POLICY STATEMENT:
OHSU hospitals and clinics have adopted these practice guidelines in order to delineate a consistent, evidence-based approach to treating the patient who presents with signs and symptoms consistent with acute non-traumatic subarachnoid hemorrhage (SAH). Although these guidelines assist in guiding care, responsibility to determine appropriate care for each individual remains with the provider themselves.

<table>
<thead>
<tr>
<th>Outcomes/goals</th>
<th>Create a multidisciplinary, evidence-based approach to the management of acute non-traumatic subarachnoid hemorrhage (SAH) patients. Patient plan of care to take into consideration the entire continuum of care from Emergency Department through rehabilitation.</th>
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</thead>
</table>
| Physician      | 1. Determine the appropriate unit for admission.  
Admission criteria for Neurosciences ICU  
   a. All acute non-traumatic subarachnoid hemorrhage patients (CT or LP positive) will be admitted to the NSICU. |
| Physician      | 2. Complete appropriate physician order set in electronic medical record:  
   a. NSG: Aneurysmal Subarachnoid Hemorrhage Orders  
   b. NSG: Craniotomy for Aneurysm: ICU post-op Orders  
   c. INR: Ruptured Aneurysm: Post Embolization Orders  
   d. NSICU: Daily care orders on rounds. Admission orders include: CBC, CMP (complete metabolic set), PT/INR/PTT, lipid panel, urine toxicology, CXR and EKG. Transthoracic echocardiogram (TTE) and BNP (B-natriuretic peptide) optional. Activity and diet orders, code status, GI and VTE prophylaxis must also be addressed.  
   e. Calculate Hunt & Hess Score within 6 hours of arrival (prior to surgical intervention/invasive intracranial procedures) and document in H&P. |
| Pharmacy and R.N. | 3. Process physician orders according to OHSU policy. |
| R.N. | 4. Complete admission database and initiate nursing plan of care according to the appropriate OHSU Adult Inpatient Standards of Care.  
   Adult Critical Care Standard of Care  
   Adult Acute Care Inpatient Standard of Care |  
5. Perform focused neurological assessments based on patient condition and physician orders, every 1-2 hours while in the ICU and every 2-4 hours in acute care.  
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.  
7. Intracranial pressure (ICP), and partial brain tissue oxygen (PbtO2) to be recorded hourly with EVD clamped, if monitor in place.  
8. Provide a quiet, low light environment for the patient. Strict bed rest until aneurysm secured (unless interdisciplinary team determines that mobilization and/or assessment can occur prior to securement). Less stringent activity restrictions in setting of non-aneurysmal peri-mesencephalic or cortical SAH.  
9. Cautious sedation and analgesia, if intubated. In non-intubated patients, analgesia will always include non-opiates, if no contraindications, and opioids only if necessary.  
10. Anti-emetics as needed. |
|-----------------|--------------------------|
| **Physician** | 11. Evaluate for loss of airway protection and need for intubation. Intubation recommended for GCS <8 and patients with deteriorating GCS (i.e., Hunt & Hess Scale 4, 5 and select Hunt & Hess 3).  
12. Consider feeding tube insertion to reduce risk of aspiration. |
<p>| <strong>Physician, R.N. and RT</strong> | 13. Maintain oxygenation saturation greater than or equal to at least 93 % (optimal &gt;95% with PaO2 &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 continuous ETCO2, correlate with ABG reading at least once daily (goal PaCO2 35-45). |</p>
<table>
<thead>
<tr>
<th>Orders placed prior to securing aneurysm</th>
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<tbody>
<tr>
<td>14. Keep mean arterial pressure (MAP) &gt;70 and systolic blood pressure &lt;140 in patients with no concern for elevated ICP (Hunt &amp; Hess 1-2); MAP &gt;80 and SBP &lt;160 for patients with concern for elevated ICP (Hunt &amp; Hess 3-5) prior to external ventricular drainage (EVD) placement and availability of ICP monitoring.</td>
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<tr>
<td>15. Continuous infusion (IV Nicardipine 5-15 mg/hr) preferred for optimization of blood pressure as opposed to PRN IV meds. Placement of arterial line for blood pressure monitoring, is recommended.</td>
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<tr>
<td>16. Initiate vasopressors, if necessary, to achieve MAP goals. If hypotensive and/or evidence of pulmonary edema on CXR, order <strong>urgent</strong> TTE and consider diagnosis of neurogenic stressed myocardium (NSM).</td>
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<tr>
<td>17. Consider EVD for patients based on neurological status, GCS score &lt;8 or evidence of neurological deterioration and suspected or proven hydrocephalus.</td>
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<tr>
<td>18. If EVD placed, ICP goal &lt;20, surveillance sampling of cerebrospinal fluid (CSF) every 72 hours by Neurosurgery (more frequent if clinically indicated).</td>
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<tr>
<td>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, avoiding pressure on neck from endotracheal tube tape, and suctioning only as needed using short-acting sedative and/or analgesic.</td>
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<tr>
<td>20. Isotonic fluids at 1-1.5 mL/kg/hr total fluid intake recommended for maintenance.</td>
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<td>21. Maintain euvoolema. Restrict diuresis to patients exceeding goals of euvoolema, and only if clinical evidence of volume overload that manifests as hypoxia and/or evidence of significant pulmonary edema/heart failure (HF), and always aim for euvoolema.</td>
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<tr>
<td>22. If failure to maintain euvoolema, increase maintenance fluids to 2mL/kg/hr or higher. Consider providing crystalloid fluid boluses until I/O at least even.</td>
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<tr>
<td>23. Cerebral salt wasting (CSW) may necessitate use of hypertonic saline as single bolus or on prn basis consistent with clinical (I/O) euvoolema goals. Consider addition of hypertonic saline and/or fludrocortisone for associated hyponatremia.</td>
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<tr>
<td>24. Consider central venous pressure monitoring, non-invasive or invasive hemodynamic pressure monitoring, with clearly stated goals, if clinically indicated.</td>
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</table>
25. Aggressively reverse coagulopathy. For coagulopathy related to pharmacological anticoagulation, see below. For warfarin-associated ICH and INR >1.4:
   a. 4-factor PCC (Kcentra):

