AHA/ASA Scientific Statement

Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage

A Statement for Healthcare Professionals from the American Heart Association/American Stroke Association

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Stroke Council Professional Education Committee

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This slide set was adapted from the Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage.

This guideline reflects a consensus of expert opinion following thorough literature review that consisted of a look at clinical trials and other evidence related to the management of aneuysmal subarachnoid hemorrhage.

Applying classification of recommendations and levels of evidence

SIZE OF TREATMENT EFFECT →

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT

	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *Risk ≥ Benefit* Procedure/Treatment should **NOT** be performed/administered **SINCE IT IS NOT HELPFUL AND MAY BE HARMFUL**
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ 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	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ 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	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ 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 is 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	is not recommended is not indicated should not is not useful/effective/beneficial may be harmful

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Introduction

- Aneurysmal subarachnoid hemorrhage (aSAH) is a common and devastating condition.
- aSAH affects up to 30,000 persons annually in the United States (US).
- Mortality rates are as high as 45% with significant morbidity among survivors.
- These recommendations summarize the best available evidence for treatment of patients with aSAH.

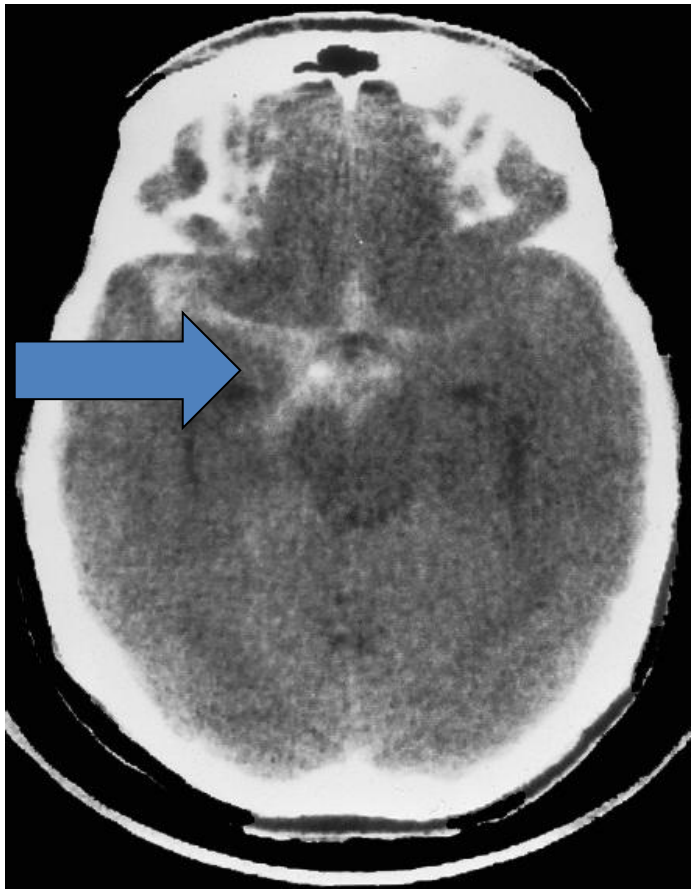
Epidemiology

- aSAH incidence varies greatly between countries, from 2 cases/100,000 in China to 22.5/100,000 in Finland.
- Many cases of aSAH are misdiagnosed.
- Thus, the annual incidence of aneurysmal aSAH in the US may exceed 30,000.
- Incidence increases with age, occurring most commonly between 40 and 60 years of age (mean age ≥ 50 years).

Epidemiology

- aSAH is ~1.2 times higher in women than men.
- Risk factors for aSAH include hypertension, smoking, female gender, and heavy alcohol use.
- Cocaine-related aSAH occurs in younger patients.
- Familial intracranial aneurysm (FIA) syndrome occurs when two first- through third-degree relatives have intracranial aneurysms.

