Subarachnoid haemorrhage (SAH)

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)

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 1 month
2. Hydrozephalus obstructive (acute / subacute) und malresorptivus (chronic)
   - Intracribial pressure elevation, herniation
3. Vasospasmen
   - Ischmic events

SAH therapeutic goals

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

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
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

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

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)
### Outcome and Prognosis of SAH

<table>
<thead>
<tr>
<th>Variable</th>
<th>Counts / Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative case fatality rates</td>
<td></td>
</tr>
<tr>
<td>- Before reaching medical attention</td>
<td>12 %</td>
</tr>
<tr>
<td>- Day 1</td>
<td>25 - 30 %</td>
</tr>
<tr>
<td>- Day 7</td>
<td>40 - 50%</td>
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<tr>
<td>- Day 30</td>
<td>59 - 60%</td>
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<tr>
<td>- Day 90</td>
<td>55 - 60%</td>
</tr>
<tr>
<td>- Year 1</td>
<td>65 %</td>
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<tr>
<td>- Year 5</td>
<td>65 - 70%</td>
</tr>
</tbody>
</table>

### 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 MRA/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 Treatment

**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 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. Hydrozephalus obstructive (acute / subacute) und malresorptivus (chronic)
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3. Vasospasmen
   - ischmic events

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)
ISAT - long term results

<table>
<thead>
<tr>
<th>Study</th>
<th>Patient characteristics</th>
<th>Patient outcome</th>
<th>Procedure</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISAT 2002 RCT</td>
<td>Patient with SAA and ruptured intracranial aneurysm</td>
<td>Primary endpoint: functional outcome (mRS 3-4) after 1 year</td>
<td>Clipping</td>
<td>Unfavourable outcome: Clipping 23.5%, Coiling 30.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Angiography: Follow-up after 6 months in all cohort-allocated patients</td>
<td>Coiling lower: 60% of patients asymptomatic after 1 year Coiling higher: 11% of neurological deficit (class III)</td>
</tr>
<tr>
<td>ISAT 2003 RCT</td>
<td>see ISAT 2002</td>
<td>Observation period: 3 years</td>
<td>Clipping: 9% increased risk of re-bleeding Coiling: 30.9%</td>
<td>Successful aneurysm closure Coiling: 80% Clipping: 82%</td>
</tr>
</tbody>
</table>

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:
  - **Patient**: age, comorbidity, presence of ICH, SAH grade, aneurysm size, location and configuration, as well as on status of collaterals (class III, level B).
  - **Procedure**: competence, technical skills and availability (class III, level B).
  - **Logistics**: the grade of inter-disciplinarity (class II, level B).

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 pressure and to remove blood; for this 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 ventricles are not filled with blood (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).

Relative risk for death or dependency of oral nimodipine

<table>
<thead>
<tr>
<th>outcome</th>
<th>treatment</th>
<th>control</th>
<th>odds ratio 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>death</td>
<td>oral</td>
<td>intravenous</td>
<td>1.97 (1.12, 3.42)</td>
</tr>
<tr>
<td>death</td>
<td>intravenous</td>
<td>oral</td>
<td>1.95 (1.09, 3.50)</td>
</tr>
<tr>
<td>death</td>
<td>intravenous</td>
<td>control</td>
<td>1.96 (1.08, 3.56)</td>
</tr>
<tr>
<td>death</td>
<td>oral</td>
<td>intravenous</td>
<td>1.97 (1.12, 3.42)</td>
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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 coarsely-grained crushed and washed down a nasogastric tube with normal saline within minutes.
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)