High-Resolution Intracranial Pressure Burden and Outcome in Subarachnoid Hemorrhage

Federico Magni, MD*; Matteo Pozzi, MD*; Matteo Rota, PhD; Alessia Vargiolu, PhD; Giuseppe Citerio, MD

Background and Purpose—Intracranial pressure (ICP) control is a therapeutic target in patients with aneurysmal subarachnoid hemorrhage, although only a limited number of studies assessed its course and effect on outcome. Pressure–time dose (PTD_{ICP}) is a method to quantify the burden and the time spent above a defined threshold of ICP. PTD_{ICP} or its relationship with outcome has never been evaluated in aneurysmal subarachnoid hemorrhage.

Methods—Analysis of data prospectively collected from aneurysmal subarachnoid hemorrhage patients admitted to a Neurointensive Care Unit. Monitored data, including intraparenchymal ICP, were digitally recorded minute-by-minute in the first 7 days. PTD_{ICP} (mm Hg h) was computed using 4 predefined thresholds (15, 20, 25, and 30 mm Hg). Outcome was assessed through Extended Glasgow Outcome Scale at hospital discharge and at 6 months.

Results—Fifty-five patients were enrolled. Forty-two patients (76%) presented with a poor clinical grade. Overall, mortality was 17% at hospital discharge and 34% at 6 months. Half of patients required extensive therapy to control high ICP during day 1. Median ICP was 10 mm Hg (4–75), whereas median PTD_{ICP15}, PTD_{ICP20}, PTD_{ICP25}, PTD_{ICP30} were, respectively, 13, 4, 2, and 1 mm Hg h. We observed an association between mortality at hospital discharge and higher level of PTD_{ICP} using 20, 25, and 30 mm Hg as thresholds and between exposure to a moderate-level PTD_{ICP30} and unfavorable long-term outcome.

Conclusions—PTD_{ICP} may better define one of the insults that the brain suffers after aneurysmal rupture, and exposure to moderate PTD_{ICP30} was significant prognostic factor of 6-month unfavorable outcome. (Stroke. 2015;46:2464-2469. DOI: 10.1161/STROKEAHA.115.010219.)

Key Words: Glasgow Outcome Scale ■ intracranial aneurysm ■ intracranial pressure ■ subarachnoid hemorrhage

Subarachnoid hemorrhage secondary to intracranial aneurysmal rupture (aneurysmal subarachnoid hemorrhage [aSAH]) is a relatively rare but catastrophic cerebrovascular event with high morbidity and mortality.1–3 When the aneurysm ruptures, intracranial pressure (ICP) abruptly rises,4 reducing cerebral perfusion and, in many cases, causing temporary intracranial circulatory arrest. Other mechanisms may produce high ICP (HICP) at different times after the initial bleed, including acute and delayed hydrocephalus, global cerebral edema, intracerebral hematoma, cerebral infarction, or impaired cerebral autoregulation.5 Monitoring and treatment of raised ICP is a reasonable therapeutic target in this clinical setting, as suggested by international guidelines.6–9 Because of the high incidence of acute hydrocephalus, an external ventricular drain (EVD) is the preferred ICP device in aSAH patients as it also allows drainage of cerebrospinal fluid (CSF).7

Even though intracranial hypertension is common after aSAH, only a limited number of studies have assessed the course of ICP and its effects on outcome.10–14 Heuer10 described the relative frequency of this condition in aSAH; 54% had HICP, including a significant proportion (48.7%) with a good clinical grade compared with the 63.6% who were with a poor grade on admission. HICP was associated with poor outcome, particularly where it did not respond to treatment. In a small microdialysis study, HICP was associated with severely deranged cerebral metabolism, namely a pathological increase in lactate/pyruvate ratio and glutamate and glycerol, probably reflecting secondary brain injury.11 Recently, Zoerle12 demonstrated that >80% of aSAH patients suffered at least one episode of HICP in the first week, with the highest mean ICP exceeding 20 mm Hg in 36%. The burden of HICP peaked 3 days after subarachnoid hemorrhage and declined after day

Received June 1, 2015; final revision received June 29, 2015; accepted July 1, 2015.
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Presented in part at the 27th Annual Congress of European Society of Intensive Care Medicine, Barcelona, Spain, September 27–October 1, 2014.
The online-only Data Supplement is available with this article at http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.115.010219/-/DC1.
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Stroke is available at http://stroke.ahajournals.org DOI: 10.1161/STROKEAHA.115.010219

2464
Patients with a highest mean ICP >20 mm Hg were significantly more likely to die. However, when considering a broader spectrum of negative outcomes (including death, vegetative state, and severe disability) at 6 month, ICP was not an independent predictor of an unfavorable outcome.12

Despite the widespread use of ICP monitoring, the precise threshold at which a patient requires treatment for HICP and the impact of the duration of intracranial hypertension remain unclear. The most common threshold for treatment is 20 mm Hg; hence, the method most commonly applied for describing HICP burden is the mean ICP from manually recorded end-hour values. Using computerized systems have been shown to improve accurate identification of HICP.14 In a cohort of aSAH patients in whom at least 120 hours of multimodality monitoring data were available, the proportion of time at which ICP exceeded an insult threshold of >20 and >25 mm Hg, was analyzed alongside secondary insults.15 Univariate analysis demonstrated that HICP increased the risk of clinical deterioration without significant effect on functional outcome. The burden of HICP has recently been more precisely characterized in traumatic brain injury (TBI) using a method that accounts for the cumulative extent and duration of secondary injury by integrating the cumulative dose of secondary injury.16–18 In TBI subjects, PTDICP was associated with mortality and functional outcome at 6 months.16–18

Our study aimed to apply the PTDICP methodology for the first time in aSAH patients to evaluate more precisely the burden of HICP and verify the association between exposure to PTDICP at different thresholds and outcome.

