

Pre-Treatment Aneurysmal Subarachnoid Hemorrhage

Standard approaches to care include: **AVOID High Blood Pressure**

General:

- Location: All patients to be managed in the ICU
- Head of bed at 30 degrees
- Room quiet: Low level external stimulation, limited visitation

Monitoring/Lines:

- Neurological exams and vitals Q1-2°
- All patients to have a arterial line
- All patients to have a foley
- Hunt Hess Grade III SAH patients with a GCS ≤ 8 and **all** grade IV patients:
 - ❖ CVP line; *CVP (6-10 with a Goal: 6)* unless otherwise instructed
 - ❖ Brain tissue oxygen, SjVO₂ and CBF probes considered on a case-by-case basis

Fluids:

- Normal Saline at 100cc/hr unless otherwise instructed

Blood Pressure: (Goal: SBP <140)

- Nicardipine gtt 5-15 mg/hr
- Labetolol gtt 2-4 mg/min
- Labetolol 5-20 mg IV Q15" PRN, not to exceed 300mg in 5°

Ventilation: (Intubate for decreased LOC or ventilatory/oxygenation issues)

- PaO₂ of 95-105 mmHg unless otherwise instructed (*Goal: 100 mmHg*)
- PaCO₂ of 35-45 mmHg unless otherwise instructed (*Goal: 40 mmHg*); pH 7.34-7.45
- **Note: Avoid acute increase in BP at time of intubation; consider lidocaine and fentanyl pretreatment**

EVD/ICP: (Consider for depressed LOC in setting of enlarged ventricles)

- Open at 20cm H₂O with Q1° ICP checks
- **Note: Remove minimal CSF at the time of insertion, release CSF slowly to decrease the chance of re-rupture**

Temperature: (Goal: temperature 37.5°)

- Temperature control per fever management order sheet (*do not substitute surface cooling measures that might induce shivering*)
 - ❖ Tylenol for T >37.5°
 - ❖ Cooling Blanket/surface cooling for T $\geq 38.3^\circ$

Labs:

- **Hematocrit:** Goal: 28-35
- **Platelet:** Goal: $\geq 100,000$
- **INR:** Goal: ≤ 1.4
- **Na⁺:** Goal: 135-145
- **Glucose:** Goal: 80-140mg/dl, initiate insulin gtt for >160

Dilantin Therapy:

- Load all patients with SAH
- Treatment should continue for 7 days post-operatively (*Extend for 30 days for witnessed seizure activity*)
- Check Dilantin level administration day 2

Analgesia/Sedation:

- Fentanyl 25-50 mcg IV Q15" PRN

Additional Medications:

- Nimodipine 60mg Q4° x 21 days post SAH
 - ❖ (*If hypotension develops divide dosage*) Nimodipine 30mg Q2° or 15mg Q1° x 21 days post SAH
- No Pre-operative Decadron

Post-Treatment Secured Aneurysms No Signs of Vasospasm

Standard approaches to care include: *AVOID hypotension and hypovolemia*

General:

- Location: All patients to be managed in the ICU for 7-14 days for vasospasm observation
- All patients will have a post-operative angiogram within 5 days following surgical clipping
- Transcutaneous Doppler (TCD) checks at least every other day OR at least one CT Angiogram (CTA) during spasm period day 5-10 post SAH
- **Note:** Consider use of CTA to evaluate vasospasm if TCD windows not present
 - ❖ **Note:** Post-op day 10 and in the absence of clinical, radiological, or TCD evidence of vasospasm, consider transfer to floor with Q4° neuro checks and vitals; Fisher grade 3 and 4 should be observed in ICU for 14 days

Monitoring/Lines:

- Neurological exams and vitals Q1-2° for at least 7 days post-op, observe for;
 - New or increasing headache
 - Subtle changes in alertness
 - Subtle changes in speech, spontaneity & quality of speech output
 - Evidence of a new pronator drift
- All patients to have a arterial line
- All patients to have continuous O₂ sat monitoring
- All patients to have a foley
- All patients to have a CVP with Q4° checks
 - ❖ **CVP Goal: 6-10 unless otherwise instructed**
- Brain tissue oxygen, SjVO₂ and CBF probes on a case-by-case basis; strongly consider for Hunt Hess Grade III with GCS ≤ 8 and Grade IV

Fluids: (Goal: Slight Positive fluid balance up to~ 800-1200 cc/day)

- Normal Saline at 125 cc/hr unless otherwise instructed
- Normal Saline boluses PRN to keep CVP >6
 - ❖ (example: NS 500cc IV Q4° PRN CVP ≤6)

Blood Pressure: (Goal: SBP at least >120, MAP 10-20 mmHg > pre-op baseline)

- Phenylephrine 5-200 mcg/min (Notify MD for dose >200 mcg/min)
- Dopamine 5-20 mcg/kg/min (If Neo dose exceeds 100mg/min, augment with dopamine)