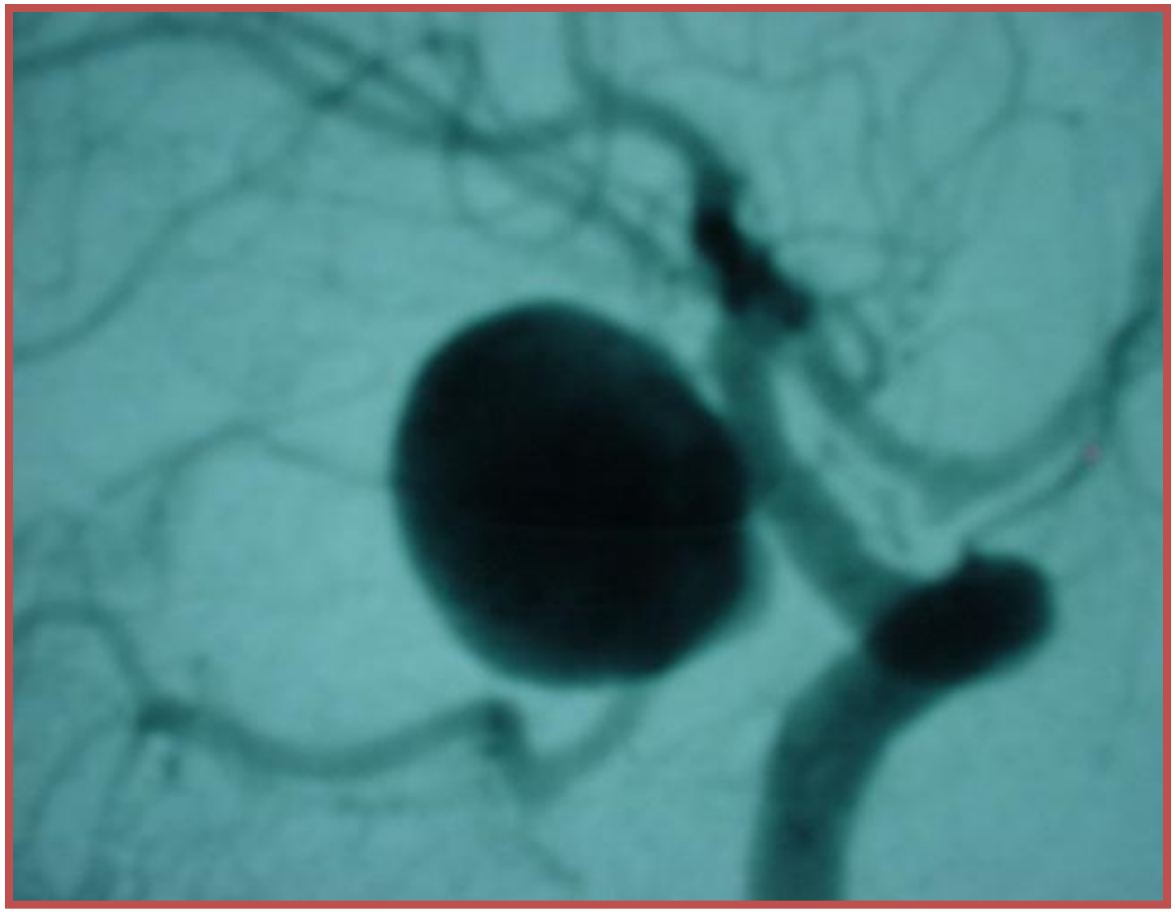
CT Scan non-contrast showing blood in basal cisterns (aSAH) – so called “Star-Sign”



CT Scan of a 65 yo woman, Hunt and Hess of 4 Subarachnoid Hemorrhage

Arrow:
Hyperintense signal.
Blood in the
subarachnoid
space

Angiogram - Giant ICA Aneurysm



Prevention of aSAH

- No randomized controlled trials have examined whether treatment of medical risk factors reduces aSAH occurrence.
- Hypertension is a common risk factor for hemorrhagic stroke.
- Indirect evidence suggests that smoking cessation reduces risk for aSAH.
- Screening for asymptomatic intracranial aneurysms in the general population is not supported by the available literature.

