Osmotherapy for Treatment of Intracranial Hypertension

20% Mannitol

Goal: To treat severe intracranial hypertension (ICP>20mmHg) in severely brain-injured patients

Patient Eligibility:
1. Administration of therapy must be per protocol.
2. Patient must have severe intracranial hypertension (ICP>20mmHg)

Contraindications:
1. ICP < 20 mmHg
2. Significant intravascular volume depletion exists: Based on a clinical assessment by Attending Physician/Fellow which synthesizes exam findings, laboratory results, and other pertinent clinical data. For example: CVP<6; net negative fluid balance; elevated BUN/creatinine ratio
3. Serum Na⁺ >160mmol/L
4. Serum osmolar gap>20
5. Relative Contraindication: Renal insufficiency/ failure

Monitoring: All patients receiving Mannitol for the treatment of intracranial hypertension must have the following parameters monitored and documented:
1. Central venous pressure via a central venous catheter OR pulmonary artery occlusion pressure via a pulmonary artery catheter (except in cases of emergent administration)
2. Intracranial pressure monitoring
3. All other monitoring and documentation per Surgical Critical Care/Neurocritical Care protocol

Protocol:
1. MD will order: XX gm mannitol q 6hrs prn ICP ≥ 20mmHg. Hold for osm>320mmol AND osm gap>20mmol. Hold for serum Na⁺ >160mmol/L.
   a. Mannitol dose should be 0.5-1.25gm/kg
   b. Maximum dose: 150 gms.
2. Administer first dose of mannitol as ordered.
   - Rate of administration should not exceed 0.1gm/kg/min (administer over 15 minutes)
   - Must use PURPLE FILTER either when withdrawing from vial OR when administering.
3. If mannitol fails to lower ICP below 20mmHg within 20 minutes of administration or if severe intracranial hypertension (ICP>20mmHg) recurs within 6 hours of administration- consider use of 5%NaCl. (*See Osmotherapy Guidelines for Treatment of Intracranial Hypertension: Hypertonic Saline- 5%NaCl)
4. If ICP responds to mannitol in a sustained fashion, then five hours post administration, check serum Na⁺, BUN, glucose, and serum osm- calculate the osm gap.
5. If ICP again exceeds 20mmHg, then:
   a. If serum osm<320mmol, then administer next dose of mannitol
   b. If serum osm>320mmol:
      i. Calculate osm gap
      ii. OSM GAP = Measured OSM – Calculated OSM
         1). Measured OSM= OSM value obtained from lab
         2). Calculated OSM= 2(Na⁺) + BUN/3 + glucose/18
      iii. If osm gap<20mmol- administer next dose of mannitol
      iv. If osm gap>20mmol- hold mannitol and notify MD. Consider use of 5%HTS.
6. Replace urinary losses on a cc per cc basis for the first 2 hrs following each administration.
7. If hypotension or a drop in CPP below 70mmHg occurs, notify MD. Consider use of 5% HTS.

For each occurrence of severe ICP review & repeat protocol.
Osmotherapy for Treatment of Intracranial Hypertension

Hypertonic Saline-5% NaCl

Goal: To treat intracranial hypertension in severely brain-injured patients who are not eligible for or are refractory to mannitol.

Patient Eligibility:
1. Administration of therapy must be per protocol.
2. Patient must have severe intracranial hypertension (ICP≥20mmHg)
3. At least one of the following criteria must be met:
   a. Mannitol failure: mannitol has failed to lower ICP to less than 20mmHg within 20 minutes of mannitol administration
   b. Mannitol is contraindicated:
      i. Serum osmolar gap>20mmol
      ii. Mannitol has been administered within the past 6 hours
      iii. Mannitol is associated with a drop in CPP<70mmHg
      iv. Significant intravascular volume depletion exists: Based on a clinical assessment by Attending Physician/Fellow which synthesizes exam findings, lab results, and other pertinent clinical data. For ex: CVP<6; net negative fluid balance; elevated BUN/creatinine ratio