Methods

We retrospectively analyzed digital data prospectively collected over a 3-year period (from September 2010 to June 2013) from an aSAH cohort admitted to the Neurointensive Care Unit (NICU) of San Gerardo Hospital, Monza, Italy. All the data were collected with Innovan Solution Suite (Draeger Medical) that automatically presents and digitally stores data from vital sign monitors, ventilators, and other medical devices. Data were sampled at 150 Hz and averaged every 60 seconds. Our institution’s Ethical Committee reviewed and approved the study. Informed consent was waived because of the retrospective characteristics of the analysis.

Inclusion criteria were the following:

• aSAH amenable to treatment through surgical clipping or endovascular coiling.
• Age ≥18 years.
• Placement of a ventricular catheter plus an intraparenchymal ICP sensor (Codman Microsensor). Our institutional policy encourages placement of both an EVD and an ICP sensor in patients deemed to require continuous CSF drainage because the ventriculostomy is unreliable when the CSF drainage system is frequently/continuously open.19 We usually insert both devices in patients with a World Federation of Neurological Surgeons grading scale (WFNS) ≥23–25 or with a poor Fisher grade (despite clinical presentation) or in patients who suffer of early neuroworsening (within 12–24 hours) after EVD placement. This practice avoids missing data and ICP underestimation during the CSF drainage, which may be more frequent in severe cases. Indeed, ICP recording obtained via an intraparenchymal catheter implanted into the cerebral parenchyma are unaffected by CSF withdrawal.
• Availability of automated high-resolution (minute-by-minute) data.

Exclusion criteria were the following:

• ICP monitoring performed through external ventricular catheter only.
• Subarachnoid hemorrhage of unknown origin.
• Patients who had cardiac arrest, who underwent decompressive craniectomy (or in which a part of the skull was not repositioned at the end of surgical procedure), or whose condition was terminal and in which case end-of-life care was instituted.

Subjects were treated according to current international recommendations,6,7 and the local institutional aSAH policies and procedures are detailed in the online-only Data Supplement.

Baseline demographics and admission Glasgow Coma Scale, Fisher grade,21 WFNS and Hunt Hess scales, and types of treatment were recorded. The database documented the presence of rebleeding, total daily CSF drainage, therapeutic intensity level (TIL; Table I in the online-only Data Supplement), and presence of delayed cerebral ischemia. TIL was used to quantify intensity of ICP-directed therapy and was recorded for each patient on a daily basis. Low TIL includes sedation, CSF withdrawal, mechanical ventilation to obtain moderate hypocapnia (PaCO2 ≥30 mm Hg), or osmotic therapy. High TIL comprises profound hypocapnia (PaCO2 <30 mm Hg) or cerebral metabolic suppression through thipental infusion or controlled hyperthermia (≥36°C). Patients who received high TIL for at least 2 days were included in the high-intensity ICP-directed therapy group, whereas the remaining patients formed the low-intensity ICP-directed therapy group. Delayed cerebral ischemia was defined as the development of new focal neurological signs and deterioration in level of consciousness, lasting for >1 hour, and the appearance of new infarctions on computed tomography or magnetic resonance imaging. ICP was averaged and recorded for each minute through a real-time automated high-resolution system. Outcome measures included length of stay in NICU, in-hospital mortality, and extended Glasgow Outcome Score (GOSE) at hospital discharge and at 6 months. Poor outcome was defined by GOSE ≤4; otherwise, GOSE ≥5 was considered as good outcome.

PTDICP (measured in millimeters of mercury hours, mm Hg h) describes the extent of exposure to an ICP above a predetermined threshold, both in terms of length of time and intensity, describing both the cumulative amplitude and duration of episodes both above and below the selected threshold. See Figure 1 for a graphic

Figure 1. Time course of intracranial pressure (ICP) in 1 patient during the observation period. Dashed line indicates the threshold of 20 mm Hg used to calculate PTDICP. Black area represents PTDICP. Grey area indicates the subthreshold ICP. PTD indicates pressure–time dose.
visualization of PTD_{ICP}. For each patient, PTD_{ICP} was computed from the time of NICU admission to day 7. Four thresholds were defined: 15 mm Hg (PTD_{ICP15}), 20 mm Hg (PTD_{ICP20}), 25 mm Hg (PTD_{ICP25}), and 30 mm Hg (PTD_{ICP30}).

### Statistical Analysis

Population baseline clinical data are expressed as relative frequencies (%) for categorical variables and medians and ranges for continuous variables. To avoid excessive PTD_{ICP} variability because of overstated values in premortem patients who deteriorated despite maximal therapy, PTD_{ICP} calculation was interrupted when ICP values were >50 mm Hg and persisted for >5 minutes without dropping under this threshold.

For each of the ICP thresholds of 20, 25, and 30 mm Hg, patients have been classified into 3 groups depending on the PTD_{ICP} dose as follows: no-dose group (no PTD_{ICP}) for patients with PTD_{ICP} equal to 0 mm Hg, low-dose group (low PTD_{ICP}) for patients with PTD_{ICP} less than or equal to the median value of the PTD_{ICP} distribution, and moderate-dose group (moderate PTD_{ICP}) for patients with PTD_{ICP} greater than the median value of the PTD_{ICP} distribution. For PTD_{ICP} dose, because all patients were exposed to a dose of HICP, we defined only 3 categories: low PTD_{ICP}, moderate PTD_{ICP}, and high PTD_{ICP} according to the 33rd and 66th percentiles of the PTD_{ICP} distribution.

The associations between PTD_{ICP} and other prognostic factors affecting the GOS at NICU discharge have been assessed using univariate logistic regression analyses. The results are presented as odds ratios (ORs) and 95% confidence intervals (CIs). The Cox regression model was applied in an univariate setting to investigate the effects of several prognostic factors affecting the GOS at 6 months, with results presented in terms of hazard ratios (HRs) with 95% CIs. The proportional hazard assumption was tested graphically and through the Kolmogorov-type supremum test. Kaplan–Meier curves for the estimated survival rate stratified according to PTD_{ICP15} and PTD_{ICP25} dose category were compared using the log-rank test. Additional multivariate Cox regression models were used to test the effect of PTD_{ICP} on long-term outcome after adjustment by other prognostic factors at admission. A P value of <0.05 was considered to be statistically significant. All analyses were performed using SPSS 19.0 (SPSS Inc., Chicago, IL) and SAS version 9.2 (SAS Institute, Cary, NC).