Recommendations: Prevention of aSAH

1. Treatment of high blood pressure with antihypertensive medication is recommended to prevent ischemic stroke, intracerebral hemorrhage, and cardiac, renal, and other end-organ injury (Class I, Level of Evidence A).
2. Hypertension should be treated, which may reduce the risk of aSAH (Class I, Level of Evidence B).
3. Tobacco use and alcohol misuse should be avoided to reduce the risk of aSAH (Class I, Level of Evidence B).

Recommendations--Prevention Con't

4. It might be reasonable to consider aneurysm morphologic and hemodynamic characteristics when discussing the risk of aneurysm rupture (Class IIb, Level of Evidence B). *New*

5. Consumption of more vegetables may lower the risk of aSAH (Class IIb, Level of Evidence B). *New*

6. Patients with familial aSAH (at least one first-degree relative) and/or a history of aSAH may be offered non-invasive screening to evaluate for de novo aneurysm growth or late regrowth of a treated aneurysm, but the risks and benefits of this screening require further study (Class IIb, Level of Evidence B).

Recommendations for Prevention

7. Repeat cerebrovascular imaging is recommended to identify aneurysm remnants or recurrence that may require treatment (Class I, Level of Evidence B). *New*

Natural History and Outcome of an Aneurysmal SAH

- 30-day mortality rate after aSAH ranges from 33%-50%.
- Severity of initial hemorrhage, age, sex, time to treatment, and medical comorbidities impact aSAH outcome.
- Aneurysm size, location in the posterior circulation, and morphology may also impact outcome.
- Endovascular services at a given institution, the volume of aSAH patients treated, and the facility where the patient is first evaluated may also impact outcome.

Natural History: Aneurysmal SAH Recommendations

1. The initial clinical severity of aSAH should be determined rapidly using simple validated scales because it is the most useful indicator of outcome after aSAH (Class I, Level of Evidence B).

2. The risk of early aneurysm rebleeding is high, and it is associated with very poor outcomes. Therefore, urgent evaluation and treatment of patients with suspected aSAH are recommended (Class I, Level of Evidence B).

3. Following discharge, it is reasonable to refer aSAH patients for a comprehensive evaluation including cognitive, behavioral, and psychosocial assessments (Class IIa, Level of Evidence B). *New*

Acute Evaluation - Diagnosis

- Importance of recognizing a warning or sentinel leak cannot be overemphasized.
- A high index of suspicion is warranted in the ED.
- The diagnostic sensitivity of CT scanning is not 100%, thus diagnostic lumbar puncture should be performed if the initial CT scan is negative.

Acute Evaluation - Diagnosis

- “The worst headache of my life” is described by ~80% of patients.
- “Sentinel” headache is described by ~20%.
- Nausea/vomiting, stiff neck, loss of consciousness, or focal neurological deficits may occur.
- Misdiagnosis of aSAH occurred in as many as 64% of cases prior to 1985.
- Recent data suggest an aSAH misdiagnosis rate of approximately 12%.

Manifestations/Diagnosis of SAH - Recommendations

1. 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).

2. Acute diagnostic workup should include non-contrast head CT, which if negative should be followed by a lumbar puncture (Class I, Level of Evidence B).

Manifestations/Diagnosis of SAH – Recommendations

3. CTA may be considered in the workup of aSAH. If an aneurysm is detected by CTA, this study may help guide the decision for type of aneurysm repair; however, if the CTA is negative, digital subtraction angiography (DSA) is still recommended (except possibly in the instance of classic perimesencephalic subarachnoid hemorrhage) (Class IIb, Level of Evidence C). *New*

Manifestations/Diagnosis of SAH – Recommendations

4. MRI (FLAIR, Proton Density, DWI, and GRE) may be reasonable for the diagnosis of aSAH in patients who present 5 or more days after symptom onset and have non-diagnostic CT scan and cerebrospinal fluid results (Class IIb, Level of Evidence C). *New*

5. DSA and 3DRA are indicated for aneurysm detection in patients with aSAH (except when the aneurysm was previously diagnosed by a non-invasive 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*

Acute Evaluation – Emergency Evaluation

- Emergency medical services (EMS) is first medical contact in about two thirds of aSAH patients.
- EMS personnel should receive continuing education regarding signs and symptoms and the importance of rapid neurological assessment in cases of possible aSAH.
- On-scene delays should be avoided.
- Rapid transport and advanced notification of the ED should occur.