Contraindications:
1. ICP<20mmHg
2. Severe CHF: Hypoxia due to pulmonary edema, Pink, frothy secretions, Severe pulmonary edema on CXR
3. Significant volume overload: Based on a clinical assessment by Attending Physician/Fellow which synthesizes exam findings, lab results, and other pertinent clinical data. For ex: CVP≥15mmHg or PAOP≥12mmHg
4. Serum Na+ >160mmol/L OR Serum osmolar gap>20
5. Relative Contraindication: Primary intracerebral hemorrhage

Monitoring: All patients receiving HTS for the treatment of intracranial hypertension must have the following parameters monitored and documented:
1. CVP via a central venous catheter OR pulmonary artery occlusion pressure via a pulmonary artery catheter (except in cases of emergent administration)
2. Intracranial pressure monitoring
3. Serum sodium every 2 hours
4. All other monitoring and documentation per Surgical Critical Care/Neurocritical Care protocol

Protocol:
**Use must be approved by Neurocritical Care or Surgical Critical Care Attending/Fellow**
**A new order is required for each HTS administration- can not be ordered PRN**
HTS must be infused via central venous catheter and via Alaris GUARDRAILS
1. STAT serum sodium must be checked and recorded under the following conditions:
   a. Last serum sodium value was obtained >2hr prior to HTS administration OR
   b. Mannitol has been administered since the last serum sodium value was obtained.
2. If ICP≥20mmHg AND serum sodium<160mmol/L AND all of the above criteria are met, patient is eligible to receive 5%NaCl.
3. Administer 150ml bolus of 5%NaCl:
   a. MD will order a one-time dose: 5%NaCl 150ml IV over 9 minutes (set pump rate at 999ml/hr) and follow-up STAT serum sodium 2 hours post administration.
   b. Notify MD if serum sodium>160mmol/L
   c. Administration of HTS may not be repeated more frequently than every 4 hours.
   d. Each administration must be performed in accordance with this protocol.
4. If 5%NaCl bolus fails to lower ICP below 20mmHg within 20 minutes of administration OR ICP increases above 20mmHg within 4 hours of administration, a continuous IV infusion of 3%NaCl may be considered. (See Osmotherapy Guidelines for Treatment of Intracranial Hypertension: 3%NaCl)
Osmotherapy for Treatment of Intracranial Hypertension

**Hypertonic Saline-3% NaCl**

**Goal:** To treat intracranial hypertension in severely brain-injured patients who are not eligible for or are refractory to 5%NaCl.

**Patient Eligibility:**
1. Administration of therapy must be per protocol.
2. Patient must have severe intracranial hypertension (ICP>20mmHg)
3. At least one of the following criteria must be met:
   a. *Mannitol failure:* mannitol has failed to lower ICP to less than 20mmHg within 20 minutes of mannitol administration
   b. *Mannitol is contraindicated:*
      i. Serum osmolar gap>20mmol
      ii. Mannitol has been administered within the past 6 hours
      iii. Mannitol is associated with a drop in CPP<70mmHg
      iv. Significant intravascular volume depletion exists: Based on a clinical assessment by Attending Physician/Fellow which synthesizes exam findings, lab results, and other pertinent clinical data. For ex: CVP<6; net negative fluid balance; elevated BUN/creatinine ratio
4. There must be a failure of 5%NaCl to lower ICP:
   a. 20 minutes after administration of 5%NaCl- ICP remains above 20mmhg OR
   b. Severe intracranial hypertension (ICP≥20mmHg) recurs within 4 hrs of 5%NaCl administration.