### Results

#### Baseline Characteristics

A total of 98 patients were screened in the study period; see flow diagram of study subjects in Figure I in the online-only Data Supplement. Fifty-five patients fulfilled inclusion criteria and were enrolled in the analysis. Five patients were lost to follow-up; hence, outcome data at 6 months was only available for 50 patients. Baseline characteristics, typical for this pathology, are shown in Table. As expected, more female patients were presented, accounting for 67% of study population. Aneurysms of the anterior circle of Willis were more common (82% of patients). Surgical treatment was performed in 56% of cases, whereas endovascular coiling was achieved in 40% of patients. A severe aSAH cohort was selected by the concomitant placement of both EVD and intraparenchymal ICP devices: 76% had a poor-grade clinical presentation (WFNS ≥4) and 97% presented a large aSAH at computed tomography scan as classified by Fisher Grade >3.

#### NICU Stay

Median length of stay in NICU was 16 (2–38) days. Three patients (6% of survivors) were discharged before day 7 with an overall mortality on NICU of 13%, occurring within day 7 in 57% of cases. All patients received therapies to control

### Table. Clinical Characteristics and Outcomes of the Study Subjects

<table>
<thead>
<tr>
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<th>Subjects with aSAH</th>
<th>Age, y</th>
<th>Females/males ratio</th>
<th>Admission revised Fisher grade</th>
<th>Admission WFNS grade</th>
<th>Location of aneurysm</th>
<th>Treatment type</th>
<th>Complications of aSAH</th>
<th>GOSE at discharge</th>
<th>GOSE at 6 mo</th>
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<td>55 (100%)</td>
<td>58 (44–81)</td>
<td>37 (67%)/18 (33%)</td>
<td>1 (2%)</td>
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<td>Anterior circulation</td>
<td>Clipping</td>
<td>Rebleading</td>
<td>1 (deaths) 17 (31%)</td>
<td>8 16 (29%)</td>
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<td>2 (3%)</td>
<td>2 (3%)</td>
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<td>2 (deaths) 1 (2%)</td>
<td>7 6 (11%)</td>
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<td>3 (7%)</td>
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<td>3 (deaths) 7 (13%)</td>
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<td>6 (11%)</td>
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<td>6 (deaths) 5 (9%)</td>
<td>8 16 (29%)</td>
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<td>8 (16%)</td>
<td>8 (16%)</td>
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<td></td>
<td>Lost follow-up 5 (9%)</td>
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</table>

Values are expressed as relative frequencies (%) for categorical variables and as medians (ranges) for continuous variables. aSAH indicates aneurysmal subarachnoid hemorrhage; DCI, delayed cerebral ischemia; GOSE, extended Glasgow outcome score; and WFNS, World Federation of Neurological Surgeons grading scale.
ICP, the requirements for which decreased day to day during the NICU course (see Figure 2). Twenty-six (47%) patients needed high TIL during day 1 compared with 8 patients at the end of the observation period. Therapeutic CSF drainage was applied in 80% of patients, and median daily withdrawal volume was 119 mL (0–360). Delayed cerebral ischemia occurred in 29% and rebleeding in 27% of patients. Delayed cerebral ischemia was not significantly correlated with both short- and long-term outcome, but the incidence was higher in patients having a moderate PTD ICP dose; however, this did not statistically differ across categories of PTD ICP for all the ICP thresholds (see Table II in the online-only Data Supplement).

Intracranial Pressure, Pressure–Time Dose, and Outcome

The median monitoring duration was 8240 (367–9662) minutes per patient, equivalent to the number of ICP data points analyzed for each individual case. 95% of patients had at least one episode of HICP, that is, ICP >20 mm Hg for >5 minutes in the first week, and 7% had a mean ICP >20 mm Hg in the first week. The median value of patient-based mean ICP was 10 mm Hg. Median value of PTD differs according to the predefined ICP threshold: 13 mm Hg h for PTDICP15 (0–2209), 4 mm Hg h for PTDICP20 (0–1962), 2 mm Hg h for PTDICP25 (0–1739), and 1 mm Hg h for PTDICP30 (0–1520).

We observed a decreasing trend of mean cerebral perfusion pressure from the no-dose category to the highest PTDICP dose ranging between 75 and 71 mm Hg, but difference between groups is clinically irrelevant. Patients with a WFNS score ≤3 had better outcomes at NICU discharge (OR 0.19, 95% CI 0.04–0.77, P=0.02) than patients with WFNS ≥4. Intensity of ICP-directed therapy (high versus low, OR 7.23, 95% CI 1.34–39.13, P=0.02) and rebleeding (OR 4.5, 95% CI 1.01–19.96, P=0.05) were significantly related to mortality on NICU. A statistically significant association was observed between this and exposure to a moderate level of PTD using 20 mm Hg (OR 5.97, 95% CI 1.11–32.09, P=0.04), 25 mm Hg (OR 8.00, 95% CI 1.47–43.46, P=0.02), and 30 mm Hg (OR 19.71, 95% CI 2.02–192.69, P=0.01) as ICP thresholds (see Tables II and III in the online-only Data Supplement).

A borderline significant association appeared between exposure to a moderate level of PTD using 20 mm Hg (HR 2.81, 95% CI 1.02–7.74, P=0.05) and 30 mm Hg (HR 3.78, 95% CI 1.19–11.99, P=0.05) as ICP thresholds and mortality at 6 months (see Tables II and III in the online-only Data Supplement). The Kaplan–Meier survival curves of patients with aSAH stratified according to levels of PTDICP20 and PTDICP25 showed a trend of higher mortality if the patients were exposed to low/moderate PTDICP20 and PTDICP25 (Log-Rank test not significant; Figure 3). When combined with different levels of PTDICP exposure in a multivariate Cox regression model, aneurysm of the posterior circle of Willis (HR 0.15, 95% CI 0.03–0.73, P=0.02), rebleeding (HR 3.89, 95% CI 1.38–10.99, P=0.01), and moderate PTDICP30 (HR 3.58, 95% CI 1.30–9.82, P=0.05) were significant prognostic factors of 6-month unfavorable outcome (see Tables IV in the online-only Data Supplement).

