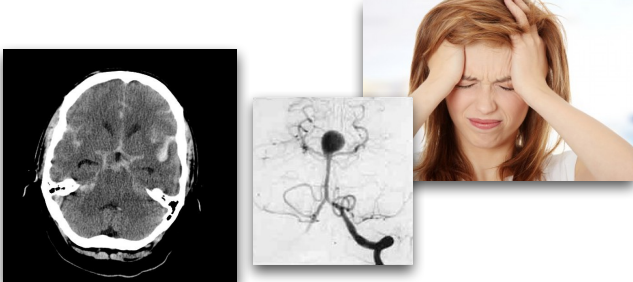


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Subarachnoid haemorrhage (SAH)

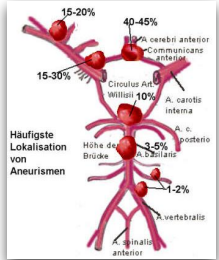


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Location of aneurysms

- 80 % anterior Circulus arteriosus Willisii
- 40% anterior cerebral artery (ACA) or anterior communicating artery (ACOM)
- 30% internal carotid artery (ICA) or posterior communicating artery (PCOM)
- 20% middle cerebri artery 10% basilar artery / vertebral artery
- 5 % arterio-venous malformation (AVM)



Häufigste Lokalisation von Aneurysmen

Schwab S, Neurointensiv, Blutungen, S. 425 – 442
Steiner T, Cerebrovasc. Dis 2013;35:93–112
http://www.neuro24.de/show_glossar.php?id=1642

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SAH complications

1. Re-Bleeding
 - ➔ risk of re-bleeding 3-4 % day 1, 2 % day 2, and 0,5 - 1% on following days
 - ➔ 50% within 1st months
2. Hydrocephalus obstructive (acute / subacute) und malresorptivus (chronic)
 - ➔ Intracranial pressure elevation, herniation
3. Vasospasmen
 - ➔ ischemic events

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SAH therapeutic goals

1. Treatment of aneurysm
 - ➔ Neuroradiologically (coiling)
 - ➔ Neurosurgically (clipping)
2. Therapy of cerebral spinal fluid disturbance
3. Prophylaxis and therapy of vasospasm

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Cerebrovascular Diseases

Guidelines

Cerebrovasc Dis 2013;35:93–112
DOI: 10.1159/000346087

Received: October 9, 2012
Accepted: November 22, 2012
Published online: February 7, 2013

European Stroke Organization Guidelines for the Management of Intracranial Aneurysms and Subarachnoid Haemorrhage

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Steiner, T et al. Cerebrovascular Diseases, 2013, 35 (2): 93-112
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Definitions

- Differentiate 'ruptured intracranial aneurysm' (RIA) from
- 'unruptured intracranial aneurysm' (UIA);
- UIA can either be 'asymptomatic' or 'symptomatic'
 - A symptomatic UIA usually causes brain nerve palsy or rarely can cause arterial embolism
 - Asymptomatic UIAs are usually found incidentally (incidental aneurysm) because of symptoms unrelated to aneurysm (long-term headache, dizziness, etc.) or can be discovered after SAH as an 'additional aneurysm', which is not the bleeding source

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SAH


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SAH

Epidemiology Risk factors


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Epidemiology

Variable	Counts / numbers
Incidence of SAH per 100,000 per year	
• Worldwide	9.1 (95% CI, 8.8–9.5)
• Finland / Japan	22.7 (95% CI, 21.9–23.5)
• Median age of onset at the first SAH [years]	50–60
• Women: men	1.6 : 1
Prevalence of intracranial aneurysms	
• In the general population	2–5%
• Of UIA in DSA and prospective autopsy series	3 - 4%
• In those with a family history of aneurysms	9,5 %


UIA: unruptured intracranial aneurysm; DSA: digital subtraction angiography Steiner, T et al. Cerebrovascular Diseases, 2013; 35 (2): 93-112
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Statement on Incidence

- The overall incidence of SAH is 9.1 per 100,000 person-years in most regions, and
- is higher in Finland and Japan;
- in the European community that means around 36,000 SAH cases per year


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Grading Scales for SAH

Scale	Grade	Criteria	Proportion of patients with poor outcome	OR for poor outcome
WFNS	I	GCS 15	14.8%	reference
	II	GCS 13–14 no focal deficits	29.4%	2.3
	III	GCS 13–14 focal deficits	52.6%	6.1
	IV	GCS 7–12	58.3%	7.7
	V	GCS 3–6	92.7%	69
PAASH	I	GCS 15	14.8%	reference
	II	GCS 11–14	41.3%	3.9
	III	GCS 8–10	74.4%	16
	IV	GCS 4–7	84.7%	30
	V	GCS 3	93.9%	84

WFNS: World Federation of Neurological Surgeons Steiner, T et al. Cerebrovascular Diseases, 2013; 35 (2): 93-112
 PAASH: Proposal on Admission of Aneurysmal Subarachnoid Haemorrhage 10th EAN/AFAN RTC, Antananarivo, 24-26.10.2018
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Recommendation on grading

