

AHA/ASA Guideline

Executive Summary: Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

Endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons; and by the Society of NeuroInterventional Surgery

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Aneurysmal subarachnoid hemorrhage (aSAH) is a significant cause of morbidity and mortality throughout the world. Although aggressive medical and surgical care for this disease has resulted in marked improvements in outcomes for those fortunate enough to be admitted to tertiary care centers experienced in handling this disease, many patients still die before hospitalization, and many others are treated in low-volume centers, where their medical and surgical options may be limited. Thus, although efforts continue to focus on developing better methods for treating patients with aSAH, considerable energy has been and will continue to be focused on primary and secondary prevention and systems of care.

This Executive Summary contains only the recommendations from the 2012 Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage. The previous version of the guidelines was published in 2009. The 2012 version serves to update those guidelines. As such, differences from former recommendations are specified in the present work. The writing group met by telephone to determine subcategories to evaluate. These subcategories included incidence, risk factors, prevention, natural history and outcome, diagnosis, prevention of rebleeding, surgical and endovascular repair of ruptured aneurysms, systems of care, anesthetic management during repair, management of vasospasm, management of hydrocephalus, management of seizures, and management of medical complications. Each subcategory was led by 1 author, with 1 or 2 additional authors who made contributions. Full MEDLINE searches

were conducted of all English-language papers on treatment of relevant human disease. Drafts of summaries and recommendations were circulated to the entire writing group for feedback. A conference call was held to discuss controversial issues. Sections were revised and merged by the writing group chair. The resulting draft was sent to the entire writing group for comment. Comments were incorporated into the draft by the writing group chair and vice chair, and the entire writing group was asked to approve the final draft. The chair and vice chair revised the document in response to peer review, and the document was again sent to the entire writing group for suggestions and approval.

The recommendations follow the American Heart Association Stroke Council's methods of classifying the level of certainty of the treatment effect and the class of evidence (Tables 1 and 2). This Executive Summary includes all recommendations, 22 of which are new and 9 of which were revised from the prior manuscript. In total, 22 of the recommendations are categorized as Class I recommendations. Two of the Class I recommendations are based on Level A evidence, and 2 are based on Level C evidence. The remainder of the Class I recommendations are based on Level B evidence.

Recommendations

Risk Factors for and Prevention of aSAH

- Treatment of high blood pressure with antihypertensive medication is recommended to prevent

The full-text version is available online at: <http://stroke.ahajournals.org/lookup/doi/10.1161/STR.0b013e3182587839>.

The American Heart Association requests that the full-text version of this document be used when cited: Connolly ES Jr, Rabinstein AA, Carhuapoma JR, Derdeyn CP, Dion J, Higashida RT, Hoh BL, Kirkness CJ, Naidech AM, Ogilvy CS, Patel AB, Thompson BG, Vespa P; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Radiology and Intervention, Council on Cardiovascular Nursing, Council on Cardiovascular Surgery and Anesthesia, and Council on Clinical Cardiology. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2012;43:1711-1737.

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Table 1. Applying Classification of Recommendation and Level of Evidence