Discussion

Our study is the first on evaluation of the PTDICP methodology in a cohort of severe aSAH patients. Episodes of HICP are more frequent in our cohort than in previous series, which may reflect higher data granularity compared with previous series (median value >8000 data points per patient), the ICP system used, and the selection of a severe aSAH group. In the first week after aSAH, therapy for controlling ICP was needed in all patients, albeit with a reduction of its intensity...
during the first days. Considering the standard threshold of 20 mm Hg the median burden (PTDICP20) was 4 mm Hg·h. The exposure to a PTDICP25–30 insult was associated with increased early mortality and, at moderate PTDICP30, long-term negative outcomes.

Although studied extensively in TBI, impact of HICP in aSAH has been analyzed in few studies. Intracranial hypertension is a common secondary insult after aSAH, either during the initial bleed or later on in the course of the condition. Most studies demonstrated a different incidence of HICP, in part as a result of heterogeneous definition, and a variable impact on outcome. Unfortunately, almost all the studies used an EVD connected to an external transducer. In our cohort, external CSF drainage was used in 80% of patients with a median daily withdrawal volume of 141 mL, suggesting that such a strategy may lead to a significant risk of underestimating the actual ICP. Our study is the only one evaluating minute-by-minute ICP via intraparenchymal probe for prolonged periods. This policy allowed us to more frequently record episodes of intracranial hypertension than in other series. The observation that the majority (95%) of patients had at least one episode of high ICP, that is, ICP >20 mm Hg for >5 minutes in the first week, is startling, given only 7% had a mean ICP >20 mm Hg in the first week. This reflects the high granularity of the analyzed samples and that a mean hourly value does not appropriately describe the HICP burden. As we have demonstrated, almost all patients required therapy to control ICP of varying intensity; therefore, mean ICP perhaps more appropriately describes response to this treatment.

We feel we have demonstrated the feasibility of the PTDICP approach in the setting of aSAH. Future studies could use this approach to compare the impact of different thresholds and therapies to control HICP in aSAH. As previously stated, much of the data regarding treatment thresholds for HICP comes from observational studies and noncontrolled series in the setting of TBI. A usual ICP treatment threshold of 20 mm Hg is primarily based on the findings of the Traumatic Data Bank. However, a static and universal ICP threshold of 20 mm Hg in all TBI patients is surely an oversimplification. Given that level I evidence is lacking, we defined 4 incremental thresholds, that is, 15 mm Hg (PTDICP15), 20 mm Hg (PTDICP20), 25 mm Hg (PTDICP25), and 30 mm Hg (PTDICP30), from NICU admission to day 7 to investigate the effect of different dose amount on the outcome.

Our approach used a concept of dose to account for both the level and the duration of any insult, and thus, it may more accurately reflects the impact of HICP. As expected, the median value of PTDICP was progressively lower moving from the lower to the highest levels. In our population, however, we demonstrate an association between exposure to such an insult and a less favorable long-term outcome only for exposure to a moderate level of PTDICP using 30 mm Hg as a threshold. As a confirmation, the multivariate analysis accounting for variables associated with a long-term poor neurological outcome showed that aneurysm located in the anterior circle of Willis, moderate PTDICP30, and rebleeding were associated with a worse outcome. We found a borderline significant association between moderate doses of PTDICP at 20 and 30 mm Hg and 6 months mortality. Our results reinforce the findings of Zoerle et al and question the contribution of HICP on late mortality in aSAH.

Our study has several limitations. First, this is a small single center study and we selected a cohort of severely ill patients. Our study was not powered to detect significant associations in a multivariate fashion; hence, any generalization requires caution. Second, and perhaps more significantly, our entire cohort was treated to maintain ICP <20 mm Hg. Nevertheless, the high granularity and fidelity of our data identified episodes of HICP in almost the entire population. Moreover, we also did not consider any systemic complications of aSAH victims, which may have significant effects on both mortality and secondary injury.

**Summary and Conclusions**

HICP is frequent and plays an important role in the clinical course of aSAH. The dose of ICP may better define one of the insults that the brain suffers after aneurysmal rupture, and exposure to moderate PTDICP30 was significant prognostic factors of 6-month unfavorable outcome. PTDICP approach is feasible in this setting, and this approach could be useful in future studies to compare the impact of different thresholds and therapies to control HICP in aSAH.

**Acknowledgments**

We acknowledge valuable suggestions in the writing of this article by Lara Prisco and Stephen Shepherd. We acknowledge Leonardo Fiori who followed up all the cases at 6 months.

**Sources of Funding**

This study was supported by institutional funds.

**Disclosures**

Dr Citerio participated at educational activities organized by Codman. The other authors report no conflicts.

**References**


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Stroke. 2015;46:2464-2469; originally published online August 4, 2015;
doi: 10.1161/STROKEAHA.115.010219

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://stroke.ahajournals.org/content/46/9/2464

Data Supplement (unedited) at:
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Supplemental Figure I. Flow diagram of study subjects

98 patients

55 were excluded:
- 39 no intraparenchymal catheter
- 3 cardiac arrest
- 1 sile matera SAH

55 patients enrolled

55 patients with GOSE at hospital discharge

5 patients lost to follow up

50 patients with GOSE at 6 months

Poor Outcome 24 patients

Good Outcome 26 patients
**Institutional aSAH policies and procedures**

At admission, after advanced life support and clinical stabilization, a brain computed tomography scan (CT) and a CT angiography were performed in all patients to confirm aSAH diagnosis and to investigate aneurysm location and anatomical features. Severity was classified with the WFNS scale. Bleeding severity was classified accordingly to the modified Fisher scale. Therapeutic plan was decided after collective clinical assessment performed by a neurosurgeon, interventional neuroradiologist and neurointensivist. A digital subtraction angiography was performed if a coiling procedure was scheduled.