Acute Evaluation – Emergency Evaluation

- Airway, breathing, and circulation should be rapidly assessed and managed.
- Emergency care providers should evaluate aSAH patients with an accepted neurologic assessment scale and record it in the ED.
  - Hunt and Hess, Fisher Scale, Glasgow Coma Scale, World Federation of Neurological Surgeons Scale.
- Expedient transfer to an appropriate referral center should be considered if necessary.

Acute Evaluation – Preventing Rebleeding

- Up to 14% of aSAH patients may experience rebleeding within 2 hours of the initial hemorrhage.
- Rebleeding was more common in those with a systolic blood pressure >160 mm Hg.
- Anti-fibrinolytic therapy may reduce rebleeding but has not been shown to improve outcomes.

Medical Measures to Prevent Rebleeding after aSAH

1. 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*

2. The magnitude of blood pressure control to reduce the risk of rebleeding has not been established, but a decrease to a systolic blood pressure of <160 mm Hg is reasonable (Class IIa, Level of Evidence C). *New*

Medical Measures to Prevent Rebleeding After aSAH

3. For patients with an unavoidable delay in aneurysm obliteration and a significant risk of rebleeding, short-term (<72h) therapy with transexamic acid or aminocaproic acid is reasonable to reduce the risk of early aneurysm rebleeding (Class IIa, Level of Evidence B). *Revised*

Surgical and Endovascular Management of aSAH

- In the International Subarachnoid Aneurysm Trial (ISAT), post-treatment re-bleeding occurred at an annualized rate of 0.9% with surgical clipping, compared to 2.9% with endovascular treatment.

- The rate of incomplete obliteration and recurrence appears significantly lower with surgical clipping than with endovascular treatment.

Surgical and Endovascular Management of aSAH

- Increased time to treatment is associated with increased rates of preoperative rebleeding:
  - 0 to 3 days, 5.7%
  - 4 to 6 days, 9.4%
  - 7 to 10 days, 12.7%
  - 11 to 14 days, 13.9%
  - 15 to 32 days, 21.5%

- Postoperative rebleeding did not differ among time intervals (1.6% overall).

Surgical and Endovascular Management of aSAH

- Estimating the consequences of complications attributable to an operation may be possible from data regarding surgery for unruptured aneurysms
- In-hospital mortality rates vary from 1.8% to 3.0% in large multicenter studies.
- Adverse outcomes in survivors vary from 8.9% to 22.4%.