<table>
<thead>
<tr>
<th>INR</th>
<th>Action</th>
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<tr>
<td>2-4</td>
<td>25 units/kg (not to exceed 2500 units)</td>
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<tr>
<td>4-6</td>
<td>35 units/kg (not to exceed 3500 units)</td>
</tr>
<tr>
<td>&gt;6</td>
<td>50 units/kg (not to exceed 5000 units)</td>
</tr>
</tbody>
</table>

26. For coagulopathy related to dabigatran: Reverse if patient shows signs of bleeding and has an elevated aPTT >40 seconds using Kcentra (4 factor PCC) 50 units/kg.

27. For coagulopathy related to rivaroxaban or apixaban: Reverse if patient shows signs of bleeding and INR >1.5 using Kcentra (4 factor PCC) 50 units/kg.

28. Platelet transfusions (2-6 units, higher end of range if evidence of aneurysm re-rupture) in patients on anti-platelet therapy. In Epic, 1 unit of platelet pheresis leukoreduced product equals 6 units of platelets.

29. Consider seizure prophylaxis in select patients (associated cortical intraparenchymal hemorrhage (IPH), especially when IPH is temporal; associated subdural hematoma (SDH); and with unclear etiology, or with possibly traumatic SAH) 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). Recommendation for IV Keppra >> Fosphenytoin as drug for seizure prophylaxis. If evidence of seizure activity, start anti-epileptic therapy as usual.

30. Start nimodipine 60 mg po every 4 hours to be given for 21 days, alter regimen to 30 po every 2 hours if medication causes hemodynamic (and/or neurological) instability, hold if patient in clinical vasospasm and unable to tolerate medication secondary to undesired blood pressure drops.

31. Monitor laboratory values as needed to monitor electrolytes, CBC, 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 symptomatic vasospasm.
   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 every 6 hours (see #49).
   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; goal is to maintain therapeutic levels.