- It is recommended that the initial assessment of SAH patients, and therefore the grading of the clinical condition, is done by means of a scale **based on the GCS**
- The **PAASH** scale performs slightly better than the WFNS scale, which has been used more often
- (class III, level C)

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Outcome and prognosis of SAH

Variable	Counts / numbers
Cumulative case fatality rates	
• Before reaching medical attention	12 %
• Day 1	25 - 30 %
• Day 7	40 - 50%
• Day 30	59 - 60%
• Day 90	55 - 60%
• Year 1	65 %
• Year 5	65 - 70%



Risk Factors

- Risk factors for SAH can be divided into risk factors for aneurysm **formation**, aneurysm **growth** and **rupture**
- The most important **modifiable** risk factors for **rupture**: cigarette **smoking**, **hypertension** and excessive **alcohol** intake, and non-modifiable risk factors: sex, age, size of aneurysm and family history
- Risk factors for de novo **formation** of aneurysms: female sex, current cigarette **smoking**, **hypertension**, age (at diagnosis) and family history
- Risk factors for aneurysm **growth**: current cigarette **smoking**



SAH Diagnosis



Recommendation for Diagnosis

- **CT/CTA and MRI** with multiple sequences are **equally** suitable for the diagnosis of SAH within 24 h (class II, level B)
- CT/CTA and multi-sequential MRI/MRA may confirm the underlying cause
- **Lumbar puncture** must be performed in a case of clinically suspected SAH if CT or MRI does not confirm the diagnosis (class II, level B);
- however, within the first 6–12 h the differentiation between genuine subarachnoidal blood and traumatic admixture of blood may be difficult
- **DSA** of all cerebral arteries should be performed if a bleeding **source** was not found on CTA and the patient has a typical basal SAH pattern on CT (class II, level B)
- If **no aneurysm** was found, **CTA or DSA** should be repeated as described with SAH without aneurysm (class III, level C)



SAH question

A 30 years-old patient has suffered an acute SAH from a communicating anterior artery aneurysm with some blood in the first and second ventricle as proven by CCT and CT-angiography. Though on admission the patient was fully awake when CCT was done he is now (about 10 minutes after CCT) deteriorating. Which one of the next measurements is needed?

1. Transcranial ultrasound to look for vasospasm
2. Blood pressure measurement to exclude hypertensive crisis
3. CCT to check for hydrocephalus
4. Blood gas to check for hypoventilation
5. Application of an external ventricular drain



SAH Treatment



SAH complications

1. **Re-Bleeding**
 - ➔ risk of re-bleeding
 - ➔ day 1: 3-4 %
 - ➔ day 2: 2 %
 - ➔ on following days: 0,5 - 1%
 - ➔ 50% within 1st months
2. Hydrocephalus obstructive (acute / subacute) and malresorptivus (chronic)
 - ➔ Intracranial pressure elevation, herniation
3. Vasospasmen
 - ➔ ischemic events



Basilar artery aneurysm: acute re-bleeding



Courtesy Prof. Bendzus Dept. Neuroradiology Heidelberg University Hospital 2019



Statement on physical management

- To avoid situations that increase intracranial pressure, the patient should be kept in bed and the application of antiemetic drugs, laxatives and analgetics should be considered before occlusion of the aneurysm (GCP)
- Hyperglycemia > 10 mmol/l should be treated (GCP)
- Increased temperature should be treated medically and physically (GCP)



Recommendation for blood pressure management

- **Until coiling or clipping**, systolic blood pressure should be kept **< 180 mm Hg**; this may be already achieved by applying analgetics and nimodipine (GCP)
- If systolic pressure remains high despite these treatments further lowering of blood pressure should be considered including antihypertensives- (class IV, level C)
- If blood pressure is lowered the mean arterial pressure should be kept at least **> 90 mm Hg** (GCP)



Recommendation for thromboprophylaxis

- Patients with SAH may be given thromboprophylaxis with pneumatic devices and / or compression stockings before occlusion of the aneurysm (class II, level B)
- In case deep vein thrombosis prevention is indicated, **low-molecular-weight heparin** should be applied not **earlier than 12 h** after surgical occlusion of the aneurysm and immediately after coiling (class II, level B)



Recommendation for seizure management

- **Antiepileptic** treatment should be administered in patients with clinically apparent seizures (GCP)
- There is **no** evidence that supports the **prophylactic** use of **antiepileptic** drugs (class IV, level C)

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Confirmation of ISAT results