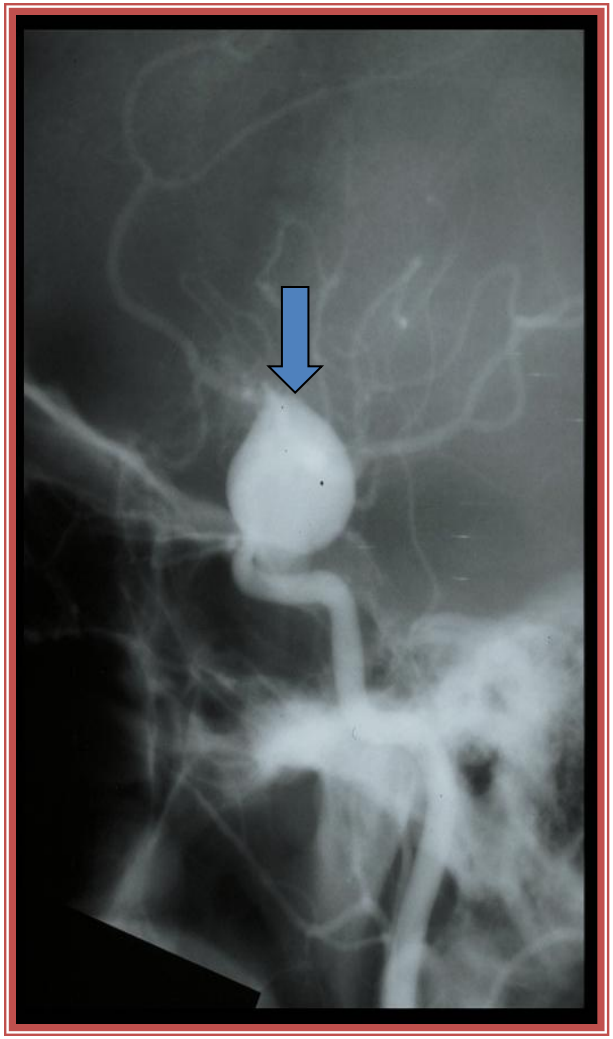
Surgical and Endovascular Management of aSAH

- The only large prospective, randomized trial to date comparing surgery and endovascular techniques is ISAT.
- At one year, there was no significant difference in mortality rates (8.1% vs. 10.1% endovascular vs. surgical).
- Disability rates were greater in surgical versus endovascular patients (21.6% vs. 15.6%).

Surgical and Endovascular Management of aSAH

- Combined morbidity and mortality was significantly greater in surgically treated patients than in those treated with endovascular techniques (30.9% vs. 23.5%; absolute risk reduction 7.4%, *P* = 0.0001).
- There have been no randomized comparisons of coiling versus clipping for unruptured aneurysms.

Left image arrow -Angio with large aneurysm
Right image arrow – Angio showing aneurysm post clipping



Surgical/Endovascular Management Recommendations

1. Surgical clipping or endovascular coiling of the ruptured aneurysm should be performed as early as is feasible in the majority of patients to reduce the rate of rebleeding after aSAH (Class I, Level of Evidence B).

2. Complete obliteration of the aneurysm is recommended whenever possible (Class I, Level of Evidence B).

Surgical/Endovascular Management Recommendations

3. Determination of aneurysm treatment, as judged by both experienced cerebrovascular surgeons and endovascular specialists, should be a multi-disciplinary decision based on patient and aneurysm characteristics (Class I, Level of Evidence C). *Revised*

4. 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*

Surgical/Endovascular Management Recommendations

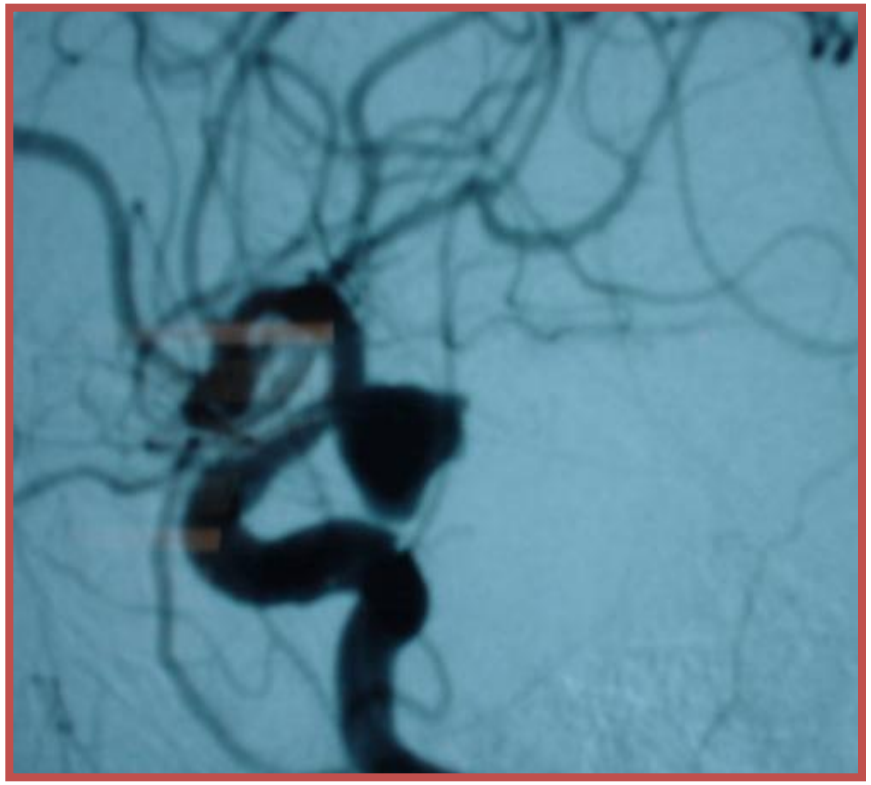
5. Patients who undergo coiling or clipping of a ruptured aneurysm should have follow-up vascular imaging and strong consideration should be given to retreatment, either by repeat coiling or microsurgical clipping, if there is a clinically significant remnant (Class I, Level of Evidence B). *New*

