. Consultants and members of ASA and SNACC strongly agree and members of NANOS and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation that adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.

Patient and Head Positioning Devices

Literature Findings. One retrospective study comparing perioperative visual loss patients with patients without perioperative

†† For the Advisory, prolonged procedures are defined as spine procedures greater than 4 h. Substantial blood loss is defined as blood loss greater than 800 ml.

visual loss reported a significant association between the use of the Wilson frame and ischemic optic neuropathy (Category B2-H evidence).[8] Retrospective observational studies obtained from institutional databases‡‡ also describe perioperative visual loss occurring when a patient is positioned prone on Wilson frame, positioned prone on a Jackson frame, or when the patient's head is supported by various devices such as Mayfield head holder, horseshoe, headrest, tongs, halo, or pillow (Category B3-H evidence).[4,11]§§ Case reports indicate that patient positioning resulting in direct pressure to the eyes (*e.g.*, from the use of a headrest, sheet roll, or other device) may precede the onset of perioperative visual loss from retinal artery occlusion in spine surgery patients (Category B4-H evidence).[12,21,30,48,49,56,57,59,67,71–74] Comparative studies are insufficient to evaluate whether positioning the patient's head below the heart compared with positioning the head in neutral or higher is associated with perioperative visual loss.

Monitoring the eyes during spine surgery may assist in the early identification of eye compression. Although there are a number of head positioning devices that enable the eyes to be checked for compression when the patient is positioned prone, the literature is insufficient to support superiority of any one head positioning device, or to recommend a particular frequency of eye checks.

Survey Findings. The consultants and members of SNACC strongly agree and members of ASA, NANOS, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to position the high-risk patient so that the head is level with or higher than the rest of the body when possible. Consultants and members of ASA and SNACC strongly agree and members of NANOS and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree with the recommendation to maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible. Consultants and members of the participating organizations strongly agree with the recommendation to avoid direct pressure on the eye to prevent retinal artery occlusion. Consultants and members of SNACC and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree and members of ASA and NANOS agree with the recommendation that a head holder may be applied by the spine surgeon in patients in whom head positioning is challenging. Finally, consultants and members of the participating organizations strongly agree with the recommendation to check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.

Staging of Surgical Procedures. The majority of spine surgery patients who experience perioperative ischemic optic neuropathy undergo prolonged procedures with substantial blood loss while they are positioned prone. Staging of spine surgical procedures involves performing the operative procedure in two or more operations, as opposed to a single surgical procedure.[75–78]

Literature Findings. The literature is insufficient to examine the impact of surgical staging on reducing the frequency of perioperative visual loss in spine surgery patients.

Survey Findings. The consultants and members of ASA, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves strongly agree and members of NANOS agree with the recommendation that staged spine procedures may be used on a case-by-case basis for high-risk patients.

Advisory Recommendations for Intraoperative Management

Blood Pressure Management

- Assess the patient's baseline blood pressure.
- Continually‖‖ monitor systemic blood pressure in high-risk patients.
- Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.
  - Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.
    - Discuss with the surgeon whether deliberate hypotension is necessary.
  - Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.
  - Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential.
    - Treat prolonged significant decreases in blood pressure.

Management of Blood Loss and Administration of Fluids

- Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.##
  - Use transfusions of blood as deemed appropriate.

‡‡ ASA perioperative visual loss Registry and The Scoliosis Research Society database.

§§ The Task Force believes that there is no pathophysiologic mechanism by which facial edema can cause perioperative ischemic optic neuropathy. There is no evidence that ocular compression causes isolated perioperative anterior ischemic optic neuropathy or posterior ischemic optic neuropathy.

‖‖ "Continual" is defined as "repeated regularly and frequently in steady and rapid succession," whereas "continuous" means prolonged without any interruption at any time (from ASA Standards for Basic Anesthetic Monitoring).

- Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.

Use of Vasopressors

- Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.

Patient and Head Positioning Devices

- Position the high-risk patient so that the head is level with or higher than the rest of the body when possible.
  - Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.
- Avoid direct pressure on the eye to prevent retinal artery occlusion.
  - A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.
- Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.

Staging of Surgical Procedures

- Staged spine procedures may be used on a case-by-case basis for high-risk patients.

Postoperative Management

Literature Findings. The literature is insufficient to evaluate the effect of assessing a high-risk patient's vision when the patient becomes alert. The literature is insufficient to evaluate the use of magnetic resonance imaging or computerized tomography to rule out intracranial causes of visual loss or the capacity of orbital magnetic resonance imaging or computerized tomography to detect optic nerve changes in perioperative visual loss.