Management included early aneurysm clipping or coiling and surgical evacuation of the intracranial hemorrhage if midline shift or mass effects were present. Acute symptomatic hydrocephalus and intraventricular bleeding were treated by CSF drainage through the EVD, whilst ICP were continuously monitored through the intraparenchymal sensor. EVD and CSF drainage were managed according to neurological and clinical characteristics, iconographic findings and ICP level. Both devices were promptly replaced in case of malfunction. Neurological exam was performed at least three times a day until NICU discharge.

The following bundles are adopted routinely in aSAH patients:

- Patients positioning (30° head elevation to control ICP);
- ICP kept <20 mmHg through an incremental steps therapy. See below Institutional aSAH Therapeutic Intensity Level;
- An arterial oxygen partial pressure (pO₂) greater than 90 mmHg and carbon dioxide partial pressure (pCO₂) 35 mmHg or progressively lower if needed to control ICP;
- A cerebral perfusion pressure (CPP) greater than 65 mmHg (arterial line pressure transducer was zeroed at the level of external acoustic meatus). Pressure autoregulation status was evaluated routinely (Consonni, F., Abate, M. G., Galli, D., & Citerio, G. (2009). Feasibility of a continuous computerized monitoring of cerebral autoregulation in neurointensive care. Neurocritical Care, 10(2), 232–240. http://doi.org/10.1007/s12028-008-9151-2);
- Blood glucose level was maintained around 8 mmol/l and plasma sodium above 140 mEq/L. Sodium balance disorders were aggressively treated;
Normothermia was targeted with continuous diclofenac iv infusion, if needed (Cormio, M., & Citerio, G. (2007). Continuous low dose diclofenac sodium infusion to control fever in neurosurgical critical care. *Neurocritical Care*, 6(2), 82–89.);

No antiepileptic drugs were administered prophylactically and frequent electroencephalograms were performed;

Oral nimodipine (60 mg every 4 hours) was administered after SAH for a period of 21 days, except in case of hypotension (CPP < 60 mmHg);

A restrictive transfusion policy was adopted;

Hemodynamic monitoring was performed through an arterial line, central venous monitoring and echocardiography. In case of severe hemodynamic impairment or myocardial stunning a transpulmonary thermodilution indicator technique was implemented;

A CT scan was performed within the day 3 after treatment to recognize early complications;

To prompt detection of vasospasm a transcranial Doppler ultrasound (TCD) was taken routinely until day 10 and cerebral perfusion CT (CPCT) was usually performed between day 4 and 5 and repeated later in case of clinical suspicion. Patients underwent a cerebral angiography if TCD velocities were higher than 120 cm/sec or mean transit time augmented (> 6 seconds) and cerebral blood flow reduced (< 18 ml/hg/min) at perfusion CT. In case of vasospasm (defined as arterial narrowing greater than 20% than baseline), an aggressive strategy consisting of medical treatment (sedation and blood pressure rise after cardiac volume optimization) and interventional procedure (intermittent or continuous intrarterial nimodipine) were employed.
**Supplemental table I. Institutional aSAH Therapeutic Intensity Level**

<table>
<thead>
<tr>
<th>TIL 0 (No specific ICP-directed therapy)</th>
<th>Low TIL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIL 1 (Basic ICU care)</strong></td>
<td></td>
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<tr>
<td>Sedation for ventilator/endotracheal tube tolerance</td>
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<tr>
<td>Volume/vasoactives for non-CNS cause (e.g., sepsis, myocardial injury)</td>
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<tr>
<td>Head-up positioning (ventilator bundle)</td>
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<tr>
<td>Normocapnia (PaCO$_2$ $\geq$ 40 mm Hg)</td>
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</table>

<table>
<thead>
<tr>
<th>TIL 2</th>
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<tbody>
<tr>
<td>Higher levels of sedation</td>
<td></td>
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<tr>
<td>Vasopressors/volume for CPP support</td>
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<tr>
<td>Low-dose osmotic therapy (less than two doses in 24 hours of mannitol 18% 100 ml or hypertonic saline 7.5% 100 ml)</td>
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<tr>
<td>Mild hypocapnia (PaCO$_2$ 35–40 mm Hg)</td>
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<tr>
<td>CSF drainage</td>
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<thead>
<tr>
<th>TIL 3</th>
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<tbody>
<tr>
<td>Higher doses of osmotic therapy</td>
<td></td>
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<tr>
<td>Moderate hypocapnia (PaCO$_2$ 30–35 mmHg)</td>
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<thead>
<tr>
<th>TIL 4</th>
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<tr>
<td>Profound hypocapnia (PaCO$_2$ $&lt;$ 30 mmHg)</td>
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<tr>
<td>Active controlled hypothermia ($&lt;$ 36°C)</td>
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<tr>
<td>Cerebral metabolic suppression (continuous iv infusion of thiopental sodium at increasing doses until burst suppression pattern on continuous electroencephalography)</td>
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</table>

Supplemental table II. Univariate logistic regression analysis for poor outcome and mortality at NICU discharge