33. Maintain glucose levels with sliding scale insulin titrated to blood glucose 140-180 mg/dL. Use insulin infusion if blood glucose >180 mg/dL.

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 4 hours, consider transition to Arctic Sun and institute the Anti-shivering protocol.

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

36. CTA or Conventional angiogram for aneurysm detection.

37. When patients are admitted with SAH due to a ruptured aneurysm, the neurosurgeon and the interventional neuroradiologist will collaborate to determine whether definitive surgical aneurysm repair or coil embolization is the superior treatment. If it appears endovascular coiling would be safe and effective, the patient or patient’s surrogate should be given this option.
Physician and R.N.

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

Post-aneurysm clipping/ coiling

Vasospasm:

39. If clinical evidence of symptomatic vasospasm, increase MAP goal with goal titrated to reversal of neurological deficits.

40. If patient cannot tolerate hypertensive therapy, consider inotropic therapy (dobutamine/ milrinone) with titration to cardiac index (CI). Patient will ideally need non-invasive or invasive hemodynamic monitoring PRIOR to institution of inotropic support and to guide treatment.

41. Fluid goals if vasospasm present: If hypertensive therapy alone or in combination with inotropic therapy fails, trial of hypervolemia with colloid boluses (25 gm 5% or 25% albumin x 2 doses or 1 liter 0.9NS x 2 or hypertonic saline with goal of Na 140-160. If patient responds to hypervolemia, cautious maintenance of hemodynamic goals as long as consistent with neurological improvement. If no response or only transient response and apparent need to escalate goals of hypervolemia further, consider alternative strategy (addition of inotropes or neurointerventional strategies).

42. Transfuse to Hemoglobin goal >10.

43. Indications for noninvasive and invasive hemodynamic monitoring (PICCO >>>Swan Ganz):
   a. Vasospasm and failure of traditional triple-h therapy 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%).

44. Indications for cerebral angiogram (diagnostic/ therapeutic: IA [intra-arterial] vasodilators, balloon angioplasty:
   a. STAT order/ Emergent (To be performed within 0 – 4 hours): 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).
   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. Surveillance: at 7 days.

45. Indications for CT Angiogram + CT Perfusion (CTA/CTP):
   a. Alternative to criteria for 46. B) (Urgent cerebral angiogram) if angiography not available or quicker turnaround desired.
   b. Clinical evidence of vasospasm with negative conventional angiogram to evaluate for distal vasospasm and possible perfusion deficits.
   c. TCD evidence of vasospasm in high grade SAH (Hunt & Hess 4, 5) with unreliable neurological exam (Alternative: conventional cerebral angiogram).

46. Transcranial Doppler (TCD) Scoring Criteria:
   a. MCA-FV >120 or BA-FV >60: 1
   b. MCA-FV >160 or BA-FV >80: 2
   c. MCA-FV >200 or BA-FV >95: 3
   d. LI >3 or BA/ VA >2: 1
   e. LI >6 or BA/VA >3: 2
   f. 24 h increase >50 cm/s (same operator): 1
### Physician and R.N.

**Recommend CTA/P in patients with Score of >/= 3 in MF 4 or >/= 4 in MF 1-3 (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.)**

47. TCD evidence of vasospasm without clinical correlate in a patient with reliable neurological exam (Hunt & Hess 1, 2): watchful observation, maintain 1-2 hour neuro-checks, ensure optimization of hemodynamic goals (MAP >70).

48. TTE may be repeated after 1 week in patients with stunned myocardium if clinically indicated.

49. **CEREBRAL SALT WASTING**
   - a. Na, K every 6 hours.
   - b. Fludrocortisone 0.2mg bid, maximal dose 0.2-0.3 mg tid.
   - c. Hypertonic saline for Na <135 mmol/dL.
   - d. Match fluid losses with crystalloids.
   - e. If patient shows evidence of neurological deterioration or failure to respond to # b-d, 25 gm albumin to be given every 4-6 hours prn to achieve volume goals and normonatremia; higher goals as previously outlined if patient in symptomatic vasospasm.

