

**OHSU HEALTH CARE SYSTEM  
PRACTICE GUIDELINES**

**Acute Stroke Practice Guidelines for Inpatient Management of Subarachnoid Hemorrhage, PS 01.20**

Last Reviewed Date: 1/29/10

**POLICY**

OHSU Hospitals and Clinics have adopted this practice standard in order to delineate a consistent, evidenced-based approach to treating the patient who presents with signs and symptoms consistent with acute non-traumatic Subarachnoid Hemorrhage (SAH). Although this standard assists in guiding care, responsibility to determine appropriate care for each individual remains with the provider themselves.

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| Outcomes/<br>goals  | <p>Create a multi-disciplinary, evidence-based, approach to the management of acute non-traumatic subarachnoid hemorrhage (SAH) patients.</p> <p>Patient plan of care to take into consideration the entire continuum of care from emergency department through rehabilitation.</p>   |
| Physician           | <p>1. Determine the appropriate unit for admission.</p> <p><b>Admission Criteria for Neurosciences ICU</b></p> <p>a. All acute non-traumatic subarachnoid hemorrhage patients (CT or LP positive) will be admitted to the NSICU.</p> <p>b. Patients with only incidentally found unruptured aneurysms do not need ICU care, unless routine post-op ICU care is required, and may be admitted to 10K. (</p>  |
| Physician           | <p>2. Complete appropriate physician order set in EPIC:</p> <p>a) NSG: Aneurysmal Subarachnoid Hemorrhage Orders.</p> <p>b) NSG: Craniotomy for Aneurysm: ICU post-op Orders.</p> <p>c) NeuroInterventional Radiology: Ruptured Aneurysm: Post Embolization Orders.</p> <p>d) NSICU: Daily care orders on rounds. Admission orders must include: CBC, CMP (complete metabolic set), PT/INR/PTT, lipid panel, cardiac enzymes, urine toxicology, CXR and EKG. Transthoracic echocardiogram (TTE) and BNP (B-natriuretic peptide) optional. Activity and diet orders, code status, GI and DVT prophylaxis must also be addressed.</p> |
| Pharmacy,<br>and RN | <p>3. Process physician orders according to OHSU policy.</p>  |
| RN                  | <p>4. Complete admission database and initiate nursing plan of care according to the OHSU Adult Inpatient Standards of Care.</p> <p><a href="http://ozone.ohsu.edu/healthsystem/nursing/policy/soc/details/104soc.pdf">http://ozone.ohsu.edu/healthsystem/nursing/policy/soc/details/104soc.pdf</a></p>   |

