Resource-Limited ENLS
Subarachnoid Hemorrhage

Critical gaps in resource-limited settings: The standard of care for management of aneurysmal subarachnoid hemorrhage (SAH) developed in high-income countries (HICs) is resource-intensive, drawing on subspecialized expertise from neurosurgeons, neurointerventionalists, and neurointensivists, and necessitating a broad range of high-cost diagnostic and therapeutic modalities that are unavailable in many low- and middle-income country (LMIC) healthcare settings. Resource gaps in LMICs affect the full spectrum of care, from pre-hospital management to acute stabilization, aneurysm treatment, critical care management of vasospasm and other secondary complications, and rehabilitation. Key branch points in SAH management in resource-limited settings include access to vessel imaging, ventriculostomy, aneurysm securement, and management of vasospasm.

Pre-hospital care: Patients presenting with symptoms of SAH should be treated at the highest available level of care, ideally a referral hospital with neurosurgical and neurology expertise, and an ICU capable of mechanical ventilation and ventriculostomy. For patients with impaired consciousness, all efforts should be made to minimize risk of aspiration by suctioning secretions and maintaining head-of-bed elevation before the patient's airway can be secured in a controlled inpatient environment. For patients who present initially to a lower-level health care facility such as a clinic or community hospital, IV access should be established and IV antihypertensive medications should be given as available to maintain a systolic blood pressure (SBP) goal of <160mmHg. If possible, the transferring provider at a peripheral health care facility should notify the referral hospital of the patient's arrival to minimize time to intubation and neurosurgical evaluation. The patient should be transported by ambulance if available; if an ambulance is unavailable, all feasible efforts should be made to maintain head-of-bed elevation and minimize noxious stimuli during transit.

Early inpatient management: As with all neurologic emergencies, patients with symptoms of SAH should undergo an evaluation of the circulation, airway and breathing upon arrival to the emergency department, and patients with impaired consciousness or other airway compromise should be intubated without delay. IV access should be established, and antihypertensive medications should be administered as needed for a goal SBP of <160mmHg. Most resource-limited settings lack IV antihypertensive infusions such as nicardipine as well as the ability to monitor blood pressure in real time via arterial line. During the hyperacute period of early stabilization, the blood pressure should be measured manually or by automated cuff if available every 15 minutes to detect increases in SBP that could precipitate aneurysm re-rupture. All patients with symptoms of SAH should receive a non-contrast head CT as soon as possible to assess hemorrhage burden and evidence of hydrocephalus. Patients with an unrevealing CT should undergo lumbar puncture to further evaluate for blood in the CSF and xanthochromia. Seizure prophylaxis should be initiated when high-risk features are present, ideally with an IV-loadable anti-seizure medication, and continued until the aneurysm is secured. If the aneurysm cannot be secured, seizure prophylaxis can be continued for 7-14 days after the ictus, acknowledging the lack of published evidence to guide treatment duration in this context.

The treatment pathways for patients with SAH in resource-limited settings will be largely determined by access to neurosurgical capacity for aneurysm securement. Surgical aneurysm clipping and endovascular coiling are unlikely to be feasible in many LMICs, and to the extent that they are, they are typically available only in large urban teaching hospitals. Where one or both of these treatment modalities are available, patients should undergo urgent vessel imaging with CT angiography or conventional angiography to guide treatment planning for aneurysm

securement. Where surgical interventions for aneurysm securement are not available, angiography may be considered but is less likely to guide immediate management and its utility should be weighed against considerations of cost to the patient.

CSF diversion with an external ventricular drain (EVD) should be performed as available for patients with evidence of hydrocephalus and impaired consciousness. Many resource-limited ICUs that have access to EVD lack ICP transducers and manometers set precise drainage parameters, as well as standardized protocols for infection prevention and EVD weaning. In these circumstances, clinicians should follow their institutional practices for EVD management, with the aim of titrating CSF drainage to treat hydrocephalus while avoiding overdrainage.

Vasospasm management: Neurologic monitoring for vasospasm in resource-limited settings is likely to depend primarily on the bedside examination, and patients with SAH should be admitted to an ICU where they can undergo neurologic examination every hour, or at the maximum feasible frequency to detect changes in neurologic function in real time. When available, nimodipine should be administered for a 21-day course to lower risk of delayed cerebral ischemia. In settings that lack capacity to secure ruptured aneurysms, blood pressure elevation poses the risk of re-rupture. Because re-rupture is associated with high risk of mortality, the use of vasopressors for blood pressure augmentation should be reserved only for patients with secure aneurysms. Hypovolemia should be strictly avoided and close monitoring of the urine output or daily weights should be used to guide fluid resuscitation strategies.