Ventilation:

- PaO₂ of 95-105 mmHg unless otherwise instructed (*Goal: 100 mmHg*)
- PaCO₂ of 35-45 mmHg unless otherwise instructed (*Goal: 40 mmHg*); pH 7.34-7.45

****** Do NOT Hyperventilate**

EVD/ICP: (*For hydrocephalus and subarachnoid/intraventricular hemorrhage*)

- Open at 10-20 cm H₂O with Q1° ICP checks
 - ❖ **Note:** *Maintain EVD open until blood discoloration in CSF starts to clear before starting CSF weaning challenges*
- Consider thrombolytics for dense SAH and intraventricular casting after clipping

Temperature: (*Goal: temperature 37.5°*)

- Temperature control per fever management order sheet
 - ❖ Tylenol for T >37.5°
 - ❖ Cooling Blanket/surface cooling for T ≥38.3

Labs:

- **Hematocrit:** *Goal: 28-35*
- **Platelet:** *Goal: ≥100,000*
- **INR:** *Goal: ≤1.4*
- **Na⁺:** *Goal: 135-145*
- **Glucose:** *Goal: 80-140mg/dl*, initiate insulin gtt for >160

Dilantin Therapy:

- 100mg Q8° x7 days post-operative; (*Extend for 30 days for witnessed seizure activity*)

Analgesia/Sedation:

- Fentanyl 25-50mcg IV Q15" PRN

Additional Medications:

- Nimodipine 60mg Q4° x 21 days post SAH
 - ❖ (*If hypotension develops divide dosage*) Nimodipine 30mg Q2° or 15mg Q1° x 21 days post SAH
- Decadron: If instituted in OR, continue post-op, taper off within 4 days

Post-Treatment
Secured Aneurysms *With* TCD/Angiographic Evidence of Vasospasm but
***No* Clinical Evidence of Vasospasm**

Definitions: (*Vasospasm*)

Transcutaneous Doppler (TCD) Mean Velocities:

>120 cm/sec Mild Vasospasm

>160 cm/sec Moderate Vasospasm

>200 cm/sec Severe Vasospasm

Increase in TCD mean velocity >50 cm/sec over 24 hrs

CT Angiogram (CTA) or Angiographic Evidence of Vasospasm

Standard approaches to care include: *Intensify Fluid and Hypertensive Therapy*

General:

- Location: All patients to be managed in the ICU
- Repeat angiogram, if evidence of moderate or severe spasm by TCD/CTA
- Daily TCD/CTA
 - ❖ **Note:** *Consider use of CTA to evaluate vasospasm if TCD windows not present*
 - ❖ **Goal:** Avoid hypotension and hypovolemia
 - The guidelines below may be modified, including use of higher infusion rates and more frequent fluid boluses, to achieve this goal.
 - In general young patients diurese volume as it is infused. However, infusion of excessive volumes should raise awareness for potential complications eg: oxygenation, platelet count and coagulation status should be monitored closely.
 - Before instituting hypertensive therapy verify that the aneurysm is secure either by checking the operative report to see that the sac was punctured intra-operatively or by performing a post-operative cerebral angiogram that documents no residual aneurysm

Monitoring/Lines:

- Neurological exams and vitals Q1° for at least 5 days post-spasm
- All patients to have a arterial line
- All patients to have continuous O₂ sat monitoring, follow ABG's and O₂ saturations closely
- All patients to have a foley
- All patients to have a CVP with Q2° checks
 - ❖ *CVP Goal: 8-12 unless otherwise instructed*
- Strongly consider brain tissue oxygen, SjVO₂ and CBF monitoring

Fluids: (Goal: Positive fluid balance of ~ 1000-1600 cc/day)

- Normal Saline at 150-175 cc/hr , maximum 200 cc/hr
- Normal Saline boluses PRN to keep CVP >8
 - ❖ (example: NS 500cc IV Q2° PRN CVP ≤8)
- **Note:** If daily fluid infusion is ≥6 liters/day
 - ❖ Monitor ABGs Q4°
 - ❖ Electrolytes, Platelets, and Coagulation Studies Q8°
 - ❖ Age >45 and Fluid requirements >6 liters/day; Obtain TTE and consider use of a PA catheter
 - ❖ If no response from fluids >6 liters/day; Obtain TTE and consider PA catheter insertion to assess cardiac function

Blood Pressure: (Goal: SBP >160)

- Phenylphrine 5-200 mcg/min (*Notify MD for dose >200mcg/min*)
- Dopamine 5-20 mcg/kg/min (*If Neo dose exceeds 100 mcg/min, augment with dopamine*)

Ventilation:

- PaO₂ of 95-105 mmHg unless otherwise instructed (*Goal: 100 mmHg*)
- PaCO₂ of 35-45 mmHg unless otherwise instructed (*Goal: 40 mmHg*); pH 7.34-7.45
- *** **Do NOT hyperventilate**