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|                       | <p>5. Perform focused neurological assessments based on patient condition and physician orders, every 1-2 hour while in the ICU and every 2-4 hours in acute care.</p> <p>6. Neurological assessment to include at a minimum: Glasgow Coma Scale (GCS), level of alertness, orientation, pupil reactivity, speech, visual fields, strength based on drift, hand grip, and foot movement. Physician to be notified for any change on exam; notification to be documented.</p> <p>7. Central venous pressure (CVP), intracranial pressure (ICP), and partial brain tissue oxygen (PbtO<sub>2</sub>) to be recorded hourly, if monitor in place.</p> <p>8. Provide a quiet, low light, environment for the patient. Strict bed rest until aneurysm secured, less stringent activity restrictions in setting of non-aneurysmal perimesencephalic or cortical SAH.</p> <p>9. Cautious sedation if intubated, analgesia preferably with non-opiates in non-intubated patients.</p> <p>10. Anti-emetics as needed.</p>  |
| Physician             | <p>11. Evaluate for loss of airway protection and need for intubation. Intubation recommended for GCS &lt; 8 and patients with significantly deteriorating GCS (i.e. Hunt &amp; Hess Scale 4, 5 and select Hunt &amp; Hess 3).</p> <p>12. Consider nasogastric tube insertion to reduce risk of aspiration.</p>  |
| Physician, RN, and RT | <p>13. Maintain oxygenation saturation greater than or equal to at least 93% (optimal &gt; 95% with PaO<sub>2</sub> &gt; 70 mmHg especially in high grade SAH) and adequate ventilation. Avoid prophylactic or prolonged hyperventilation. If 'lung protective ventilation' instituted for ALI/ ARDS, permissive hypercarbia is strongly discouraged; use ET-CO<sub>2</sub>, correlate with ABG reading at least once daily, (goal 35-45).</p>   |
| Physician and RN      | <p><b>(ORDERS PLACED) PRIOR to SECURING ANEURYSM</b></p> <p>14. Keep mean arterial pressure (MAP) &gt; 70 and systolic blood pressure &lt; 140 in patients with no concern for elevated ICP; MAP &gt; 80 and SBP &lt; 160 for patients with concern for elevated ICP prior to external ventricular drainage (EVD) placement and availability of ICP monitoring.</p> <p>15. Place an arterial line for continuous blood pressure monitoring in all SAH patients. Continuous infusion (IV Nicardipine 5-15 mg/hr. or Labetalol) preferred for optimization of blood pressure as opposed to PRN IV meds.</p> <p>16. Initiate vasopressors, if necessary, to achieve MAP and cerebral perfusion pressure (CPP) goals. If hypotensive and/or evidence of pulmonary edema on CXR, order <i>urgent</i> TTE and consider diagnosis of stunned cardiomyopathy (SM). Norepinephrine &gt; phenylephrine &gt; dopamine as vasopressor of choice for MAP goals; consider concomitant use of dobutamine.</p> <p>17. Consider ICP and/or EVD for patients based on neurological status, GCS score &lt;8 or evidence of neurological deterioration and suspected or proven hydrocephalus.</p> <p>18. If EVD placed, ICP goal &lt; 20 with cerebrospinal fluid (CSF) surveillance sampling q 72h by Neurosurgery (more frequent if clinically indicated) and CPP goal &gt; 70.</p> <p>19. Measures to prevent increased ICP include: head of bed elevation &gt; 30 degrees, avoiding excessive hip flexion, keeping head in midline position as much as possible,</p> |

avoiding pressure on neck from endotracheal tube tape, and suctioning only as needed using short acting sedative or lidocaine prior to suctioning.

20. Measures to treat elevated ICP include controlled hyperventilation (PaCO<sub>2</sub> goal 28-32, short term use only), osmotherapy with mannitol and/or hypertonic saline (central line for latter), analgesia and sedation, controlled external ventricular drainage, pharmacological coma, hypothermia (goal 34-36 degrees centigrade; if persistently elevated ICPs may escalate to moderate hypothermia: 32-34 degrees centigrade post aneurysm clipping/coiling) and, in refractory cases, craniectomy as indicated by patient condition.

21. Place a central line for CVP monitoring unless peri-mesencephalic or cortical non-aneurysmal SAH (if Hunt & Hess 1/2, Modified Fisher 1) in whom central line may be placed as needed. If CVP monitoring, Swan Ganz or PiCCO monitoring available, order clearly stated goals for volume status. Also place central line if vasopressors or hypertonic saline indicated.

22. Isotonic fluids recommended for maintenance with fluids at 1-1.5 mL/kg/hr.

23. Intake/output (I/O) goals: euvolemia to + 500 mL/day. Restrict diuresis in patients exceeding goals of euvolemia, indicated only if clinical evidence of volume overload manifesting as hypoxia and/or evidence of significant pulmonary edema/heart failure (HF), avoid over-diuresis.

24. If failure to maintain goals of lower limit of I/O goals, increase maintenance fluids to 2mL/kg/hr. or higher and give crystalloid fluid boluses.

25. Failure to respond to crystalloids or presence of significantly increased urine output suggestive of cerebral salt wasting (CSW) may necessitate use of colloids (25g albumin = 500 mL 5% albumin or 100 mL 25% albumin) as single bolus or on prn basis q4-6h for CVP goals (CVP 5-8 mmHg), PiCCO goals (stroke volume variation [SVV] < 10% or global end diastolic index [GEDII] > 700 mL/m<sup>2</sup>), Swan Ganz Goals (PCWP 8-12 mmHg) or consistent with clinical (I/O) euvolemia goals. Consider addition of hypertonic saline and/or fludrocortisone for associated hyponatremia.

26. Aggressively reverse coagulopathy with INR goal < 1.3 using Fresh Frozen Plasma (FFP). Vitamin K 10 mg q 12-24h times three doses (q 12 with significantly elevated INR), may be given as slow infusion as well. Administer IV upon admission, may be continued IV or transitioned to po. Consider Factor VIIa (20 mcg/kg) in Warfarin-associated SAH especially if patient is getting an emergent surgical procedure (EVD/ craniotomy).