A case report of a spine surgery patient with bilateral posterior ischemic optic neuropathy indicated that visual recovery occurred after the deliberate maintenance of increased hematocrit and blood pressure (Category B4-B evidence).[31]

Two case reports indicated that the patients' visual loss improved with the administration of corticosteroids to treat ischemic optic neuropathy (Category C4-B evidence)[58,65]; fourteen case reports found no visual improvement after the administration of steroids (Category B4-E evidence).[22,29,33,34,40,41,43,57,63,70–72,74] There is insufficient evidence to support the administration of antiplatelet agents or intraocular pressure-lowering agents in the treatment of ischemic optic neuropathy. With respect to perioperative retinal artery occlusion, the literature is insufficient to support the use of any form of treatment.*** At this time, there is no evidence of a role for antiplatelet agents, corticosteroids, or intraocular pressure-lowering agents in the management of perioperative ischemic optic neuropathy.

Survey Findings. The consultants and members of ASA, NANOS, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves agree that for the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor). Consultants and members of the participating organizations strongly agree with the recommendation that if there is concern regarding potential visual loss, to obtain an urgent ophthalmologic consultation to determine its cause. Consultants strongly agree and members of the participating organizations agree with the recommendation that computerized tomography or magnetic resonance imaging may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve. Finally, consultants and members of the participating organizations strongly agree with the recommendation that additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.

Advisory Recommendations for Postoperative Management

- Assess the vision of a high-risk patient when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).
  - If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.
  - Computerized tomography or magnetic resonance imaging may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.
  - Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.

Appendix 1: Summary of Advisory Statements

Preoperative Patient Evaluation and Preparation

- Review a patient's preoperative history and perform an appropriate examination to identify patients with

The Task Force believes that there is no documented lower limit of hemoglobin concentration that has been associated with the development of perioperative visual loss. Therefore, the Task Force believes a transfusion threshold that would eliminate the risk of perioperative visual loss related to anemia cannot be established at this time.

*** The pathogenesis of retinal artery occlusion in this setting is different from patients with spontaneous retinal artery occlusion. Although thrombolysis *via* catheter in the central retinal artery may dissolve a clot within the early hours after nonperioperative retinal artery occlusion, bleeding in a newly postoperative patient is a potential risk.

conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis, tobacco use), and obesity.
- Inform patients that certain preoperative conditions may increase their risk of perioperative visual loss in spine surgery. These include, but are not limited to, those who are male, obese, or have vascular disease risk factors such as hypertension, and peripheral vascular disease.
- Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of perioperative visual loss.*
  - Determine on a case-by-case basis whether or not to inform patients who are *not* anticipated to be "high-risk" for visual loss.

Intraoperative Management

Blood Pressure Management.

- Assess the patient's baseline blood pressure.
- Continually† monitor systemic blood pressure in high-risk patients.
- Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.
  - Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.
    - Discuss with the surgeon whether deliberate hypotension is necessary.
  - Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.
  - Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential.
    - Treat prolonged significant decreases in blood pressure.

Management of Blood Loss and Administration of Fluids

- Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.‡
  - Use transfusions of blood as deemed appropriate.
  - Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.

Use of Vasopressors

- Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.

Patient and Head Positioning Devices

- Position the high-risk patient so that the head is level with or higher than the rest of the body when possible.
  - Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.
- Avoid direct pressure on the eye to prevent retinal artery occlusion.
  - A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.
- Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.

Staging of Surgical Procedures

- Staged spine procedures may be used on a case-by-case basis for high-risk patients.

Postoperative Management

- Assess the vision of a high-risk patient when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).
  - If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.
  - Computerized tomography or magnetic resonance imaging may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.
  - Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.

Appendix 2: Methods and Analyses

For this updated practice advisory, a systematic search and review of peer-reviewed published literature was conducted, with scientific findings summarized and reported below and in the document. Assessment of conceptual issues and the practicality and feasibility of the advisory recommendations were also evaluated, with opinion data collected from surveys

* For the purposes of this Advisory, the Task Force considers such patients (hereafter referred to as "high-risk patients") to have a higher risk for perioperative visual loss than patients who do not undergo prolonged procedures, have substantial blood loss, or both.

† "Continual" is defined as "repeated regularly and frequently in steady and rapid succession," whereas "continuous" means prolonged without any interruption at any time (from ASA Standards for Basic Anesthetic Monitoring).