Univariate logistic regression analysis for poor outcome and mortality at NICU discharge according to several prognostic risk factors, including different levels of PTD (i.e. PTD_{ICP15}, PTD_{ICP20}, PTD_{ICP25} and PTD_{ICP30}) as defined by different predefined ICP threshold (15, 20, 25 and 30 mmHg). Values are expressed as relative frequencies (%) for categorical variables and medians (ranges) for continuous factors.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Outcome at NICU discharge (n=55)</th>
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<th>Mortality at NICU discharge (n=55)</th>
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<td></td>
<td>Poor (n=29)</td>
<td>Favourable (n=26)</td>
<td>OR (95% CI)</td>
<td>P</td>
<td>Deaths (n=9)</td>
<td>OR (95% CI)</td>
<td>P</td>
</tr>
<tr>
<td>Age, years</td>
<td>61 (44-80)</td>
<td>57 (46-81)</td>
<td>1.02 (0.96-1.07)</td>
<td>0.57</td>
<td>57 (50-80)</td>
<td>1.01 (0.94-1.09)</td>
<td>0.79</td>
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<tr>
<td>Female</td>
<td>17 (59%)</td>
<td>20 (77%)</td>
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<td>Male</td>
<td>12 (41%)</td>
<td>6 (23%)</td>
<td>2.35 (0.73-7.61)</td>
<td>0.15</td>
<td>3 (33%)</td>
<td>1.03 (0.23-4.71)</td>
<td>0.97</td>
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<tr>
<td>2-3</td>
<td>4 (14%)</td>
<td>5 (19%)</td>
<td>0.67 (0.16-2.83)</td>
<td>0.59</td>
<td>3 (33%)</td>
<td>3.33 (0.65-17.01)</td>
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<tr>
<td>1-2-3</td>
<td>3 (10%)</td>
<td>10 (38%)</td>
<td>0.19 (0.04-0.77)</td>
<td>0.02*</td>
<td>1 (11%)</td>
<td>0.35 (0.04-3.14)</td>
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<td>1-2-3</td>
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<td>10 (38%)</td>
<td>0.19 (0.04-0.77)</td>
<td>0.02*</td>
<td>2 (22%)</td>
<td>0.91 (0.16-5.03)</td>
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<td>PTD_{ICP15}, mmHg*h</td>
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<td>High PTD_{ICP15} (&gt;26 mmHg*h)</td>
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<td>PTD_{ICP20}, mmHg*h</td>
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* p < 0.05, ** p < 0.01
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<th>Moderate PTD&lt;sub&gt;ICP20&lt;/sub&gt; (&gt;5 mmHg*h)</th>
<th>PTD&lt;sub&gt;ICP25&lt;/sub&gt;, mmHg*h</th>
<th>No PTD&lt;sub&gt;ICP25&lt;/sub&gt; (0 mmHg*h)</th>
<th>Low PTD&lt;sub&gt;ICP25&lt;/sub&gt; (0&lt; mmHg*h ≤2)</th>
<th>Moderate PTD&lt;sub&gt;ICP25&lt;/sub&gt; (&gt;2 mmHg*h)</th>
<th>PTD&lt;sub&gt;ICP30&lt;/sub&gt;, mmHg*h</th>
<th>No PTD&lt;sub&gt;ICP30&lt;/sub&gt; (0 mmHg*h)</th>
<th>Low PTD&lt;sub&gt;ICP30&lt;/sub&gt; (0&lt; mmHg*h ≤3)</th>
<th>Moderate PTD&lt;sub&gt;ICP30&lt;/sub&gt; (&gt;3 mmHg*h)</th>
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<tr>
<td></td>
<td>13 (45%)</td>
<td>11 (42%)</td>
<td>2 (0-1739)</td>
<td>6 (21%)</td>
<td>12 (41%)</td>
<td>11 (38%)</td>
<td>1 (0-1520)</td>
<td>11 (38%)</td>
<td>10 (34%)</td>
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<td>11 (42%)</td>
<td>11 (42%)</td>
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<td>6 (23%)</td>
<td>10 (38.5%)</td>
<td>10 (38.5%)</td>
<td>0.5 (0-46)</td>
<td>13 (50%)</td>
<td>8 (31%)</td>
<td>5 (19%)</td>
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<td>1.58 (0.29-8.61)</td>
<td>1.01 (0.99-1.03)</td>
<td>1.20 (0.29-4.91)</td>
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<td>1.01 (0.98-1.04)</td>
<td>1.01 (0.98-1.04)</td>
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<td>1.89 (0.48-7.49)</td>
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<td>0.86</td>
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<td>1.20 (0.29-4.91)</td>
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<td>2 (Reference)</td>
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<td>7 (78%)</td>
<td>29 (1-1739)</td>
<td>7 (78%)</td>
<td>7 (78%)</td>
<td>22 (0-1520)</td>
<td>1 (11%)</td>
<td>2 (22%)</td>
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<td>5.97 (1.11-32.09)</td>
<td>1.04 (0.96-1.12)</td>
<td>8.00 (1.47-43.46)</td>
<td>1.04 (0.96-1.13)</td>
<td>1.04 (0.96-1.13)</td>
<td>1 (Reference)</td>
<td>2.88 (0.24-34.46)</td>
<td>19.71 (2.02-192.69)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.04*</td>
<td></td>
<td>0.02*</td>
<td>0.36</td>
<td>0.36</td>
<td></td>
<td>0.01*</td>
<td></td>
</tr>
</tbody>
</table>

‡ Defined as high when a patient received high TIL for at least 2 days.

<sup>a</sup> PTD<sub>ICP15</sub> was categorized as low PTD<sub>ICP15</sub> (≤33<sup>rd</sup> percentile of PTD<sub>ICP15</sub> distribution), moderate PTD<sub>ICP15</sub> (33<sup>rd</sup> percentile< mmHg*h ≤66<sup>th</sup> percentile of PTD<sub>ICP15</sub> distribution) and high PTD<sub>ICP15</sub> (>66<sup>th</sup> percentile of PTD<sub>ICP15</sub> distribution).

<sup>b</sup> PTD<sub>ICP</sub> dose at different thresholds, i.e. 20, 25 and 30 mmHg, was categorized as no PTD<sub>ICP</sub> (0 mmHg*h), low PTD<sub>ICP</sub> (0< mmHg*h ≤50<sup>th</sup> percentile of PTD<sub>ICP</sub> distribution) and moderate PTD<sub>20</sub> (>50<sup>th</sup> percentile of PTD<sub>ICP</sub> distribution).

* Statistically significant at α=0.05.