27. Platelet transfusions (2-6 units, higher end of range if evidence of re-rupture) in patients on anti-platelet therapy.

28. Consider seizure prophylaxis only in select patients (associated cortical intracerebral hemorrhage (ICH), especially temporal; associated subdural hematoma (SDH); unclear etiology... possibly traumatic) for no greater than 1 week. In high grade SAH Hunt & Hess 3-5 or in patients with neurologic deterioration not otherwise explained, continuous EEG monitoring to rule out non-convulsive status epilepticus (NCSE). IV Keppra>> Fosphenytoin as drug for seizure prophylaxis. If evidence of seizure activity, treat with anti-epileptic therapy.

29. Start nimodipine 60 mg po q4h to be given for 21 days, alter regimen to 30 po q2h if medication causes hemodynamic (and/or neurological) instability, hold if patient in clinical vasospasm and unable to tolerate medication secondary to hypotension.

30. Start pravastatin 40 once daily for 14 days, d/c if abnormal liver function or increasing CPK, monitor LFT weekly and CPK q 72h through the first week.

31. Monitor laboratory values as needed to monitor electrolytes, blood counts, coagulation status, and drug levels.

32. Serial labs:

- a) CBC: Check Hemoglobin (Hgb) daily, goal Hgb > 9; transfuse to Hgb goal > 10 in setting of vasospasm (vasospasm (either clinical, angiographic, per CTA/CTP or per TCD criteria: score  $\geq 4$  in Modified Fisher 1-3 or  $\geq 3$  in Modified Fisher 4).
- b) Na (sodium): Goal of normonatremia unless evidence of increased ICP, significant mass effect, or global cerebral edema.
- c) Na, K (potassium): Concern for cerebral salt wasting, check q4h (see #52).
- d) Mg (magnesium): Goal higher end of normal 2-2.5 mg/dL, check daily.
- e) Phenytoin level: If phenytoin used for treatment or prophylaxis, check daily initially.

33. Maintain glucose levels with sliding scale insulin titrated to blood glucose 120-160 mg/dL. Use Insulin infusion if blood glucose > 180 mg/dL for two consecutive checks.

34. Maintain normothermia. Treat fever by trying to identify source; tailor interventions to possible source(s); provide antibiotics, if indicated; and use of antipyretics. Attempt to achieve goals with acetaminophen, cooling blankets, ice packs etc; if failure to achieve goal of 36-37 degrees centigrade in 4h, transition to Arctic Sun and institute shivering protocol. Cultures q 48h if on normothermia protocol.

35. Daily transcranial Doppler (TCD) for vasospasm surveillance.

36. CTA or Conventional angiogram for aneurysm detection.

37. Repeat CTA/ conventional angiogram in 1 week if angio negative for SAH and high clinical suspicion for aneurysmal etiology.

**38. Definitive aneurysm repair per Neurosurgery.**

**POST ANEURYSM CLIPPING/ COILING**

**VASOSPASM:**

39. Keep MAP > 70 in all patients; if clinical evidence of symptomatic vasospasm increase MAP goal with goal titrated to reversal of neurological deficits.

40. Routine choice of vasopressor: Norepinephrine > phenylephrine >> dopamine.

41. If evidence of stunned myocardium OR failure to respond to hypertensive therapy, ADD or SUBSTITUTE inotropic therapy (dobutamine/ milrinone) with titration to cardiac index (CI) > 3 in former (stunned myocardium) and supra-normal CI > 4.5 in latter (refractory vasospasm without evidence of stunned myocardium). Patient will ideally need PiCCO catheter or Swan Ganz catheter PRIOR to institution of inotropic support.

42. Fluid goals in absence of vasospasm: euolemia to +500 mL (CVP: 6-8 mmHg,

PiCCO: SVV < 10% or GEDI > 700 mL/m<sup>2</sup>, Swan Ganz: PCWP 8-12mmHg).