‡ The Task Force believes that there is no documented lower limit of hemoglobin concentration that has been associated with the development of perioperative visual loss. Therefore, the Task Force believes a transfusion threshold that would eliminate the risk of perioperative visual loss related to anemia cannot be established at this time.

and other sources. Both the systematic literature review and the opinion data are based on evidence linkages, or statements regarding potential relationships between interventions and outcomes associated with perioperative visual loss associated with a spine procedure during which general anesthesia is administered and permanent impairment or total loss of sight occurs. The evidence linkage interventions are listed below.* The evidence model below guided the search, providing inclusion and exclusion information regarding patients, procedures, practice settings, providers, clinical interventions, and outcomes. After review of all evidentiary information, the task force placed each recommendation into one of three categories: (1) provide this intervention or treatment, (2) this intervention or treatment may be provided to the patient based on circumstances of the case and the practitioner's clinical judgment, or (3) do not provide this intervention or treatment. The ASA Committee on Standards and Practice Parameters reviews all practice parameters at the ASA annual meeting and determines update and revision timelines. The policy of the ASA Committee on Standards and Practice Parameters is to update practice guidelines every 5 yr.

Evidence Model

Patients

- Inclusion criteria
  - Patients undergoing back or spine surgery
  - Patients undergoing head and neck surgery
  - Patients positioned prone
  - Patients receiving general anesthesia
- Exclusion criteria
  - Children younger than 12 yr
  - Patients not positioned prone

Procedures

- Inclusion criteria
  - Back surgery
  - Spine surgery
- Exclusion criteria
  - Procedures where anesthetic care is not provided
  - Nonsupine surgical procedures
    - Cardiac surgery
    - Radical neck dissection
    - Ocular surgery
    - Intracranial procedures

Practice Settings

- Inclusion criteria
  - Any health care facility
    - Medical centers
    - Hospitals
    - Operating room
    - Postanesthesia care unit
    - Intensive care unit
    - Spine surgery postop nursing unit
    - Other anesthetizing locations
    - Recovery rooms
    - Intensive care units
    - Outpatient procedural units
    - Office-based practices
- Exclusion criteria
  - Nonperioperative settings

Providers

- Inclusion criteria
  - All anesthesia providers
    - Anesthesiologists
    - Anesthesia providers working under the direction of anesthesiologists
    - Nurse anesthetists
  - Orthopedic surgeons
  - Neuro-ophthalmologists
  - Neurologists
  - Neurosurgeons
  - Perioperative nurses
- Exclusion criteria
  - Individuals who do not evaluate or care for patients undergoing surgery nor consult on them

Interventions

- Preoperative evaluation
  - Ophthalmic or neuro-ophthalmic evaluation for high-risk patients or procedures†
  - Informing patients of the risk of perioperative visual loss in spine surgery
  - Determine acceptable blood pressure according to patient's preoperative history (*i.e.*, hypertensive patients at risk)
- Preoperative preparation
  - Pharmacologic methods to reduce increased intraocular pressure (*i.e.*, use of topical β blockers)
  - α_2 Agonists to protect the optic nerve (*e.g.*, dexmedetomidine)
  - Mild deliberate hypothermia to protect the optic nerve (by maintaining temperature 34°C)
- Intraoperative management
  - Blood pressure
    - Continual‡ monitoring of blood pressure to avoid hypotension§
  - Blood loss and administration of fluids
    - Continual monitoring of hydration levels to avoid overhydration
    - Fluid replacement limitation

* Unless otherwise specified, outcomes for the listed interventions refer to the occurrence of perioperative visual loss.

† For this Advisory, prolonged procedures are defined as spine procedures greater than 4 h. Substantial blood loss is defined as blood loss greater than 800 ml.

        - Colloids (*e.g.*, albumin, hetastarch) *versus* crystalloids (*e.g.*, saline, lactated Ringer's) to maintain optimal levels of hydration
        - Periodic monitoring of hemoglobin/hematocrit values during surgery in high-risk patients who experience substantial blood loss
    - Patient positioning
        - Avoidance of direct pressure on the globe of the eye
        - Positioning the patient so that the head is level with or higher than the heart
        - Maintaining of face in a neutral forward position (*e.g.*, without significant neck flexion or extension, lateral flexion, or rotation)
    - Surgical procedures
        - Use of staged procedures for spine surgery when anticipated length is greater than 6 h
- Postoperative management
    - Assess patient's visual status for loss of vision
    - Assess visual evoked potentials to detect optic nerve dysfunction
    - Begin initial treatment (*e.g.*, increase blood pressure and hemoglobin/hematocrit if appropriate, administer supplemental oxygen, antiplatelet drugs, aspirin, or steroids)