Surgical/Endovascular Management Recommendations

6. Microsurgical clipping may receive increased consideration in patients presenting with large (>50mL) intraparenchymal hematomas and middle cerebral artery aneurysms. Endovascular coiling may receive increased consideration in the elderly (>70y), in those presenting with poor grade (IV/V) aSAH, and in those with aneurysms of the basilar apex (Class IIb, Level of Evidence C). *New*
7. Stenting of a ruptured aneurysm is associated with increased morbidity/mortality (Class III, Level of Evidence C). *New*

Guglielmi Coil System (GDC) Embolization: Immediate Result

Angio showing large ICA aneurysm



Same aneurysm - Post GDC Coiling

Hospital/Systems of Care

- Treatment volume is an important determinant of outcome for intracranial aneurysms – higher volume equals lower mortality.
- This effect may be more important for patients with unruptured aneurysms than for those with ruptured aneurysms.
- It is uncertain whether the benefits of receiving care at a high-volume center would outweigh the costs and risks of transfer.

Hospital/Systems of Care - Recommendations

1. Low-volume hospitals (e.g., <10 aSAH cases per year) should consider early transfer to high-volume centers (>35 aSAH patients/y) that have experienced cerebrovascular surgeons, endovascular specialists, and neuro-intensivists (Class I, Level of Evidence B). *Revised*
2. Annual monitoring of complication rates for surgical and interventional procedures is reasonable (Class IIa, Level of Evidence C). *New*
3. 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*

Management of Common In-Hospital aSAH Complications

- Common issues related to in-hospital management of aSAH include
  - Anesthetic Management
  - Cerebral Vasospasm
  - Hydrocephalus
  - Seizures
  - Hyponatremia

Anesthetic Management During Surgical and Endovascular Treatments

- Goals of intraoperative anesthetic management during aneurysm treatment include
  - limiting the risk of intraprocedural aneurysm rupture and
  - protecting the brain against ischemic injury.

Anesthetic Management - Recommendations

1. Minimizing the degree and duration of intraoperative hypotension during aneurysm surgery is probably indicated (Class IIa, Level of Evidence B).

2. 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**).**

Anesthetic Management - Recommendations

3. Induced hypothermia during aneurysm surgery may be a reasonable option in selected cases but is not routinely recommended (Class III, Level of Evidence B).
4. Preventing intra-operative hyperglycemia during aneurysm surgery is probably indicated (Class IIa, Level of Evidence B).
5. The use of general anesthesia during the endovascular treatment of ruptured cerebral aneurysms can be beneficial in selected patients (Class IIa, Level of Evidence C).