43. Fluid goals if vasospasm present: trial of hypervolemia with colloid boluses (25 gm 5% or 25% albumin x 2 doses or 1 liter 0.9NS x 2) with CVP goal 8-12 mmHg, PCWP 12-16 mmHg or aggressively meeting PiCCO goals of SVV < 10% or GEDI > 700 mL/m<sup>2</sup> with CI goal > 4.5 if hypertensive therapy alone or in combination with inotropic therapy fails. If patient responds to hypervolemia, cautious maintenance of hemodynamic goals consistent with neurological improvement. If no response or transient response with need to escalate goals of hypervolemia further, consider alternative strategy (addition of inotropes or neurointerventional strategies).

44. Transfuse to Hemoglobin goal > 10.

45. Indications for PiCCO/ Swan (PiCCO > Swan Ganz):

- a. Failure of traditional triple-h therapy for vasospasm necessitating inotrope trial.
- b. Vasospasm in setting of significantly stunned myocardium (SM).
- c. Vasospasm in setting of patient with past medical history of moderate to severe HF (ejection fraction < 40%).

Goals:

1. CI > 3 (SM/HF), >4.5 as tolerated in rest.
2. Extravascular lung water index (EVLWI) < 10.
3. GEDI 700-850 mL/m<sup>2</sup> OR SVV < 10% (latter if sedated on ventilator).
4. Systemic vascular resistance index (SVRI) 1600-2400 dynes sec/cm<sup>5</sup>.

46. Indications for angiogram (diagnostic/ therapeutic: IA (intra-arterial)vasodilators, Balloon angioplasty):

- A) Surveillance: at 7 days.
- B) Urgent (To be performed the same day or following morning if ordered after hours): Diagnostic in patients in whom etiology of neurological deterioration unclear.
- C) STAT order/ Emergent (To be performed within 0 - 4h): Failure to respond to traditional medical therapy OR complications secondary to institution of triple-h therapy necessitating alternative management (patient with high pre-test probability of vasospasm).

47. Indications for CT Angiogram + CT Perfusion (CTA/CTP):

- a) Alternative to criteria for 46. B) (Urgent angiogram) with likely quicker turnaround time.
- b) Clinical evidence of vasospasm with negative conventional angiogram to evaluate for micro-vascular vasospasm and possible perfusion deficits.
- c) TCD evidence of vasospasm in high grade SAH (Hunt & Hess 4, 5) with unreliable neurological exam (Alternative: conventional angiogram).

48. Transcranial Doppler (TCD) Scoring Criteria:

1. MCA-FV > 120 or BA-FV > 60: 1
2. MCA-FV > 160 or BA-FV > 80: 2
3. MCA-FV > 200 or BA-FV > 95: 3
4. LI > 3 or BA/ VA > 2: 1
5. LI > 6 or BA/VA > 3: 2
6. 24 h increase > 50 cm/s (same operator): 1

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|                                  | <p><u>Recommend CTA/P in patients with Score of <math>\geq 3</math> in MF 4 or <math>\geq 4</math> in MF 1-3</u></p> <p>(MCA-FV: Middle Cerebral Artery mean flow velocity; BA-FV: Basilar Artery Flow velocity, LI: Lindegaard's Index; BA/ VA: Basilar Flow velocity/ Vertebral Artery Flow velocity ratio; MF: Modified Fisher's Grade.)</p> <p>49. TCD evidence of vasospasm without clinical correlate in a patient with reliable neurological exam (Hunt &amp; Hess 1, 2): watchful observation, no de-escalation in neuro-checks, ensure optimization of hemodynamic goals.</p> <p>50. TTE may be repeated after 1 week in patients with stunned myocardium if clinically indicated.</p> <p>51. Consider IABC (Intra-aortic balloon counter-pulsation) in patients with stunned myocardium, and vasospasm refractory to medical interventions and neuro-interventional therapy; will need transfer out of NSICU with Neurosurgery primary and NSICU consult service.</p> <p>52. CEREBRAL SALT WASTING</p> <p>a. Na, K q4h.<br/> b. Fludrocortisone 0.2mg bid, maximal dose tid.<br/> c. Hypertonic saline for Na &lt; 135 mmol/dL.<br/> d. Match fluid losses with crystalloids.</p> <p>e. If patient shows evidence of neurological deterioration or failure to respond to # b-d, 25 gm albumin to be given q4-6 prn to achieve volume goals and normonatremia and/or CVP goal 6-8 (may titrate to PiCCO or pulmonary artery catheter goals, if available); higher goals as previously outlined if patient in symptomatic vasospasm.</p> <p>53. All other goals remain identical to orders from pre-op (normothermia, blood glucose 120-160 mg/dL, Mg 2-2.5 mg/dL, use of statins, nimodipine, seizure prophylaxis if indicated and ICP goals with CSF surveillance).</p> |
| RN                               | <p>54. Changes in patient condition to be reported to the physician in a timely manner. Maintain VAP (Ventilator Associated Pneumonia) precautions per protocol.</p>  |
| RN and Rehabilitation Services   | <p>55. Keep head of bed 30-45 degrees, if vented, and not contraindicated. Use reverse trendelenberg as needed.</p> <p>56. Bedrest for 24 hours from admission or until aneurysm is secured, whichever comes later. Initiate activity as patient condition allows, and as ordered by the physician, to promote active exercise, strength training, and gait training.</p> <p>57. Initiate interventions as needed to prevent formation of contractures and minimize edema formation, using bracing/orthotic devices as needed.</p> <p>58. Provide aphasia treatment, cognitive rehabilitation, communication devices, movement therapy, spasticity treatment, and functional adaptation to visual/spatial neglect.</p>  |
| RN, Rehabilitation Services, and | <p>59. Dysphagia screening, using the Bedside Swallow Screen, to be completed prior to anything by mouth. Initiate Speech Language Therapist consult for formal swallow evaluation, as needed, and when patient able to participate.</p>  |