		SIZE OF TREATMENT EFFECT											
		CLASS I <i>Benefit >>> Risk</i> Procedure/Treatment SHOULD be performed/administered	CLASS IIa <i>Benefit >> Risk</i> <i>Additional studies with focused objectives needed</i> IT IS REASONABLE to perform procedure/administer treatment	CLASS IIb <i>Benefit ≥ Risk</i> <i>Additional studies with broad objectives needed; additional registry data would be helpful</i> Procedure/Treatment MAY BE CONSIDERED	CLASS III <i>No Benefit or CLASS III Harm</i>								
				<table border="1"> <thead> <tr> <th></th> <th>Procedure/Test</th> <th>Treatment</th> </tr> </thead> <tbody> <tr> <td>COR III: No benefit</td> <td>Not Helpful</td> <td>No Proven Benefit</td> </tr> <tr> <td>COR III: Harm</td> <td>Excess Cost w/o Benefit or Harmful</td> <td>Harmful to Patients</td> </tr> </tbody> </table>		Procedure/Test	Treatment	COR III: No benefit	Not Helpful	No Proven Benefit	COR III: Harm	Excess Cost w/o Benefit or Harmful	Harmful to Patients
	Procedure/Test	Treatment											
COR III: No benefit	Not Helpful	No Proven Benefit											
COR III: Harm	Excess Cost w/o Benefit or Harmful	Harmful to Patients											
ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	<ul style="list-style-type: none"> Recommendation that procedure or treatment is useful/effective Sufficient evidence from multiple randomized trials or meta-analyses 	<ul style="list-style-type: none"> Recommendation in favor of treatment or procedure being useful/effective Some conflicting evidence from multiple randomized trials or meta-analyses 	<ul style="list-style-type: none"> Recommendation's usefulness/efficacy less well established Greater conflicting evidence from multiple randomized trials or meta-analyses 	<ul style="list-style-type: none"> Recommendation that procedure or treatment is not useful/effective and may be harmful Sufficient evidence from multiple randomized trials or meta-analyses 								
	LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	<ul style="list-style-type: none"> Recommendation that procedure or treatment is useful/effective Evidence from single randomized trial or nonrandomized studies 	<ul style="list-style-type: none"> Recommendation in favor of treatment or procedure being useful/effective Some conflicting evidence from single randomized trial or nonrandomized studies 	<ul style="list-style-type: none"> Recommendation's usefulness/efficacy less well established Greater conflicting evidence from single randomized trial or nonrandomized studies 	<ul style="list-style-type: none"> Recommendation that procedure or treatment is not useful/effective and may be harmful Evidence from single randomized trial or nonrandomized studies 								
	LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	<ul style="list-style-type: none"> Recommendation that procedure or treatment is useful/effective Only expert opinion, case studies, or standard of care 	<ul style="list-style-type: none"> Recommendation in favor of treatment or procedure being useful/effective Only diverging expert opinion, case studies, or standard of care 	<ul style="list-style-type: none"> Recommendation's usefulness/efficacy less well established Only diverging expert opinion, case studies, or standard of care 	<ul style="list-style-type: none"> Recommendation that procedure or treatment is not useful/effective and may be harmful Only expert opinion, case studies, or standard of care 								
Suggested phrases for writing recommendations		should be recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	COR III: No Benefit is not recommended is not indicated should not be performed/administered/other is not useful/beneficial/effective	COR III: Harm potentially harmful causes harm associated with excess morbidity/mortality should not be performed/administered/other							
Comparative effectiveness phrases†		treatment/strategy A is recommended/indicated in preference to treatment B treatment A should be chosen over treatment B	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B										

A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as sex, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

†For comparative effectiveness recommendations (Class I and IIa; Level of Evidence A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

ischemic stroke, intracerebral hemorrhage, and cardiac, renal, and other end-organ injury (*Class I; Level of Evidence A*).

- Hypertension should be treated, and such treatment may reduce the risk of aSAH (*Class I; Level of Evidence B*).
- Tobacco use and alcohol misuse should be avoided to reduce the risk of aSAH (*Class I; Level of Evidence B*).
- In addition to the size and location of the aneurysm and the patient's age and health status, it might be reasonable to consider morphological and hemodynamic characteristics of the aneurysm when discuss-

ing the risk of aneurysm rupture (*Class IIb; Level of Evidence B*). (New recommendation)

- Consumption of a diet rich in vegetables may lower the risk of aSAH (*Class IIb; Level of Evidence B*). (New recommendation)
- It may be reasonable to offer noninvasive screening to patients with familial (at least 1 first-degree

AQ: 6

AQ: 7

Table 2. Definition of Classes and Levels of Evidence Used in AHA Stroke Council Recommendations