Management of Cerebral Vasospasm after aSAH

- Narrowing (vasospasm) of the angiographically visible cerebral arteries after aSAH is common, occurring most frequently 7 to 10 days after aneurysm rupture and resolving spontaneously after 21 days.
- Large artery narrowing seen in angiographically visible vessels only results in ischemic neurological symptoms in 50% of cases.
- There are patients with severe large artery spasm who never become symptomatic and those with quite modest spasm who develop not only symptoms but go on to develop infarction.

Management of Cerebral Vasospasm after aSAH

- Calcium-channel blockers, particularly nimodipine, have been shown to improve neurological outcomes, but not cerebral vasospasm.

- However, the reduction in morbidity and improvement in functional outcome may have been due more to cerebral protection than actual effect on the cerebral vasculature.

Management of Cerebral Vasospasm after aSAH

- Delayed cerebral ischemia (DCI), especially that associated with arterial vasospasm, remains a major cause of death and disability in aSAH patients.

- Various diagnostic tools are commonly used to identify (1) arterial narrowing and/or (2) perfusion abnormalities or reduced brain oxygenation.

Management of Cerebral Vasospasm after aSAH

- When DCI is diagnosed, the initial treatment is the induction of hemodynamic augmentation to improve cerebral perfusion.
- Endovascular intervention is often used in patients who do not improve with hemodynamic augmentation and those with sudden focal neurological deficits and focal lesions on angiography referable to their symptoms.

Management of Cerebral Vasospasm after aSAH

- Balloon angioplasty has been shown to be effective in reversing cerebral vasospasm in large proximal conducting vessels, but has not been shown to improve ultimate outcome.
- Many different vasodilators are also in use.
- As with hemodynamic augmentation, there have been no randomized trials of these interventions; however, there are large case series demonstrating angiographic and clinical improvement.

Cerebral Vasospasm Recommendations

1. Maintaining euvolemia and normal circulating blood volume are recommended to prevent DCI (Class I, Level of Evidence B). *Revised*
2. 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 neurologic outcomes but not cerebral vasospasm. The value of other calcium antagonists, whether administered orally or intravenously, remains uncertain.

Cerebral Vasospasm Recommendations

3. Prophylactic hypervolemia or balloon angioplasty before the development of angiographic spasm is not recommended (Class III, Level of Evidence B). *New*
4. Transcranial Doppler is reasonable to monitor for the development of arterial vasospasm (Class IIa, Level of Evidence B). *New*
5. Perfusion imaging with CT or MR can be useful to identify regions of potential brain ischemia (Class IIa, Level of Evidence B). *New*

Cerebral Vasospasm Recommendations

6. Induction of hypertension is recommended for patients with DCI, unless their blood pressure is elevated at baseline or their cardiac status precludes it (Class I, Level of Evidence B). *Revised*

7. 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*

Management of Hydrocephalus Associated With aSAH

- Acute hydrocephalus occurs in 15% to 87% of patients with aSAH.
- Shunt dependence for hydrocephalus occurs in about 8.9% to 48% of patients with aSAH.
- Acute hydrocephalus in aSAH is usually managed by external ventricular drainage (EVD).
- Lumbar drainage has also been used to manage hydrocephalus associated with aSAH.

Management of Hydrocephalus Associated With aSAH

- A meta-analysis of 11 non-randomized pooled 1973 patients (975 fenestrated, 998 non-fenestrated) and found no significant difference in shunt-dependent hydrocephalus between patients that had undergone fenestration of the lamina terminalis versus patients who had not.