§ The information was missing for a patient in the favourable outcome group.
Supplemental table III. Univariate Cox regression analysis for poor outcome and mortality at 6 months

Univariate Cox regression analysis for poor outcome and mortality at 6 months according to several prognostic risk factors, including different levels of PTD (i.e. PTD\textsubscript{ICP15}, PTD\textsubscript{ICP20}, PTD\textsubscript{ICP25} and PTD\textsubscript{ICP30}) as defined by different predefined ICP threshold (15, 20, 25 and 30 mmHg). Values are expressed as relative frequencies (%) for categorical variables and medians (ranges) for continuous factors.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Outcome at 6 months (n=50\textsuperscript{†})</th>
<th>Mortality at 6 months (n=50\textsuperscript{†})</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor (n=24)</td>
<td>Favourable (n=26)</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>Age, years</td>
<td>58 (46-80)</td>
<td>61 (46-81)</td>
<td>1.00 (0.96-1.05)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>16 (67%)</td>
<td>17 (65%)</td>
<td>1 (Reference)</td>
</tr>
<tr>
<td>Male</td>
<td>8 (33%)</td>
<td>9 (35%)</td>
<td>1.06 (0.45-2.50)</td>
</tr>
<tr>
<td>Fisher grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20 (83%)</td>
<td>21 (81%)</td>
<td>1 (Reference)</td>
</tr>
<tr>
<td>2-3</td>
<td>4 (17%)</td>
<td>5 (19%)</td>
<td>1.13 (0.38-3.32)</td>
</tr>
<tr>
<td>WFNS grading scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>22 (92%)</td>
<td>17 (65%)</td>
<td>1 (Reference)</td>
</tr>
<tr>
<td>1-2-3</td>
<td>2 (8%)</td>
<td>9 (35%)</td>
<td>0.27 (0.06-1.16)</td>
</tr>
<tr>
<td>Hunt and Hess scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>21 (87.5%)</td>
<td>18 (69%)</td>
<td>1 (Reference)</td>
</tr>
<tr>
<td>1-2-3</td>
<td>3 (12.5%)</td>
<td>8 (31%)</td>
<td>0.45 (0.14-1.53)</td>
</tr>
<tr>
<td>Aneurysm location</td>
<td>Anterior</td>
<td>Posterior</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22 (92%)</td>
<td>19 (73%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>0.42 (0.10-1.78)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 (88%)</td>
<td>2 (12%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>0.66 (0.15-2.92)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment type</th>
<th>Clipping</th>
<th>Coiling</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16 (67%)</td>
<td>6 (25%)</td>
<td>2 (8%)</td>
</tr>
<tr>
<td></td>
<td>11 (42%)</td>
<td>15 (58%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>0.46 (0.18-1.20)</td>
<td>N.A.</td>
</tr>
<tr>
<td></td>
<td>11 (65%)</td>
<td>4 (24%)</td>
<td>2 (11%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>0.50 (0.16-1.60)</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intensity of ICP-directed therapy‡</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 (50%)</td>
<td>12 (50%)</td>
</tr>
<tr>
<td></td>
<td>19 (73%)</td>
<td>7 (27%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>2.29 (1.01-5.20)</td>
</tr>
<tr>
<td></td>
<td>6 (35%)</td>
<td>11 (65%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>3.99 (1.44-11.02)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Re-bleeding</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17 (71%)</td>
<td>7 (29%)</td>
</tr>
<tr>
<td></td>
<td>21 (81%)</td>
<td>5 (19%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>2.04 (0.84-4.97)</td>
</tr>
<tr>
<td></td>
<td>10 (59%)</td>
<td>7 (41%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>3.32 (1.23-8.96)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Delayed cerebral ischemia§</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15 (62.5%)</td>
<td>9 (37.5%)</td>
</tr>
<tr>
<td></td>
<td>21 (84%)</td>
<td>4 (16%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>1.71 (0.74-3.95)</td>
</tr>
<tr>
<td></td>
<td>13 (76%)</td>
<td>4 (24%)</td>
</tr>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>0.89 (0.29-2.75)</td>
</tr>
</tbody>
</table>

| Average daily drained CSF, mL | 98 (1-183) | 130 (0-241) |
|                              | 0.99 (0.99-1.00) | 1.00 (0.99-1.00) |
|                              | 0.08 | 0.00 |
|                              | 111 (41-183) | 1.00 (0.99-1.00) |

| PTD_{ICP15}, mmHg*h | 16 (3-2209) | 13 (0-147) |
|                     | 1.00 (1.00-1.01) | 1.01 (1.00-1.01) |
|                     | 0.04* | 0.07 |
|                     | 37 (3-2209) | 1.01 (1.00-1.01) |

<table>
<thead>
<tr>
<th>Low PTD_{ICP15} (≤7 mmHg*h)</th>
<th>7 (29%)</th>
<th>11 (42%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate PTD_{ICP15} (7&lt;mmHg*h ≤26)</th>
<th>7 (29%)</th>
<th>9 (35%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.43 (0.48-4.26)</td>
<td>4 (23.5%)</td>
</tr>
</tbody>
</table>