Class I	Conditions for which there is evidence for and/or general agreement that the procedure or treatment is useful and effective.
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.
Class IIa	The weight of evidence or opinion is in favor of the procedure or treatment.
Class IIb	Usefulness/efficacy is less well established by evidence or opinion.
Class III	Conditions for which there is evidence and/or general agreement that the procedure or treatment is not useful/effective and in some cases may be harmful.
Therapeutic recommendations	
Level of Evidence A	Data derived from multiple randomized clinical trials or meta-analyses
Level of Evidence B	Data derived from a single randomized trial or nonrandomized studies
Level of Evidence C	Consensus opinion of experts, case studies, or standard of care
Diagnostic recommendations	
Level of Evidence A	Data derived from multiple prospective cohort studies using a reference standard applied by a masked evaluator
Level of Evidence B	Data derived from a single grade A study, or ≥1 case-control studies, or studies using a reference standard applied by an unmasked evaluator
Level of Evidence C	Consensus opinion of experts

- After any aneurysm repair, immediate cerebrovascular imaging is generally recommended to identify remnants or recurrence of the aneurysm that may require treatment (*Class I; Level of Evidence B*). (New recommendation)

Natural History and Outcome of aSAH

- The initial clinical severity of aSAH should be determined rapidly by use of simple validated scales (eg, Hunt and Hess, World Federation of Neurological Surgeons), because it is the most useful indicator of outcome after aSAH (*Class I; Level of Evidence B*). AQ: 8
- The risk of early aneurysm rebleeding is high, and rebleeding is associated with very poor outcomes. Therefore, urgent evaluation and treatment of patients with suspected aSAH is recommended (*Class I; Level of Evidence B*). AQ: 9
- After discharge, it is reasonable to refer patients with aSAH for a comprehensive evaluation, including cognitive, behavioral, and psychosocial assessments (*Class IIa; Level of Evidence B*). (New recommendation) AQ: 10

Clinical Manifestations and Diagnosis of aSAH

- aSAH is a medical emergency that is frequently misdiagnosed. A high level of suspicion for aSAH should exist in patients with acute onset of severe headache (*Class I; Level of Evidence B*).
- Acute diagnostic workup should include noncontrast head computed tomography, which, if nondiagnostic, should be followed by lumbar puncture (*Class I; Level of Evidence B*).
- Computed tomographic angiography may be considered in the workup of aSAH. If an aneurysm is detected by computed tomographic angiography, this study may help guide the decision for type of aneurysm repair, but if computed tomographic angiography is inconclusive, digital subtraction angiography is still recommended (except possibly in the instance of classic perimesencephalic aSAH) (*Class IIb; Level of Evidence C*). (New recommendation)
- Magnetic resonance imaging, fluid-attenuated inversion recovery, proton density, diffusion-weighted imaging, and gradient echo sequences may be reasonable for the diagnosis of aSAH in patients with a nondiagnostic computed tomographic scan, although a negative result does not obviate the need for cerebrospinal fluid analysis (*Class IIb; Level of Evidence C*). (New recommendation) AQ: 12
- Digital subtraction angiography with 3-dimensional rotational angiography is indicated for detection of aneurysm in patients with aSAH (except when the aneurysm was previously diagnosed by a noninvasive angiogram) and for planning treatment (to determine whether an aneurysm is amenable to coiling or to expedite microsurgery) (*Class I; Level of Evidence B*). (New recommendation)

Medical Measures to Prevent Rebleeding After aSAH

- Between the time of aSAH symptom onset and aneurysm obliteration, blood pressure should be controlled with a titratable agent to balance the risk of stroke, hypertension-related rebleeding, and maintenance of cerebral perfusion pressure (*Class I; Level of Evidence B*). (New recommendation) AQ: 13
- The magnitude of blood pressure control to reduce the risk of rebleeding has not been established, but a decrease in systolic blood pressure to <160 mm Hg is reasonable (*Class IIa; Level of Evidence C*). (New recommendation) AQ: 14
- For patients with an unavoidable delay in obliteration of aneurysm, a significant risk of rebleeding, and no compelling medical contraindications, short-term (<72 hours) therapy with tranexamic acid or aminocaproic acid is reasonable to reduce the risk of early aneurysm rebleeding (*Class IIa; Level of Evidence B*). (Revised recommendation from previous guidelines)

