Neurointensive care after SAH

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Epidemiology

- Ischemic stroke: $\frac{80}{100 \, 000}$/rok
- ICH: $\frac{10}{100 \, 000}$/rok
- SAH: $\frac{10}{100 \, 000}$/rok
- Source: Aneurysm in 80%, unknown in 20%
Reason for grading of SAH

• measure the severity of initial neurological injury

• to provide prognostic information regarding outcome

• to guide treatment decisions

• to standardize patient assessment across medical centers for the purposes of scientific study
Current scales on SAH

- Hunt and Hess Scale severity of SAH
- Glasgow Coma Score severity of SAH
- WFNS Scale severity of SAH
- Fisher Scale severity, vasospasm
- Barrow Neurological Institute severity, vasospasm
- Ogilvy prognosis
- GOS (Glasgow Outcome Scale) outcome
- Modified Rankin Scale outcome
Hunt and Hess scale (1968)

1. Asymptomatic or minimal headache and slight neck stiffness

2. Moderate to severe headache; neck stiffness; no neurologic deficit except cranial nerve palsy

3. Drowsy; minimal neurologic deficit

4. Stuporous; moderate to severe hemiparesis; possibly early decerebrate rigidity and vegetative disturbances

5. Deep coma; decerebrate rigidity; moribund
**WFNS scale (1988)**

<table>
<thead>
<tr>
<th>Grade</th>
<th>GCS</th>
<th>Focal neurological deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>Absent</td>
</tr>
<tr>
<td>2</td>
<td>13–14</td>
<td>Absent</td>
</tr>
<tr>
<td>3</td>
<td>13–14</td>
<td>Present</td>
</tr>
<tr>
<td>4</td>
<td>7–12</td>
<td>Present or absent</td>
</tr>
<tr>
<td>5</td>
<td>&lt;7</td>
<td>Present or absent</td>
</tr>
<tr>
<td>Grade</td>
<td>Appearance of hemorrhage</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>None evident</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Less than 1 mm thick</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>More than 1 mm thick</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Diffuse or none with intraventricular hemorrhage or parenchymal extension</td>
<td></td>
</tr>
</tbody>
</table>
## TABLE 1. The BNI SAH Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Maximum SAH Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No visible SAH</td>
</tr>
<tr>
<td>2</td>
<td>$\leq 5.0$</td>
</tr>
<tr>
<td>3</td>
<td>$&gt;5.0$ to 10.0</td>
</tr>
<tr>
<td>4</td>
<td>$&gt;10.0$ to 15.0</td>
</tr>
<tr>
<td>5</td>
<td>$&gt;15.0$</td>
</tr>
</tbody>
</table>

$^a$SAH, subarachnoid hemorrhage.

$^b$Thickness measured perpendicular to direction of cistern or fissure.
1 Younger than 50 years, not in coma, Fisher score 0–2, or aneurysm <10 mm

2 Only 1 of age >50 years, coma, Fisher score 3–4, or aneurysm >10 mm

3 Two of age >50 years, coma, Fisher score 3–4, or aneurysm >10 mm

4 Three of age >50 years, coma, Fisher score 3–4, or aneurysm >10 mm

5 Four of age >50 years, coma, Fisher score 3–4, or aneurysm >10 mm
## Glasgow Outcome Scale (1975)

<table>
<thead>
<tr>
<th>1. Death</th>
<th>Severe injury or death without recovery of consciousness</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Persistent vegetative state</td>
<td>Severe damage with prolonged state of unresponsiveness and a lack of higher mental functions</td>
</tr>
<tr>
<td>3. Severe disability</td>
<td>Severe injury with permanent need for help with daily living</td>
</tr>
<tr>
<td>4. Moderate disability</td>
<td>No need for assistance in everyday life, employment is possible but may require special equipment.</td>
</tr>
<tr>
<td>5. Good outcome</td>
<td>No or light damage with minor neurological and psychological deficits.</td>
</tr>
</tbody>
</table>
Modified Rankin Scale (1988)

0 - No symptoms.
1 - No significant disability.
   Able to carry out all usual activities, despite some symptoms.
2 - Slight disability.
   Able to look after own affairs without assistance, but unable to carry out all previous activities.
3 - Moderate disability.
   Requires some help, but able to walk unassisted.
4 - Moderately severe disability.
   Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
5 - Severe disability.
   Requires constant nursing care and attention, bedridden, incontinent.
6 - Dead.
Decision making process in SAH

- multifactorial, complicated

- initial diagnostic algorithm, the way of securing the aneurysm and its timing.

- factors which have to be taken into consideration (grading scales, age, general medical condition, the time from the rupture, the location, size and shape of the aneurysm, the presence of intracerebral hematoma or hydrocephalus
Proof of SAH

- CT
- Lumbar puncture
Proof of the bleeding source

- CTA, DSA

- Role of multiple aneurysms (20% of cases) – consider the distribution of blood on CT, more proximal and larger aneurysms tend to bleed
Risky pathophysiological mechanisms for SAH

• **Rebleeding** – early obliteration of the aneurysm

• **Early raised ICP** – EVD, spinal line

• **Vasospasms** – treatment on ICU
Algorithm in patients in good condition (HH I a II)

CT

negative

LP

negative

positive

CTA

negative

positive

DSA after 14 days

early operation or embolisation
Algorithm in somnolent patients (HH III)