Management of Hydrocephalus Recommendations

1. aSAH-associated acute symptomatic hydrocephalus should be managed by CSF diversion (external ventricular drainage or lumbar drainage depending on the clinical scenario) (Class I, Level of Evidence B). *Revised*
2. Patients with aSAH-associated chronic symptomatic hydrocephalus should be treated with permanent CSF diversion (Class I, Level of Evidence C). *Revised*

Management of Hydrocephalus Recommendations

3. Weaning external ventricular drainage over longer than 24 hours does not appear to be effective in reducing the need for ventricular shunting (Class III, Level of Evidence B). *New*

4. Routine fenestration of the lamina terminalis is not useful to reduce the rate of shunt-dependent hydrocephalus, and therefore it should not be routinely performed (Class III, Level of Evidence B). *New*

Management of Seizures Associated With aSAH

- A large number of seizure-like episodes are associated with aneurysmal rupture.
- It is unclear, however, whether all these episodes are truly epileptic.
- Retrospective reviews report that early seizures occur in 6% to 18% of aSAH patients.
- Non-convulsive seizures may occur in 19% of stuporous or comatose aSAH patients.
- The relationship between seizures and outcome is uncertain.

Management of Seizures Recommendations

1. The use of prophylactic anticonvulsants may be considered in the immediate post hemorrhagic period (Class IIb, Level of Evidence B).

2. 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 hypertension, infarction, or aneurysm at the middle cerebral artery (Class IIb, Level of Evidence B).

Management of Hyponatremia and Volume Contraction

- Both hypernatremia and hyponatremia are frequently observed in the acute phase following aSAH.
- Hyponatremia has been chronologically associated with the onset of sonographic and clinical vasospasm.
- Uncontrolled studies using crystalloid or colloid agents suggest that aggressive volume resuscitation can ameliorate the effect of cerebral salt wasting on the incidence risk of cerebral ischemia following aSAH.

Management of Hyponatremia and Volume Contraction

- Two randomized, controlled trials have been performed to evaluate the ability of fludrocortisone to correct hyponatremia and fluid balance.

- One trial found that it helped to correct the negative sodium balance, and the other reported a reduced need for fluids and improved sodium levels using this mineralocorticoid.

Other Medical Complications

- Improved functional outcome with effective control of fever has been reported.
- Data obtained from consecutive patients with aSAH using historical controls suggest that effective glucose control following aSAH can significantly reduce the risk of poor outcome.
- Data obtained from prospective registries of aSAH patients suggest that higher hemoglobin values are associated with improved outcomes after aSAH.

Management of Medical Complications Recommendations

1. Administration of large volumes of hypotonic fluids and intravascular volume contraction is not recommended after aSAH (Class III, Level of Evidence B).
2. Monitoring volume status in certain patients with recent aSAH using some combination of central venous pressure, pulmonary wedge pressure, and fluid balance is reasonable, as is treatment of volume contraction using crystalloid or colloid fluids (Class IIa, Level of Evidence B).
3. Aggressive fever control to a target of normothermia using standard or advanced temperature modulating systems is reasonable in the acute phase of aSAH (Class IIa, Level of Evidence B). *New*

Management of Medical Complications Recommendations

4. Careful glucose management with strict avoidance of hypoglycemia may be considered as part of the general critical care management of aSAH patients (Class IIb, Level of Evidence B).
5. The use of packed red blood cell transfusion to treat anemia might be reasonable in patients with aSAH at risk of cerebral ischemia. The optimal hemoglobin goal is still to be determined (Class IIb, Level of Evidence B). *New*
6. The use of fludrocortisone acetate and hypertonic saline is reasonable for preventing and correcting hyponatremia (Class IIa, Level of Evidence B).

Management of Medical Complications

7. Heparin-induced thrombocytopenia and deep venous thrombosis are both infrequent but not uncommon occurrences after an 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*

Summary and Conclusions

- The current standard of practice calls for microsurgical clipping or endovascular coiling of the aneurysm neck whenever possible.

- Treatment morbidity is determined by numerous factors, including *patient*, *aneurysm*, and *institutional* factors.

Summary and Conclusions

- *Favorable outcomes* are more likely in institutions that treat high volumes of patients with aSAH, in institutions that offer endovascular services, and in selected patients whose aneurysms are coiled rather than clipped.
- Optimal treatment requires availability of both experienced cerebrovascular surgeons and endovascular surgeons working in a collaborative effort to evaluate each case of aSAH.