ISAT - long term results

Study	Study design	Patients	n	Method	Endpoints	Results
ISAT 2002	RCT	<ul style="list-style-type: none"> • Patient with SAB and ruptured intracranial aneurysm • eligible for endovascular or microsurgical therapy • in most cases small aneurysm of anterior circulation with low WFNS-grade 	2143	Completion of 1-year follow-up <ul style="list-style-type: none"> • Clipping • Coiling • Angiographic follow-up after 6 months in all coiled patients and selected clipping patients 	Primary endpoint: functional outcome (mRS 3-6) after 1 year Secondary outcome: <ul style="list-style-type: none"> • re-bleeding <30 days, 30 days to 1 year 	Unfavourable outcome <ul style="list-style-type: none"> • Clipping: 23.5% • Coiling: 30.9% • Absolute risk reduction 7-4% (95% CI 3.6–11.2, p=0.0001) Coiling lower <ul style="list-style-type: none"> • risk of epileptic seizures • neuropsychological deficit Coiling higher <ul style="list-style-type: none"> • risk of re-bleeding Successful aneurysm closure <ul style="list-style-type: none"> • Coiling 66% • Clipping 82% Frequency of re-bleeding <ul style="list-style-type: none"> • Coiling: 9% increased compared to clipping, but no influence on outcome 5-year-mortality <ul style="list-style-type: none"> • Coiling significant lower than clipping
ISAT 2009	RCT	see ISAT 2002	2143	Observation period: 9 years	mortality and re-bleeding	

Molyneux AJ, Lancet 2005; 366:809-17, Molyneux AJ, Lancet 2009; 8: 427-433

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Movie coiling

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Recommendation for interventional prevention of re-bleeding

- The **best mode of intervention** should be discussed in an **interdisciplinary dialogue** between Neurosurgery and Neuroradiology
- Based on this discussion **patients** should be informed and **included** in the process of decision making whenever possible
- In cases where the aneurysm appears to be **equally effectively** treated either by coiling or clipping, **coiling is the preferred** treatment (class I, level A)
- In general, the **decision** on whether to clip or coil depends on several factors related to **3 major components**:
 1. **Patient**: age, comorbidity, presence of ICH, SAH grade, aneurysm size, location and configuration, as well as on status of collaterals (class III, level B)
 2. **Procedure**: competence, technical skills and availability (class III, level B)
 3. **Logistics**: the grade of inter-disciplinarity (class III, level B)

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Recommendations for hydrocephalus management

- In patients with **CT-proven hydrocephalus** and the third or fourth ventricle filled with blood, an **external ventricular drain** should be applied; this **drain** can be used to reduce and **monitor** pressure and to remove blood; for this last reason the level of evidence is low (GCP)
- In patients who are not sedated and who deteriorate from acute hydrocephalus, **lumbar puncture** might be considered if the **third and fourth ventricle are not filled** with blood and supratentorial herniation is prevented (class IV, level C)
- In patients who are sedated and have CT-proven hydrocephalus, lumbar drainage should be considered if the third and fourth ventricles are not filled with blood (class IV, level C)
- Patients with symptomatic **chronic hydrocephalus** require ventriculo-peritoneal or ventriculo-atrial **shunting** (GCP)

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Relative risk for death or dependency of oral nimodipine

Study or subgroup	treatment n/N	control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
3 Nimodipine, orally only					
Niel-Dwyer 1997	9/38	17/37		4.5 %	0.52 [0.26, 1.01]
Petruk 1988	44/72	54/82		13.1 %	0.93 [0.73, 1.18]
Philippou 1986	3/31	1/309		3.0 %	0.29 [0.09, 0.93]
Pickard 1989	55/278	91/276		23.8 %	0.60 [0.45, 0.80]
Subtotal (95% CI)	419	434		44.4 %	0.67 [0.55, 0.81]

Total events: 111 (treatment), 175 (control)
Heterogeneity: Chi² = 10.21, df = 3 (P = 0.02); I² = 71%
Test for overall effect: Z = 4.23 (P = 0.000023)

Dorhout Mees, S M et al. Cochrane Database Syst Rev. 2007; (5): CD000277
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Recommendation on pharmacological prevention of DIC (delayed ischemic deficit) with Nimodipine

- Nimodipine should be administered orally (60 mg/4 h) to prevent delayed ischaemic events (class I, level A) for 3 weeks
- In case oral administration is not possible nimodipine should be applied intravenously (GCP)
- If the patient is unable to swallow, the nimodipine tablets should be coarse-grained crushed and washed down a nasogastric tube with normal saline within minutes.

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SAH summary

1. Re-Bleeding
 - ➔ treatment within 72 hours
 - ➔ Coiling vs. clipping
 - ➔ interdisciplinary decision
 - ➔ If both seem to be equally doable: coiling should be preferred
2. CSF circulation disturbances (hydrocephalus)
 - ➔ EVD, lumbar drain if 3rd and 4th ventricles cleared
3. **Vasospasmen**
 - ➔ Hemodynamic therapie: moderate hypertension (CPP 80-120 mmHg), normovolemia
 - ➔ Nimodipin: orally or i.v., intraventriculär (neu)
 - ➔ Endovascular (mechanical / pharmacological)