- Hydrocephalus
- Hemocephalus
- Intracerebral hematoma

CT → SAK → CTA

Ventriculostomy

Early operation or embolisation

CTA → Urgent operation
Algorithm in comatous patients (HH IV a V)

1. **hydrocephalus** → **ventriculostomy**
2. **hemocehpalus** → **ventriculostomy**
3. **CT** → **SAK** → **CTA** → **early embolisation**
4. **intracerebral hematoma** → **CTA** → **urgent operation**
Timing for aneurysm obliteration

- Urgent (immediate) – intracerebral hematoma, severe condition
- Early (within 24 hours) – others
- Patients with vasospasm – usually coming several days after the rupture – individual approach – balancing the risks
Options of aneurysm obliteration

- **Microsurgery** (clipping, wrapping, trapping, proximal ligation)

- **Endovascular methods** (coiling, stenting)
Clip or coil

• Even after the ISAT trial no definite recommendation have been established.

• Both methods are still legitimate to be used.

• It depends on the preferences of a certain department and many factors here play a role (personal, technological, economical).

• Overall, however, endovascular procedures are the preferential treatment in more and more departments worldwide.
Clip or coil

- Dominantly coiling: In France, other EU countries and now also in USA

- Dominantly microsurgery (Finland, China, Japan).

- Many exceptions
Factors which influence the choice of the treatment modality

• **Age**: older patients probably benefit from endovascular treatment.

• **Clinical status**: higher HH grade patients probably benefit from endovascular treatment.

• **Location of the aneurysm**: this is related to the difficulty of open surgery in certain locations. Vertebralbasilar aneurysms, carotid-ophtalmic aneurysms, ACoA aneurysms pointing posteriorly or upwards are often treated by endovascular means.
Factors which influence the choice of the treatment modality

- **Size and shape of the aneurysm**: In giant and fusiforme aneurysms sometimes bypass is needed for a correct solution. Nevertheless new endovascular tools like stents and flow diverters are promising in this field.

- **Presence of significant intracerebral hematoma**: indication for open surgery.
Specific treatment on ICU – before aneurysm obliteration

- Keep the patient calm, no coughing, sneezing
- Keep the blood pressure to max. 140 syst.
- Introduce EVD or spinal line – to decrease ICP, improve symptoms
- Painkillers, hemostatics (Dicynone)
- Nimodipin
Specific treatment on ICU – after aneurysm obliteration

- Keep the blood pressure about 140-160 syst.
- EVD or signal line
- Nimodipine
- Monitoring (detection of vasospasm)
Monitoring on ICU

- **Clinical monitoring**
- **Blood pressure (syst BP is the most important)**
  - TCD (transcranial dopplerometry)
  - ICP (CPP)
- Tissue oxymetry
- CBF
- Microdialysis
- CT
Tissue oxymetry (PbtO2)

- Detection of focal ischemia
- Normal values above 20 mmHg
- Critical level <15 mm Hg
- Has been adopted as standard monitoring in many centres
Probe for PtiO2:

Depends on aneurysm location:

ACA – medial from Kocher’s point
MCA – lateral from Kocher’s point
PtiO₂ and GOS in severe SAH

PbtO₂ (means and their 95% CI) in group of GOS 1 (n=9), GOS 2,3 (n=11) and GOS 4,5 (n=15)

The day after the SAH

Torr

The day after the SAH
CBF monitoring

Real time monitoring

CBF in absolute values

[ml/100g.min⁻¹]
Vasospasms – main cause of mortality after SAH

- Onset 4.-14. day after SAH
- Develops in 30% of patients
- Mortality 30%
## Mortality for SAH in Brno (2005-2009) (n=242)

<table>
<thead>
<tr>
<th></th>
<th>clip (n=160)</th>
<th></th>
<th>coil (n=82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH I+II</td>
<td>1 (1%)</td>
<td>HH I+II</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>(n=81)</td>
<td></td>
<td>(n=37)</td>
<td></td>
</tr>
<tr>
<td>HH III</td>
<td>7 (17%)</td>
<td>HH III</td>
<td>3 (17%)</td>
</tr>
<tr>
<td>(n=41)</td>
<td></td>
<td>(n=18)</td>
<td></td>
</tr>
<tr>
<td>HH IV +V</td>
<td>20 (53%)</td>
<td>HH IV +V</td>
<td>14 (52%)</td>
</tr>
<tr>
<td>(n=38)</td>
<td></td>
<td>(n=27)</td>
<td></td>
</tr>
</tbody>
</table>
Tretment of vasospasms

- Nimodipin – prevention (or treatment?)
- H(HH) terapie (hypertension, hemodilution, hypervolemia)
- Intrathecal or i.v. application of vasoactive agents
- Injection to ggl. Stellatum
- Endovascular treatment (papaverin, angioplasty)
- Mild hypothermia
- Others
• Postoperative record - patient GOS 1
  ➢ m=19,0 Torr
  ➢ SD= 10,3 Torr
Surface cooling – 34 C

Decompressive craniectomy
- $m=25,99$ Torr, $SD=6,5$
Conclusion

• Correct assessment and grading of SAH patients help to establish the correct individual treatment algorithm.

• Neurointensive care must be very active, dynamic, continuous, including multimodal monitoring.

• Maintaining adequate perfusion is the main goal on ICU.

• New research should aim besides the new technologies related to aneurysm occlusion particularly on group of patients in a bad clinical condition after SAH who have the worst treatment results.