Surgical and Endovascular Methods of Treatment of Ruptured Cerebral Aneurysms

- Surgical clipping or endovascular coiling of the ruptured aneurysm should be performed as early as feasible in the majority of patients to reduce the rate of rebleeding after aSAH (*Class I; Level of Evidence B*).
- Complete obliteration of the aneurysm is recommended whenever possible (*Class I; Level of Evidence B*).
- Determination of aneurysm treatment, as judged by both experienced cerebrovascular surgeons and endovascular specialists, should be a multidisciplinary decision based on characteristics of the patient and the aneurysm (*Class I; Level of Evidence C*). (Revised recommendation from previous guidelines)
- For patients with ruptured aneurysms judged to be technically amenable to both endovascular coiling and neurosurgical clipping, endovascular coiling should be considered (*Class I; Level of Evidence B*). (Revised recommendation from previous guidelines)
- In the absence of a compelling contraindication, patients who undergo coiling or clipping of a ruptured aneurysm should have delayed follow-up vascular imaging (timing and modality to be individualized), and strong consideration should be given to retreatment, either by repeat coiling or microsurgical clipping, if there is a clinically significant (eg, growing) remnant (*Class I; Level of Evidence B*). (New recommendation)
- Microsurgical clipping may receive increased consideration in patients presenting with large (>50 mL) intraparenchymal hematomas and middle cerebral artery aneurysms. Endovascular coiling may receive increased consideration in the elderly (>70 years of age), in those presenting with poor-grade (World Federation of Neurological Surgeons classification IV/V) aSAH, and in those with aneurysms of the basilar apex (*Class IIb; Level of Evidence C*). (New recommendation)
- Stenting of a ruptured aneurysm is associated with increased morbidity and mortality, and should only be considered when less risky options have been excluded (*Class III; Level of Evidence C*). (New recommendation)

Hospital Characteristics and Systems of Care

- Low-volume hospitals (eg, <10 aSAH cases per year) should consider early transfer of patients with aSAH to high-volume centers (eg, >35 aSAH cases per year) with experienced cerebrovascular surgeons, endovascular specialists, and multidisciplinary neuro-intensive care services (*Class I; Level of Evidence B*). (Revised recommendation from previous guidelines)
- Annual monitoring of complication rates for surgical and interventional procedures is reasonable (*Class IIa; Level of Evidence C*). (New recommendation)

- A hospital credentialing process to ensure that proper training standards have been met by individual physicians treating brain aneurysms is reasonable (*Class IIa; Level of Evidence C*). (New recommendation)

Anesthetic Management During Surgical and Endovascular Treatment

- Minimization of the degree and duration of intraoperative hypotension during aneurysm surgery is probably indicated (*Class IIa; Level of Evidence B*).
- There are insufficient data on pharmacological strategies and induced hypertension during temporary vessel occlusion to make specific recommendations, but there are instances when their use may be considered reasonable (*Class IIb; Level of Evidence C*).
- Induced hypothermia during aneurysm surgery is not routinely recommended but may be a reasonable option in selected cases (*Class III; Level of Evidence B*).
- Prevention of intraoperative hyperglycemia during aneurysm surgery is probably indicated (*Class IIa; Level of Evidence B*). AQ: 18
- The use of general anesthesia during endovascular treatment of ruptured cerebral aneurysms can be beneficial in selected patients (*Class IIa; Level of Evidence C*).