Outcomes

- Inclusion criteria
    - Perioperative visual loss
        - Posterior ischemic optic neuropathy
        - Anterior ischemic optic neuropathy
        - Retinal artery occlusion
        - Posterior reversible encephalopathy syndrome
        - Cerebral visual loss
- Exclusion criteria
    - Nonperioperative visual loss
    - Acute angle-closure glaucoma
    - Retinal detachment
    - Vitreous hemorrhage

Guideline Goals

- To reduce the frequency of perioperative visual loss
- To enhance awareness of the potential for perioperative visual loss
- To benefit patients by reducing the risk of visual loss
- To help guide those caring for these patients in identifying and preventing the problem

Evidence Collection

- Literature inclusion criteria
    - Randomized controlled trials
    - Prospective nonrandomized comparative studies (*e.g.*, quasiexperimental, cohort)
    - Retrospective comparative studies (*e.g.*, case–control)
    - Observational studies (*e.g.*, correlational or descriptive statistics)
    - Case reports, case series
- Literature exclusion criteria (except to obtain new citations)
    - Editorials
    - Literature reviews
    - Meta-analyses conducted by others
    - Abstracts greater than 5 yr old
    - Unpublished studies
    - Studies in non–peer reviewed journals
    - Newspaper articles
- Survey evidence
    - Expert consultant survey
    - ASA membership survey
    - Other participating organization surveys
    - Reliability survey
    - Feasibility survey

State of the Literature. For the systematic review, potentially relevant clinical studies were identified *via* electronic and manual searches. Healthcare database searches included PubMed, EMBASE, Web of Science, Google Scholar, and the Cochrane Central Register of Controlled Trials. The searches covered a 6.5-yr period from January 1, 2012, through June 1, 2018. Accepted studies from the previous advisory were also re-reviewed, covering the period of January 1, 2002, through December 31, 2011. Only studies containing original findings from peer-reviewed journals were acceptable. Editorials, letters, and other articles without data were excluded. A literature search strategy and PRISMA‖ flow diagram is available as Supplemental Digital Content 2, http://links.lww.com/ALN/B811.

In total, 569 new citations were identified, with 484 articles assessed for eligibility. After review, 457 were excluded, with 27 new studies meeting the criteria stated above. These studies were combined with 47 pre-2012 articles used in the previous advisory and 8 provided by task force members, resulting in a total of 82 articles accepted as evidence for these guidelines. In this document, 77 are referenced, with a complete bibliography of articles used to develop these guidelines, organized by section, available as Supplemental Digital Content 3, http://links.lww.com/ALN/B812.

Each pertinent outcome reported in a study was classified by evidence category and level and designated as beneficial, harmful, or equivocal. Findings were then

‡ Note that "continual" is defined as "repeated regularly and frequently in steady and rapid succession," whereas "continuous" means prolonged without any interruption at any time (from ASA Standards for Basic Anesthetic Monitoring).

§ Hypotension is defined as mean pressures less than 20% below baseline, or systolic blood pressure more than 90 mmHg despite surgical incision.

‖ Preferred reporting items of systematic reviews and meta-analyses.

summarized for each evidence linkage and reported in the text of the updated Advisory, with evidence tables available as Supplemental Digital Content 4, http://links.lww.com/ALN/B813.

Interobserver agreement among task force members and two methodologists was obtained by interrater reliability testing of 33 randomly selected studies. Agreement levels using a κ statistic for two-rater agreement pairs were as follows: (1) research design, $\kappa = 0.64$ to 0.94; (2) type of analysis, $\kappa = 0.62$ to 1.00; (3) evidence linkage assignment, $\kappa = 0.66$ to 0.81; and (4) literature inclusion for database, $\kappa = 0.27$ to 1.00. Three-rater κ values were as follows: (1) research design, $\kappa = 0.76$; (2) type of analysis, $\kappa = 0.74$; (3) linkage assignment, $\kappa = 0.74$; and (4) literature database inclusion, $\kappa = 0.33$. These values represent moderate to high levels of agreement.

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 moderate procedural sedation and analgesia; (2) survey opinions from a randomly selected sample of active members of the ASA, NANOS, SNACC, and AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves; (3) testimony from attendees of publicly held open forums for the original advisory at a national anesthesia meeting**; (4) internet commentary; and (5) task force opinion and interpretation. The survey rate of return was 50% (n = 35 of 70) for consultants. For membership respondents, survey data were collected from 259 ASA members, 103 AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves members, 119 NANOS members, and 57 SNACC members. The results of the surveys are reported in tables 1–5 and are summarized in the text of the advisory.