50. All other goals remain identical to orders from pre-op.

### R.N.

51. Changes in patient condition to be reported to the physician in a timely manner.

52. Maintain VAP (ventilator-associated pneumonia) precautions per protocol.

### R.N. and Rehabilitation Services

53. Keep head of bed 30-45 degrees, if vented, and not contraindicated. Use reverse Trendelenberg position as needed.

54. Bedrest until aneurysm is secured (unless interdisciplinary team determines that mobilization and/or assessment can occur prior to securement), then advance activity as tolerated to promote alertness, active exercise, strength training and gait training when the interdisciplinary team assesses patient as clinically appropriate for early mobilization.

55. R.N. to initiate interventions as needed to prevent formation of contractures, subluxation, and minimize edema formation, using bracing/orthotic devices as needed.

56. Consult Rehabilitation Services to provide aphasia treatment, cognitive rehabilitation, delirium management, communication devices, mobility/balance/gait training, spasticity treatment functional adaptation to visual/spatial neglect and activities of daily living training.
   - a. If patient has returned to prior level of function and does not need rehabilitation services during this hospitalization, this will be documented.

### R.N., Rehabilitation Services and Nutrition Services

57. 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.

58. Place feeding tube within 24 hours of admission if patient unable to swallow to optimize nutrition needs.

59. Nutrition consult as needed, to maximize nutritional support.

### Physician and R.N.

60. Initiate VTE prophylaxis by hospital day two with intermittent pneumatic compression (SCD’s) in all SAH patients. Initiate chemoprophylaxis with Lovenox 40 mg subcutaneous every day or Heparin 5000 subcutaneous every 8 hours following 48 hours after aneurysm is secured via clip or coil, and at least 24 hours following insertion of extra-ventricular drain. Chemoprophylaxis will be continued throughout ICU stay regardless of patient's mobilization status. Primary attending may choose to opt out of chemoprophylaxis for individual patients, and this decision must be documented in the medical record. Vascular ultrasound for patients with clinical symptoms of DVT or PE.

61. Initiate peptic ulcer prophylaxis (PUD) as appropriate.

62. Review FAST HUG during daily rounds.
R.N., social worker (MSW), case manager and physician

63. Provide social and psychological support for the patient and their significant others as needed.

64. Social work will perform a caregiver assessment and assist in creating a plan for respite, when applicable. If a patient is returning to an independent living situation, social work will provide independent living resources. They will screen patients for depression and provide additional evaluation as indicated and provide patients/family with education and resources with regard to post stroke depression.

65. 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, outpatient rehab and durable medical equipment).

Multidisciplinary team

66. 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, alcohol intake, nutrition, exercise, and blood pressure regulation; warning signs for stroke; activation of EMS; need for follow-up after discharge; and medications prescribed.

67. Document education provided in the Patient Education section of the electronic medical record or LIP documentation in progress notes.

Bibliography:

- Blissitt, P., et al. (2014). Care of the patient undergoing intracranial pressure monitoring/external ventricular drainage, or lumbar drainage. AANN Clinical Practice Guideline Series. Publisher: AANN.


OHSU HEALTH CARE SYSTEM

PRACTICE GUIDELINES

ACUTE STROKE PRACTICE GUIDELINES FOR INPATIENT MANAGEMENT OF SUBARACHNOID HEMORRHAGE, HC.STK.104.GD
OHSU HEALTH CARE SYSTEM
PRACTICE GUIDELINES

ACUTE STROKE PRACTICE GUIDELINES FOR INPATIENT MANAGEMENT OF SUBARACHNOID HEMORRHAGE, HC.STK.104.GD

Related documents:
- Acute Stroke Practice Standard for the Emergency Department, HC.STK.100.GD
- Intravenous Administration of t-PA in Acute Ischemic Stroke Practice Standard, HC.STK.101.GD
- Adult Critical Care Standard of Care
- Adult Acute Care Inpatient Standard of Care
- Bedside Nurse Swallow Screen

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Approved by:

Reviewed by:
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Dept. of Neurosurgery Faculty (2009, 2012)

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