<p>|                             | 4 (23.5%) | 1.62 (0.36-7.26) |</p>
<table>
<thead>
<tr>
<th>PTD_{ICP20}, mmHg*h</th>
<th>No PTD_{ICP20} (0 mmHg*h)</th>
<th>Low PTD_{ICP20} (0&lt; mmHg*h ≤5)</th>
<th>Moderate PTD_{ICP20} (&gt;5 mmHg*h)</th>
<th>PTD_{ICP25}, mmHg*h</th>
<th>No PTD_{ICP25} (0 mmHg*h)</th>
<th>Low PTD_{ICP25} (0&lt; mmHg*h ≤2)</th>
<th>Moderate PTD_{ICP25} (&gt;2 mmHg*h)</th>
<th>PTD_{ICP30}, mmHg*h</th>
<th>No PTD_{ICP30} (0 mmHg*h)</th>
<th>Low PTD_{ICP30} (0&lt; mmHg*h ≤3)</th>
<th>Moderate PTD_{ICP30} (&gt;3 mmHg*h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High PTD_{ICP15} (&gt;26 mmHg*h)</td>
<td>10 (42%)</td>
<td>6 (23%)</td>
<td>3.04 (1.10-8.40)</td>
<td>0.08</td>
<td>9 (53%)</td>
<td>5.13 (1.38-19.04)</td>
<td>0.02*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTD_{ICP20}, mmHg*h</td>
<td>5 (0-1962)</td>
<td>4 (0-62)</td>
<td>1.01 (1.00-1.01)</td>
<td>0.05*</td>
<td>10 (1-1962)</td>
<td>1.01 (1.00-1.01)</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No PTD_{ICP20} (0 mmHg*h)</td>
<td>1 (4%)</td>
<td>4 (16%)</td>
<td>1 (Reference)</td>
<td>0 (0%)</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low PTD_{ICP20} (0&lt; mmHg*h ≤5)</td>
<td>12 (50%)</td>
<td>11 (42%)</td>
<td>3.52 (0.45-27.27)</td>
<td>7 (41%)</td>
<td>2 (12%)</td>
<td>1 (Reference)</td>
<td>2 (12%)</td>
<td>1.52 (0.29-7.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PTD_{ICP20} (&gt;5 mmHg*h)</td>
<td>11 (46%)</td>
<td>11 (42%)</td>
<td>4.60 (0.59-35.69)</td>
<td>0.33</td>
<td>10 (59%)</td>
<td>2.81 (1.02-7.74)</td>
<td>0.05*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTD_{ICP25}, mmHg*h</td>
<td>2 (0-1739)</td>
<td>1 (0-47)</td>
<td>1.01 (1.00-1.01)</td>
<td>0.05*</td>
<td>3 (0-1739)</td>
<td>1.01 (1.00-1.01)</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No PTD_{ICP25} (0 mmHg*h)</td>
<td>4 (16%)</td>
<td>7 (27%)</td>
<td>1 (Reference)</td>
<td>2 (12%)</td>
<td>6 (35%)</td>
<td>1.52 (0.29-7.82)</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low PTD_{ICP25} (0&lt; mmHg*h ≤2)</td>
<td>10 (42%)</td>
<td>9 (35%)</td>
<td>1.39 (0.43-4.51)</td>
<td>6 (35%)</td>
<td>2 (12%)</td>
<td>1 (Reference)</td>
<td>2 (12%)</td>
<td>1.52 (0.29-7.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PTD_{ICP25} (&gt;2 mmHg*h)</td>
<td>10 (42%)</td>
<td>10 (38%)</td>
<td>1.94 (0.61-6.19)</td>
<td>0.51</td>
<td>9 (53%)</td>
<td>3.42 (0.74-15.85)</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTD_{ICP30}, mmHg*h</td>
<td>1 (0-1520)</td>
<td>0 (0-46)</td>
<td>1.01 (1.00-1.02)</td>
<td>0.08</td>
<td>1 (0-1520)</td>
<td>1.01 (1.00-1.02)</td>
<td>0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No PTD_{ICP30} (0 mmHg*h)</td>
<td>8 (33.3%)</td>
<td>14 (54%)</td>
<td>1 (Reference)</td>
<td>5 (29.5%)</td>
<td>1 (Reference)</td>
<td>1 (Reference)</td>
<td>2 (12%)</td>
<td>1.52 (0.29-7.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low PTD_{ICP30} (0&lt; mmHg*h ≤3)</td>
<td>8 (33.3%)</td>
<td>7 (27%)</td>
<td>1.39 (0.51-3.85)</td>
<td>5 (29.5%)</td>
<td>2 (12%)</td>
<td>1 (Reference)</td>
<td>2 (12%)</td>
<td>1.52 (0.29-7.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PTD_{ICP30} (&gt;3 mmHg*h)</td>
<td>8 (33.3%)</td>
<td>5 (19%)</td>
<td>2.73 (1.02-7.31)</td>
<td>0.13</td>
<td>7 (41%)</td>
<td>3.78 (1.19-11.99)</td>
<td>0.05*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† 50 patients out of 55 were considered since for 5 patients lost to follow-up outcome data at 6 months were not available.
‡ Defined as high when a patient received high TIL for at least 2 days.

a PTD_{ICP15} was categorized as low PTD_{ICP15} (<33th percentile of PTD_{ICP15} distribution), moderate PTD_{ICP15} (33th percentile< mmHg*h ≤66th percentile of PTD_{ICP15} distribution) and high PTD_{ICP15} (>66th percentile of PTD_{ICP15} distribution).
b PTD_{ICP} dose at different thresholds, i.e. 20, 25 and 30 mmHg, was categorized as no PTD_{ICP} (0 mmHg*h), low PTD_{ICP} (0< mmHg*h ≤50th percentile of PTD_{ICP} distribution) and moderate PTD_{ICP20} (>50th percentile of PTD_{ICP} distribution).

* Statistically significant at α=0.05.
§ The information was missing for a patient in the favourable outcome group.
Supplemental table IV. Multivariate Cox regression models of admission variables and PTDICP15, PTDICP20, PTDICP25 and PTDICP30 with poor outcome at 6 months (as defined by GOS≤4) as the dependent variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Outcome at 6 months (n=50†)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor (n=29)</td>
<td>Favourable (n=26)</td>
</tr>
<tr>
<td>Aneurysm location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>22 (92%)</td>
<td>19 (73%)</td>
</tr>
<tr>
<td>Posterior</td>
<td>2 (8%)</td>
<td>7 (27%)</td>
</tr>
<tr>
<td>Re-bleeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 (71%)</td>
<td>21 (81%)</td>
</tr>
<tr>
<td>Yes</td>
<td>7 (29%)</td>
<td>5 (19%)</td>
</tr>
<tr>
<td>No PTDICP30 (0 mmHg*h)</td>
<td>8 (33.3%)</td>
<td>14 (54%)</td>
</tr>
<tr>
<td>Low PTDICP30 (0&lt; mmHg*h ≤3)</td>
<td>8 (33.3%)</td>
<td>7 (27%)</td>
</tr>
<tr>
<td>Moderate PTDICP30 (&gt;3 mmHg*h)</td>
<td>8 (33.3%)</td>
<td>5 (19%)</td>
</tr>
</tbody>
</table>

† 50 patients out of 55 were considered since for 5 patients lost to follow-up outcome data at 6 months were not available.

a PTDICP30 was categorized as no PTDICP30 (0 mmHg*h), low PTDICP30 (0< mmHg*h ≤50th percentile of PTDICP30 distribution) and moderate PTDICP30 (>50th percentile of PTDICP distribution).

* Statistically significant at α=0.05.