For the Feasibility survey, consultants were asked to indicate which, if any, of the evidence linkages would change their clinical practices if the guidelines were instituted. The rate of return was 41% (n = 29 of 70). Ninety-three percent of the responding consultants expected *no changes* in new equipment, supplies or training in order to implement the Practice Advisory. Ninety-six percent expected *no changes* to their practice that would affect costs. The percent of responding consultants expecting *no changes* associated with each linkage were as follows: evaluation of patient condition, 72%; prolonged procedures (greater than 4 h), 79%; substantial blood loss (greater than 800 ml), 86%; prolonged procedures (> 4 h) combined with substantial blood loss (> 800 ml), 72%; perioperative visual loss occurring when intraoperative hypotension occurred (not deliberate), 79%; deliberate hypotension, 86%; colloid and/or crystalloid administration for fluid resuscitation, 90%; blood pressure monitoring, 90%; use of devices (*e.g.*, headrests, sheet rolls) where direct pressure to the eye occurs, 90%; surgical procedures (*i.e.*, staging of surgical procedures), 90%; positioning of head equal to or higher than heart, 76%; and antiplatelet agents, steroids, or intraocular pressure lowering agents, 83%. Eighteen respondents (62%) indicated that the guidelines would have *no appreciable change* on the amount of time spent on a typical case with the implementation of these guidelines. Two respondents indicated that there would be an increase in the amount of time, estimating an increase ranging from 15 to 20 min. No respondent estimated a decrease in the amount of time they would spend on a typical case.

Consultants were drawn from the following specialties where perioperative visual loss is a concern: anesthesiology, ophthalmology, orthopedic surgery, and neurosurgery.

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

Table 1. Expert Consultant Survey Results (Response Rate = 51%)

Recommendations	Answer Rate N (%)	Strongly Agree (%)	Agree (%)	Equivocal (%)	Disagree (%)	Strongly Disagree (%)
Preoperative patient evaluation and preparation						
1. Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.,* hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use.	35 (97)	83*	14	3	0	0
2. Inform patients that certain preoperative conditions may increase their risk of POVL in spine surgery. These include, but are not limited to, those who are male, obese, have vascular disease risk factors such as hypertension and peripheral vascular disease, or have diabetic retinopathy.	35 (97)	40	46*	11	0	0
3. Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of POVL.	35 (97)	69*	20	11	0	0
4. Determine on a case-by-case basis whether or not to inform patients who are not anticipated to be "high-risk" for visual loss.	35 (97)	31	31*	17	20	0
Intraoperative blood pressure management						
5. Continually monitor systemic blood pressure in high-risk patients.	34 (94)	82*	9	9	0	0
6. Assess the patient's baseline blood pressure on a case-by-case basis.	33 (92)	67*	33	0	0	0
7. Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.	34 (94)	44	15*	3	3	35
8. Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.	34 (94)	71*	12	9	3	6
9. Discuss with the surgeon whether deliberate hypotension is necessary.	34 (94)	68*	15	3	6	9
10. Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.	33 (92)	64*	21	15	0	0
11. Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential despite employing other means to minimize bleeding.	35 (97)	37	34*	6	6	17
12. Treat prolonged significant decreases in blood pressure.	34 (94)	91*	9	0	0	0
13. Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.	33 (92)	58*	39	3	0	0
Intraoperative patient and head position devices and surgical staging						
14. Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.	35 (97)	89*	9	3	0	0
15. Use transfusions of blood as deemed appropriate.	35 (97)	83*	17	0	0	0
16. Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.	35 (97)	29	34*	23	9	6
17. Position the high-risk patient so that the head is level with or higher than the heart when possible.	35 (97)	49*	34	9	9	0
18. Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.	33 (92)	67*	30	3	0	0
19. Avoid direct pressure on the eye to prevent RAO.	34 (94)	88*	12	0	0	0
20. A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.	35 (97)	63*	31	6	0	0
21. Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.	35 (97)	91*	9	0	0	0
22. Staged spine procedures may be used on a case-by-case basis for high-risk patients.	34 (94)	65*	32	3	0	0
Postoperative management						
23. For the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).	35 (97)	34	17*	29	20	0
24. If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.	34 (94)	82*	18	0	0	0
25. CT or MRI may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.	34 (94)	50*	32	18	0	0
26. Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.	35 (97)	63*	29	9	0	0

*Median.
ASA, American Society of Anesthesiologists; CT, computerized tomography; MRI, magnetic resonance imaging; POVL, perioperative visual loss; RAO, retinal artery occlusion.