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| Nutrition Services                                   | <p>60. Place dobbhoff tube (DHT) within 24h of admission if patient unable to swallow to optimize nutrition needs.</p> <p>61. Nutrition consult, as needed, to maximize nutritional support. Initiate dietary interventions to lower LDL's, if greater than 100 mg/dL.</p>   |
| Physician and RN                                     | <p>62. Initiate DVT prophylaxis upon admission with intermittent pneumatic compression (IPC); do not initiate pharmacological prophylaxis with Lovenox 40 qd unless otherwise ordered. Surveillance venous duplex of affected limb/ limbs q 3 days in high risk patients (comatose or non-ambulatory and D-dimer elevated); q 7 days in all other ICH patients.</p> <p>63. Initiate peptic ulcer prophylaxis (PUD) as appropriate.</p> <p>64. Review FAST HUG during daily rounds.</p>                                       |
| RN, Social Worker (MSW), Case Manager, and Physician | <p>65. Provide social and psychological support for the patient and their significant others as needed.</p> <p>66. Case management services to begin upon admission. providing ongoing utilization review. Works with multiple disciplines to determine patient's condition and needs/barriers for discharge. Coordinates discharge planning with patient and family (e.g., inpatient rehab, skilled nursing facility, home health, durable medical equipment).</p>  |
| Multi-disciplinary team                              | <p>67. Identify patient and family education needs and provide appropriate information and resources found in the stroke education packet. This should include identification of personal modifiable risk factors, such as tobacco cessation, nutrition, exercise, and blood pressure regulation; warning signs for stroke; activation of EMS; need for follow-up after discharge; and medications prescribed.</p> <p>68. Document education provided in the Patient Education section of the electronic medical record.</p> |

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## Related documents:

- Acute Stroke Practice Standard for the Emergency Department,  
<http://ozone.ohsu.edu/healthsystem/HealthSystems/PracStand/PS01-11.html>
- [Nursing Standard of Care: Adult Inpatient Critically Ill](http://ozone.ohsu.edu/healthsystem/nursing/policy/soc/details/104soc.pdf)  
<http://ozone.ohsu.edu/healthsystem/nursing/policy/soc/details/104soc.pdf>

## Education & Training Resources: None

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Originator/Author: OHSU Stroke Advisory Committee.

**Revised by:** Neeraj Naval, MD, NSICU Neurointensivist & Karen Ellmers, RN, MS, CCNS, Stroke Coordinator

## Reviewed & Approved By:

NSICU Faculty Group (12/15/2010)

OHSU Stroke Center (12/17/2010)

Dept of Neurosurgery (12/17/2010)

NSICU Protocol Review committee (01/7/2010)

NSICU and 10K UBNPC (1/10)

OHSU Nursing Practice Council (1/07)

Neurosciences Best Practices Committee (01/22/2010)

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