**Contraindications:**
1. ICP<20mmHg
2. Severe CHF: Hypoxia due to pulmonary edema, Pink, frothy secretions, Severe pulmonary edema on CXR
3. Significant volume overload: Based on a clinical assessment by Attending Physician/Fellow which synthesizes exam findings, lab results, and other pertinent clinical data. Use caution if CVP≥15mmHg or PAOP≥12mmHg
4. Serum Na⁺ >160mmol/L OR Serum osmolar gap>20
5. *Relative Contraindication:* Primary intracerebral hemorrhage

**Monitoring:** All patients receiving HTS for the treatment of intracranial hypertension must have the following parameters monitored and documented:
1. CVP via a central venous catheter OR pulmonary artery occlusion pressure via a pulmonary artery catheter (except in cases of emergent administration)
2. Intracranial pressure monitoring
3. Serum sodium every 2 hours
4. All other monitoring and documentation per Surgical Critical Care/Neurocritical Care protocol

**PROTOCOL – ON PAGE 2**
Osmotherapy for Treatment of Intracranial Hypertension

**Hypertonic Saline-3% NaCl**

**Protocol:**

**Use must be approved by Neurocritical Care or Surgical Critical Care Attending/Fellow**

HTS must be infused via central venous catheter and via Alaris GUARDRAILS

1. STAT serum sodium must be checked and recorded under the following conditions:
   a. Last serum sodium value was obtained >2hr prior to HTS administration OR
   b. Mannitol or 5%NaCl has been administered since the last serum sodium value was obtained.

2. If ICP >20mmHg AND serum sodium<160mmol/L AND all of the above criteria are met, patient is eligible to receive 3%NaCl.

3. Start infusion of 3%NaCl:
   a. MD will order a continuous 3%NaCl infusion to start at a rate of 10ml-50ml and titrated every 2 hours per sliding scale to achieve a target serum sodium level that will be ≤160mmol/L
   b. Serum sodium level must be checked every 2 hours during infusion
   c. Neither mannitol nor 5%NaCl should be administered during 3%NaCl administration
   d. Infusion rates are increased based on ICP levels. Infusion rate is increased ONLY if the ICP ≥ 20mmHg. If ICP<20mmHg, infusion remains at current rate.

   e. **SLIDING SCALE**

<table>
<thead>
<tr>
<th>Serum Sodium</th>
<th>ICP</th>
<th>3%NaCl Infusion Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤140mmol</td>
<td>≥20mmHg</td>
<td>Increase rate by 20ml/hr not to exceed 100ml/hr</td>
</tr>
<tr>
<td></td>
<td>&lt;20mmHg</td>
<td>Continue current rate</td>
</tr>
<tr>
<td>141-150mmol</td>
<td>≥20mmHg</td>
<td>Increase rate by 10ml/hr not to exceed 100ml/hr</td>
</tr>
<tr>
<td></td>
<td>&lt;20mmHg</td>
<td>Continue current rate</td>
</tr>
<tr>
<td>151-160mmol</td>
<td>≥20mmHg</td>
<td>Increase rate by 5ml/hr not to exceed 100ml/hr</td>
</tr>
<tr>
<td></td>
<td>&lt;20mmHg</td>
<td>Continue current rate</td>
</tr>
<tr>
<td>&gt;161mmol</td>
<td>STOP infusion: Call MD. Recheck serum sodium in 2hrs.</td>
<td></td>
</tr>
</tbody>
</table>

   f. Treatment endpoints: Treatment should continue until:
      i. Causes of intracranial hypertension have been resolved or definitively treated
      ii. Signs/Symptoms of volume overload or CHF develop. Daily assessment and documentation regarding the necessity of ongoing treatment is mandatory
      iii. Infusion must be discontinued if serum sodium≥161mmol

   g. **Weaning 3%NaCl**: When treatment is no longer required, infusion rate can be decreased and weaned off:
      i. Decrease infusion rate by 10ml/hr every 4 hours.
      ii. Continue to monitor serum sodium every 2 hours during wean
      iii. STOP wean if serum sodium decreases by 10mmol in any 24 hour period. Call MD