Table 2. ASA Member Survey Results

Recommendations	Answer Rate N (%)	Strongly Agree (%)	Agree (%)	Equivocal (%)	Disagree (%)	Strongly Disagree (%)
Preoperative patient evaluation and preparation						
1. Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use.	258 (99)	73*	24	3	0	0
2. Inform patients that certain preoperative conditions may increase their risk of POVL in spine surgery. These include, but are not limited to, those who are male, obese, have vascular disease risk factors such as hypertension and peripheral vascular disease, or have diabetic retinopathy.	259 (100)	42	39*	15	3	1
3. Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of POVL.	257 (99)	52*	35	11	2	1
4. Determine on a case-by-case basis whether or not to inform patients who are not anticipated to be "high-risk" for visual loss.	256 (98)	18	43*	19	14	5
Intraoperative blood pressure management						
5. Continually monitor systemic blood pressure in high-risk patients.	236 (91)	67*	23	8	1	0
6. Assess the patient's baseline blood pressure on a case-by-case basis.	234 (90)	53*	29	3	11	4
7. Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.	236 (91)	44	26*	7	14	9
8. Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.	235 (90)	73*	23	1	2	1
9. Discuss with the surgeon whether deliberate hypotension is necessary.	236 (91)	73*	24	1	0	2
10. Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.	237 (91)	60*	31	7	2	0
11. Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential despite employing other means to minimize bleeding.	235 (90)	49	29*	8	7	7
12. Treat prolonged significant decreases in blood pressure.	236 (91)	86*	14	0	0	0
13. Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.	233 (90)	60*	36	2	2	0
Intraoperative patient and head position devices and surgical staging						
14. Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.	228 (88)	73*	23	4	0	0
15. Use transfusions of blood as deemed appropriate.	226 (87)	71*	28	1	0	0
16. Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.	226 (87)	31	43*	19	6	1
17. Position the high-risk patient so that the head is level with or higher than the heart when possible.	222 (85)	32	43*	21	2	1
18. Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.	220 (85)	62*	33	4	0	0
19. Avoid direct pressure on the eye to prevent RAO.	219 (84)	84*	16	0	0	0
20. A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.	222 (85)	43	50*	6	0	0
21. Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.	221 (85)	78*	20	1	0	0
22. Staged spine procedures may be used on a case-by-case basis for high-risk patients.	219 (84)	58*	33	8	0	0
Postoperative management						
23. For the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).	218 (84)	22	39*	28	9	2
24. If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.	219 (84)	68*	29	2	0	0
25. CT or MRI may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.	217 (83)	34	48*	17	1	0
26. Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.	217 (83)	61*	37	2	0	0

*Median.
ASA, American Society of Anesthesiologists; CT, computerized tomography; MRI, magnetic resonance imaging; POVL, perioperative visual loss; RAO, retinal artery occlusion.

Table 3. AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves Member Survey Results

Recommendations	Answer Rate N (%)	Strongly Agree (%)	Agree (%)	Equivocal (%)	Disagree (%)	Strongly Disagree (%)
Preoperative patient evaluation and preparation						
1. Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use.	103 (99)	53*	34	11	1	1
2. Inform patients that certain preoperative conditions may increase their risk of POVL in spine surgery. These include, but are not limited to, those who are male, obese, have vascular disease risk factors such as hypertension and peripheral vascular disease, or have diabetic retinopathy.	103 (99)	29	37*	27	7	0
3. Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of POVL.	103 (99)	35	41*	16	9	0
4. Determine on a case-by-case basis whether or not to inform patients who are not anticipated to be "high-risk" for visual loss.	101 (97)	18	40*	17	17	9
Intraoperative blood pressure management						
5. Continually monitor systemic blood pressure in high-risk patients.	89 (85)	69*	28	2	0	1
6. Assess the patient's baseline blood pressure on a case-by-case basis.	87 (84)	33	46*	9	7	5
7. Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.	88 (85)	24	27*	18	18	13
8. Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.	87 (84)	49	28*	17	2	3
9. Discuss with the surgeon whether deliberate hypotension is necessary.	82 (79)	57*	27	11	5	0
10. Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.	86 (83)	35	38*	24	1	1
11. Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential despite employing other means to minimize bleeding.	85 (82)	33	36*	14	12	5
12. Treat prolonged significant decreases in blood pressure.	86 (83)	74*	22	3	0	0
13. Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.	86 (83)	34	51*	15	0	0
Intraoperative patient and head position devices and surgical staging						
14. Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.	82 (79)	57*	32	11	0	0
15. Use transfusions of blood as deemed appropriate.	80 (77)	63*	35	3	0	0
16. Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.	78 (75)	27	37*	21	12	4
17. Position the high-risk patient so that the head is level with or higher than the heart when possible.	78 (75)	44	35*	19	3	0
18. Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.	79 (76)	47	42*	9	3	0
19. Avoid direct pressure on the eye to prevent RAO.	78 (75)	82*	14	4	0	0
20. A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.	79 (76)	65*	32	4	0	0
21. Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.	78 (75)	67*	28	5	0	0
22. Staged spine procedures may be used on a case-by-case basis for high-risk patients.	78 (75)	50*	41	8	1	0
Postoperative management						
23. For the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).	77 (74)	22	39*	18	16	5
24. If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.	77 (74)	66*	30	4	0	0
25. CT or MRI may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.	77 (74)	34	47*	18	1	0
26. Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.	78 (75)	54*	38	8	0	0