Management of Cerebral Vasospasm and Delayed Cerebral Ischemia After aSAH

- Oral nimodipine should be administered to all patients with aSAH (*Class I; Level of Evidence A*). (It should be noted that this agent has been shown to improve neurological outcomes but not cerebral vasospasm. The value of other calcium antagonists, whether administered orally or intravenously, remains uncertain.)
- Maintenance of euvolemia and normal circulating blood volume is recommended to prevent delayed cerebral ischemia (*Class I; Level of Evidence B*). (Revised recommendation from previous guidelines) AQ: 19
- Prophylactic hypervolemia or balloon angioplasty before the development of angiographic spasm is not recommended (*Class III; Level of Evidence B*). (New recommendation)
- Transcranial Doppler is reasonable to monitor for the development of arterial vasospasm (*Class IIa; Level of Evidence B*). (New recommendation)
- Perfusion imaging with computed tomography or magnetic resonance can be useful to identify regions of potential brain ischemia (*Class IIa; Level of Evidence B*). (New recommendation)
- Induction of hypertension is recommended for patients with delayed cerebral ischemia unless blood pressure is elevated at baseline or cardiac status precludes it (*Class I; Level of Evidence B*). (Revised recommendation from previous guidelines)

- Cerebral angioplasty and/or selective intra-arterial vasodilator therapy is reasonable in patients with symptomatic cerebral vasospasm, particularly those who are not rapidly responding to hypertensive therapy (*Class IIa; Level of Evidence B*). (Revised recommendation from previous guidelines)

Management of Hydrocephalus Associated With aSAH

- aSAH-associated acute symptomatic hydrocephalus should be managed by cerebrospinal fluid diversion (external ventricular drainage or lumbar drainage, depending on the clinical scenario) (*Class I; Level of Evidence B*). (Revised recommendation from previous guidelines)
- aSAH-associated chronic symptomatic hydrocephalus should be treated with permanent cerebrospinal fluid diversion (*Class I; Level of Evidence C*). (Revised recommendation from previous guidelines)
- Weaning external ventricular drainage over >24 hours does not appear to be effective in reducing the need for ventricular shunting (*Class III; Level of Evidence B*). (New recommendation)
- Routine fenestration of the lamina terminalis is not useful for reducing the rate of shunt-dependent hydrocephalus and therefore should not be routinely performed (*Class III; Level of Evidence B*). (New recommendation)

Management of Seizures Associated With aSAH

- The use of prophylactic anticonvulsants may be considered in the immediate posthemorrhagic period (*Class IIb; Level of Evidence B*).
- The routine long-term use of anticonvulsants is not recommended (*Class III; Level of Evidence B*) but may be considered for patients with known risk factors for delayed seizure disorder, such as prior seizure, intracerebral hematoma, intractable hyper-

tension, infarction, or aneurysm at the middle cerebral artery (*Class IIb; Level of Evidence B*).

Management of Medical Complications Associated With aSAH

- Administration of large volumes of hypotonic fluids and intravascular volume contraction is not recommended after aSAH (*Class III; Level of Evidence B*).
- Monitoring volume status in certain patients with recent aSAH by some combination of central venous pressure, pulmonary wedge pressure, and fluid balance is reasonable, as is treatment of volume contraction with crystalloid or colloid fluids (*Class IIa; Level of Evidence B*).
- Aggressive control of fever to a target of normothermia by use of standard or advanced temperature modulating systems is reasonable in the acute phase of aSAH (*Class IIa; Level of Evidence B*). (New recommendation) AQ: 21
- Careful glucose management with strict avoidance of hypoglycemia may be considered as part of the general critical care management of patients with aSAH (*Class IIb; Level of Evidence B*).
- The use of packed red blood cell transfusion to treat anemia might be reasonable in patients with aSAH who are at risk of cerebral ischemia. The optimal hemoglobin goal is still to be determined (*Class IIb; Level of Evidence B*). (New recommendation)
- The use of fludrocortisone acetate and hypertonic saline solution is reasonable for preventing and correcting hyponatremia (*Class IIa; Level of Evidence B*).
- Heparin-induced thrombocytopenia and deep venous thrombosis are relatively frequent complications after aSAH. Early identification and targeted treatment are recommended, but further research is needed to identify the ideal screening paradigms (*Class I; Level of Evidence B*). (New recommendation) AQ: 22

References

References are available in the full text of this guideline: <http://stroke.ahajournals.org/lookup/doi/10.1161/STR.0b013e3182587839>.