EVD/ICP: (For hydrocephalus and subarachnoid/intraventricular hemorrhage)

- Open at 10-20 cm H₂O with Q1° ICP checks
 - ❖ **Note:** *Maintain EVD open; do not wean until blood discoloration in CSF starts to clear and vasospasm resolved ; Do NOT attempt to wean the EVD with Transcutaneous Doppler, radiological or clinical evidence of spasm*
- Consider thrombolytics for dense SAH and intraventricular casting after clipping

Temperature: (Goal: temperature 37.5°)

- Temperature control per fever management order sheet
 - ❖ Tylenol for T >37.5°
 - ❖ Cooling Blanket/surface cooling for T ≥38.3

Labs:

- **Hematocrit:** Goal: 26-35
- **Platelet:** Goal: $\geq 100,000$
- **INR:** Goal: ≤ 1.4
- **Na⁺:** Goal: 135-145
- **Glucose:** Goal: 80-140mg/dl, initiate insulin gtt for >160

Dilantin Therapy:

- *Continue:* 100mg Q8° x7 days post-operative; Extend for 30 days for witnessed seizure

Analgesia/Sedation:

- Fentanyl 25-50mcg IV Q15" PRN

Additional Medications:

- Nimodipine 60mg Q4° x 21 days post SAH
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- Decadron: If instituted in OR, continue post-op, taper off within 4 days

Post-Treatment Secured Aneurysms with Clinical Evidence of Vasospasm

Definition: (*Clinical Evidence of Vasospasm*)

Any new post-operative neurological deficit

Standard approaches to care: *Emergency, Assume Vasospasm, Treat Aggressively while ruling out other causes of neurological deficit*

General:

- Location: All patients to be managed in the ICU
- Immediate decision regarding need for angiogram and intra-arterial angioplasty or vasodilator therapy
- Daily Transcutaneous Doppler (TCD) /CT Angiogram (CTA)
 - ❖ **Note:** *Consider use of CT Angiogram to evaluate vasospasm if TCD windows not present*
- **Rule out** other causes of neurological deficit (eg. hyponatremia, hydrocephalus, hypo-perfusion secondary to hypotension, post-op hematoma)

Monitoring/Lines:

- Neurological exams and vitals Q1°
- All patients to have a arterial line
- All patients to have continuous O₂ sat monitoring, if not intubated follow ABG's and O₂ saturations closely
- All patients to have a foley
- All patients to have a CVP with Q1° checks
 - ❖ **CVP Goal:** *>10 unless otherwise instructed*
- Strongly consider brain tissue oxygen, SjVO₂ and CBF monitoring

Fluids: (*Goal: Positive fluid balance of > 1600 cc/day*)

- Normal Saline at 175 -200 cc/hr, maximum 250 cc/hr; unless otherwise instructed
- Normal Saline boluses PRN to keep CVP >10
 - ❖ (*example: NS 500cc IV Q1° PRN CVP ≤12*)
- **Note:** No limit on fluid boluses; may need Swan Ganz Catheter

Blood Pressure: (*Goal: SBP >180*)

- **Note:** No upper limits for BP and/or MAP if aneurysm is secured
- Phenylephrine 5-200 mcg/min (*Notify MD for dose >200mcg/min*)
- Dopamine 5-20 mcg/kg/min (*If Neo does exceeds 100 mcg/min, augment with dopamine*)

Ventilation:

- Maintain O₂ sats > 95%; Low threshold for intubation given volume requirements
- PaO₂ of 95-105 mmHg unless otherwise instructed (*Goal: 100 mmHg*)
- PaCO₂ of 35-45 mmHg unless otherwise instructed (*Goal: 40 mmHg*), pH 7.34-7.45;
- **** **Do Not Hyperventilate**

EVD/ICP: (*For hydrocephalus and subarachnoid/intraventricular hemorrhage*)

- Open at 10-20 cm H₂O with Q1° ICP checks
 - ❖ **Note:** *Maintain EVD open until blood discoloration in CSF starts to clear. Do not attempt to wean during symptomatic vasospasm*
Consider thrombolytics for dense SAH and intraventricular casting after clipping

Temperature: (*Goal: temperature 37.5°*)

- Temperature control per fever management order sheet
 - ❖ Tylenol for T >37.5°
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- Decadron: If instituted in OR, continue post-op, taper off within 4 days

Angioplasty/Intra-arterial (IA) Therapy:

- If neurological deficit does not respond to hypervolemia and hypertensive management within 1 hour push SBP Goal up to 220 mm/Hg and consider angiography with angioplasty/ intra-arterial therapy.
- If neurological deficit does not respond with an increase in B/P (220 mmHg) and CVP (≥12) within 2 hours, proceed to angiography and angioplasty/intra-arterial therapy