*Median.
AANS/CNS, American Association of Neurological Surgeons/Congress of Neurological Surgeons; CT, computerized tomography; MRI, magnetic resonance imaging; POVL, perioperative visual loss; RAO, retinal artery occlusion.

Table 4. NANOS Member Survey Results

Recommendations	Answer Rate N (%)	Strongly Agree (%)	Agree (%)	Equivocal (%)	Disagree (%)	Strongly Disagree (%)
Preoperative patient evaluation and preparation						
1. Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use.	119 (99)	55*	40	4	0	0
2. Inform patients that certain preoperative conditions may increase their risk of POVL in spine surgery. These include, but are not limited to, those who are male, obese, have vascular disease risk factors such as hypertension and peripheral vascular disease, or have diabetic retinopathy.	118 (98)	40	42*	15	3	1
3. Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of POVL.	118 (98)	54*	42	3	2	0
4. Determine on a case-by-case basis whether or not to inform patients who are not anticipated to be "high-risk" for visual loss.	118 (98)	15	33	31*	17	4
Intraoperative blood pressure management						
5. Continually monitor systemic blood pressure in high-risk patients.	109 (91)	64*	32	4	0	0
6. Assess the patient's baseline blood pressure on a case-by-case basis.	108 (90)	27	41*	11	18	4
7. Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.	109 (91)	38	35*	16	11	1
8. Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.	109 (91)	57*	34	7	1	1
9. Discuss with the surgeon whether deliberate hypotension is necessary.	108 (90)	44	37*	13	4	2
10. Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.	105 (88)	20	48*	31	1	0
11. Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential despite employing other means to minimize bleeding.	109 (91)	35	51*	13	1	0
12. Treat prolonged significant decreases in blood pressure.	109 (91)	51*	43	6	0	0
13. Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.	108 (90)	15	55*	28	2	1
Intraoperative patient and head position devices and surgical staging						
14. Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.	106 (88)	42	44*	11	3	0
15. Use transfusions of blood as deemed appropriate.	106 (88)	52*	44	4	0	0
16. Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.	106 (88)	16	33	29*	20	2
17. Position the high-risk patient so that the head is level with or higher than the heart when possible.	98 (82)	29	42*	23	6	0
18. Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.	100 (83)	37	45*	17	1	0
19. Avoid direct pressure on the eye to prevent RAO.	99 (83)	86*	13	1	0	0
20. A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.	101 (84)	33	50*	17	1	0
21. Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.	103 (86)	63*	35	2	0	0
22. Staged spine procedures may be used on a case-by-case basis for high-risk patients.	101 (84)	29	48*	23	1	0
Postoperative management						
23. For the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).	101 (84)	22	37*	26	14	2
24. If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.	102 (85)	71*	27	2	0	0
25. CT or MRI may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.	103 (86)	32	54*	13	1	0
26. Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.	103 (86)	61*	34	5	0	0

*Median.
CT, computerized tomography; MRI, magnetic resonance imaging; NANOS, North American Neuro-Ophthalmology Society; POVL, perioperative visual loss; RAO, retinal artery occlusion.

