Supplemental Material

Predicting the Lack of Development of Delayed Cerebral Ischemia after Aneurysmal Subarachnoid Hemorrhage

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Summary of management protocol for patients with aneurysmal subarachnoid hemorrhage at Mayo Clinic, Rochester

Upon admission all patients are treated with intravenous crystalloids to maintain euvoemia and started on nimodipine 60 mg every 4 hours. Analgesics and antiemetics are given avoiding excessive sedation. We do not start anticonvulsant unless there is evidence of seizures. Antifibrinolytics (tranexamic acid 1 gram intravenously every 6 hours) are used for most patients until the aneurysm is secured and never exceeding 72 hours. We do not prescribe statins for prevention of delayed ischemic damage, as it is a therapy still under investigation for this indication, but do continue the drug if being used before aneurysm rupture. Until aneurysm treatment, we keep the systolic blood pressure < 160 mm Hg carefully avoiding precipitous drops. All patients are evaluated with a chest X-ray and an electroencephalogram; if signs of cardiopulmonary compromise are present, arterial blood gases and an emergency transthoracic echocardiogram are obtained. In case of early clinical deterioration, patients have a repeat CT scan of the brain to exclude hydrocephalus or rebleeding. Our initial resuscitation paradigm includes immediate establishment of cerebrospinal fluid diversion (by means of ventriculostomy or lumbar drainage) and cardiopulmonary stabilization with fluids, vasopressors, inotropes, oxygen, and mechanical ventilation as indicated.

Once the patient is stable, a cerebral angiogram is obtained to determine the source of bleeding. Selection of treatment with craniotomy and clipping or endovascular coil occlusion results from a consensus reached between the treating vascular neurosurgeon and the neurointerventionalist after analyzing risks and chances of success.
of both therapeutic modalities on each particular case. When both procedures are deemed feasible, patients are generally coiled.

After the aneurysm treatment is accomplished, the patient is kept in our Neuroscience ICU under close neurological monitoring. Starting on the third or fourth day after bleeding, transcranial Doppler is performed every day or every other day depending on the perceived risk of vasospasm. A repeat cerebral angiogram is usually performed between post-bleeding days 6 and 8. In case of symptoms suspicious of delayed cerebral ischemia, a CT perfusion may be done to evaluate for hypoperfusion. CT angiograms are done at the same time to evaluate for arterial narrowing.

Treatment of delayed cerebral ischemia relies on the induction of hypertension with vasopressors (usually phenylephrine or norepinephrine). We initially titrate the vasopressor dose to raise the mean arterial pressure by 20%. Subsequent dose adjustments are based on symptom response. Fluids are used to keep the patients euvoletic to mildly hypervolemic. Occasionally we use dobutamine for optimization of cardiac output (cardiac index > 3.5). If symptoms do not improve within 2-3 hours (sooner in severe cases with focal deficits or severe decline in level of consciousness and proven severe vasospasm), patients are taken to the angiographic suite for possible angioplasty or intra-arterial infusion of a calcium channel blocker.

Hyponatremia is treated with hypertonic saline (1.5% or 3% sodium chloride depending on its severity) and fludrocortisone. Sodium acetate is used instead when hyperchloremic acidosis develops. In cases of severe polyuria, we add albumin 5% 200 cc every 4 or 6 hours. The hemoglobin concentration triggering transfusion is 8 g/dL. In
patients with ischemic symptoms we strive to keep the hemoglobin concentration above 9 g/dL.

**Main practice changes over the last decade**

Trend towards more cases treated with coiling

Re-introduction of anti-fibrinolytics over the last 3 years

Less reliance on induced hypervolemia in favor or hypertension for patients having DCI

Use of CT perfusion over the last 3 years