Table 5. SNACC Member Survey Results

Recommendations	Answer Rate N (%)	Strongly Agree (%)	Agree (%)	Equivocal (%)	Disagree (%)	Strongly Disagree (%)
Preoperative patient evaluation and preparation						
1. Review a patient's preoperative history and perform an appropriate examination to identify patients with conditions such as preoperative anemia, vascular risk factors (*e.g.*, hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, and tobacco use.	55 (96)	67*	25	4	4	0
2. Inform patients that certain preoperative conditions may increase their risk of POVL in spine surgery. These include, but are not limited to, those who are male, obese, have vascular disease risk factors such as hypertension and peripheral vascular disease, or have diabetic retinopathy.	56 (98)	30	36*	21	11	2
3. Inform patients in whom prolonged procedures, substantial blood loss, or both are anticipated that there may be an increased risk of POVL.	56 (98)	46	36*	14	2	2
4. Determine on a case-by-case basis whether or not to inform patients who are not anticipated to be "high-risk" for visual loss.	57 (100)	25	51*	11	7	7
Intraoperative blood pressure management						
5. Continually monitor systemic blood pressure in high-risk patients.	46 (81)	85*	13	2	0	0
6. Assess the patient's baseline blood pressure on a case-by-case basis.	47 (82)	55*	23	2	9	11
7. Determine on a case-by case basis whether deliberate hypotension should be used in high-risk patients.	48 (84)	44	17*	6	21	13
8. Check for the presence of preoperative hypertension, its degree of control, the preoperative use of antihypertensive drugs, and the patient's risk of end-organ damage before using deliberate hypotension in a high-risk patient.	47 (82)	74*	17	2	4	2
9. Discuss with the surgeon whether deliberate hypotension is necessary.	48 (84)	71*	17	2	10	0
10. Maintain arterial pressure at higher levels in hypertensive patients to prevent risks to end organs.	49 (86)	65*	31	4	0	0
11. Use deliberate hypotension in high-risk patients only when the anesthesiologist and surgeon agree that its use is essential despite employing other means to minimize bleeding.	47 (82)	40	28*	13	13	6
12. Treat prolonged significant decreases in blood pressure.	48 (84)	100*	0	0	0	0
13. Adrenergic agonists may be used on a case-by-case basis when it is necessary to correct for hypotension.	47 (82)	64*	32	4	0	0
Intraoperative patient and head position devices and surgical staging						
14. Periodically monitor hemoglobin or hematocrit values during surgery in high-risk patients who experience substantial blood loss.	47 (82)	74*	26	0	0	0
15. Use transfusions of blood as deemed appropriate.	47 (82)	68*	30	0	2	0
16. Crystalloids or colloids alone or in combination may be used to maintain adequate replacement of intravascular volume.	47 (82)	45	36*	9	11	0
17. Position the high-risk patient so that the head is level with or higher than the heart when possible.	47 (82)	57*	26	15	2	0
18. Maintain the high-risk patient's head in a neutral forward position (*e.g.*, without significant neck flexion, extension, lateral flexion, or rotation) when possible.	47 (82)	70*	30	0	0	0
19. Avoid direct pressure on the eye to prevent RAO.	47 (82)	87*	13	0	0	0
20. A head holder may be applied by the spine surgeon in patients in whom head positioning is challenging.	46 (81)	59*	37	4	0	0
21. Check the position of the eyes periodically during surgery to ensure the head has not moved and there is no eye compression.	47 (82)	79*	19	0	2	0
22. Staged spine procedures may be used on a case-by-case basis for high-risk patients.	46 (81)	57*	37	7	0	0
Postoperative management						
23. For the high-risk patient, conduct an ophthalmologic assessment when the patient becomes alert (*e.g.*, in the recovery room, intensive care unit, or nursing floor).	47 (82)	26	40*	19	15	0
24. If there is concern regarding potential visual loss, obtain an urgent ophthalmologic consultation to determine its cause.	46 (81)	78*	20	0	2	0
25. CT or MRI may be used on a case-by-case basis to rule out intracranial causes of visual loss as well as to visualize an abnormal optic nerve.	47 (82)	38	47*	15	0	0
26. Additional management may include optimizing hemoglobin or hematocrit values, hemodynamic status, and arterial oxygenation.	47 (82)	53*	40	6	0	0

*Median.
CT, computerized tomography; MRI, magnetic resonance imaging; POVL, perioperative visual loss; RAO, retinal artery occlusion; SNACC, Society for Neuroscience in Anesthesiology and Critical Care.

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Competing Interests

The authors declare no competing interests. Drs. Roth, Newman, and Todd have provided expert witness evaluation and testimony in cases of perioperative visual loss on behalf of patients, physicians, and hospitals.

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Address correspondence to the American Society of Anesthesiologists: 1061 American Lane, Schaumburg, Illinois 60173. jeffa@dacc.uchicago.edu. These updated Practice Advisories, and all ASA Practice Parameters, may be obtained at no cost through the Journal Web site, www.anesthesiology.org.

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