Case D: Young Man With Acute Symptomatic Hyponatremia Due to SIADH Following Subarachnoid Hemorrhage

A Case-Based Approach to Hyponatremia: Applying the Expert Panel Recommendations to Clinical Practice

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Clinical Presentation

- Headache and collapse
- Patient drowsy
- Glasgow Coma Scale (GCS) 12/15
- Vomiting
- Examination revealed neck stiffness
- BP - 192/104 mm Hg, HR - 110 beats per min (bpm), regular
- ECG – voltage criteria for LVH with lateral T-wave inversion
- Serum $[\text{Na}^+]$ 142 mmol/L
Case D: Acute Hyponatremia, SIADH After SAH

Case: Hospital Course

- Day 3 post coiling, GCS 10/15, poor rehab
- Serum $[\text{Na}^+]$ 119 mmol/L; typical pattern of SIADH

SIADH, syndrome of inappropriate antidiuretic hormone secretion.
Neurosurgical Hyponatremia: A Common Problem

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Total</th>
<th>$p[Na^+]$ &lt; 130 mmol/L (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>1698</td>
<td>187 (11)</td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>316</td>
<td>62 (20)</td>
</tr>
<tr>
<td>Traumatic brain injury</td>
<td>457</td>
<td>44 (10)</td>
</tr>
<tr>
<td>Intracranial tumor</td>
<td>355</td>
<td>56 (16)</td>
</tr>
<tr>
<td>Pituitary surgery</td>
<td>81</td>
<td>5 (6)</td>
</tr>
<tr>
<td>Spinal disorders</td>
<td>489</td>
<td>4 (1)</td>
</tr>
</tbody>
</table>

Case D: Acute Hyponatremia, SIADH After SAH

## Differential Diagnosis: Neurosurgical Hyponatremia

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Blood Volume</th>
<th>Clinical Pointers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate IV fluids</td>
<td>Hypervolemic</td>
<td>Check fluid balance chart</td>
</tr>
<tr>
<td>Drugs (e.g., diuretics)</td>
<td>Hypovolemic</td>
<td>Check prescribed drugs</td>
</tr>
<tr>
<td>SIADH</td>
<td>Euvolemic</td>
<td>Commonest cause</td>
</tr>
<tr>
<td>Acute ACTH deficiency</td>
<td>Euvolemic</td>
<td>Hypotension, hypoglycemia, random cortisol &lt; 300 nmol/L</td>
</tr>
<tr>
<td>Cerebral salt wasting</td>
<td>Hypovolemic</td>
<td>Hypotension, marked diuresis and natriuresis, low CVP</td>
</tr>
</tbody>
</table>

ACTH, adrenocorticotropic hormone; CVP, cerebral venous pressure.
Hyponatremia Following SAH is Primarily Due to SIADH and Glucocorticoid Deficiency

- 100 unselected patients with acute SAH
- Prospective evaluation for hormonal/hemodynamic changes preceding hyponatremia
  - 49 developed hyponatremia
    - 36 SIADH
    - 4 Acute glucocorticoid deficiency
    - 5 Excess IV fluid
    - 5 Hypovolemic
- No case of cerebral salt wasting identified

SAH, subarachnoid hemorrhage.
Case: Lab Results

- Plasma osmolality: 247 mOsm/kg H₂O
- Urine osmolality: 670 mOsm/kg H₂O
- Plasma [Na⁺]: 119 mmol/L
- Blood urea: 2.6 mmol/L
- Urine [Na⁺]: 56 mmol/L
- TSH: 1.5 mIU/L
- 9 AM cortisol: 849 nmol/L [30 µg/dL]
- Urine volume: 1,400 mL/24h

TSH, thyroid stimulating hormone.
Case D: Acute Hyponatremia, SIADH After SAH

Case Summary

• Acute hyponatremia with symptoms
• Biochemical/hemodynamic data indicate euvolemic hyponatremia
• Random cortisol shows appropriate stress activation of hypothalamic-pituitary-adrenal axis
• Low urine output and normotension argue against cerebral salt wasting
### Treatment Options

<table>
<thead>
<tr>
<th>Option 1</th>
<th>No Treatment</th>
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<tbody>
<tr>
<td></td>
<td>• Progressive cerebral edema/herniation</td>
</tr>
<tr>
<td></td>
<td>• Mortality 60%–90%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2</th>
<th>Acute Elevation of Serum [Na⁺]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Reduction in mortality</td>
</tr>
<tr>
<td></td>
<td>• Reduction in neurological damage</td>
</tr>
<tr>
<td></td>
<td>• Balance risk of osmotic demyelination(^a)</td>
</tr>
</tbody>
</table>

\(^a\) risk of demyelination is less where hyponatremia is acute.
Option 2: What therapies are available to treat this patient with acute hyponatremia?  

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>Water deprivation</td>
<td>Unlikely to elevate plasma $[Na^+]$ quickly enough $U_{Osm}$ too high for fluid restriction to be effective Neurosurgeons will not allow water restriction</td>
</tr>
<tr>
<td>Isotonic saline</td>
<td>May not be effective</td>
</tr>
<tr>
<td>Hypertonic saline</td>
<td>Standard therapy; clinician familiarity</td>
</tr>
<tr>
<td>Urea</td>
<td>Retrospective data suggest rate of increase may be too slow for emergency treatment</td>
</tr>
<tr>
<td>Vasopressin antagonists</td>
<td>Theoretical benefit</td>
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$U_{Osm}$, urine osmolality.
Case D: Acute Hyponatremia, SIADH After SAH

CT Brain Showing Cerebral Edema
Pontine Osmotic Demyelination
Consensus Recommendations for Symptomatic Acute Hyponatremia

1. Correct cerebral edema, treat or prevent hyponatremic seizures, improve level of consciousness

   100-mL bolus of 3% saline infused over 10 minutes, repeated twice as needed

   4- to 6-mmol/L increase in serum \([\text{Na}^+]\) sufficient to reverse serious manifestations

2. Allow serum \([\text{Na}^+]\) to correct to normal
Case D: Management

- Emergency situation: development of cerebral edema
- 50 ml IV hypertonic (3%) sodium chloride; plasma sodium to 121 mmol/L after an hour
- A second bolus caused a further rise to 123 mmol/L after 3 hours (a rise of 4 mmol/L)
- The patient had no further seizures and GCS rose to 14/15
- Pulse rate rose to 70 bpm and BP fell to 146/88 mm Hg
Case D: Progress

- Patient alert, but serum $[\text{Na}^+]$ fell to $121 \text{ mmol/L}$
- Tolvaptan $15 \text{ mg daily}$ started
- Serum $[\text{Na}^+]$ rose by $5 \text{ mmol/L}$ over the next $20 \text{ hours}$ (total increase of $9 \text{ mmol/L}$ over $24 \text{ h}$)
- Further rise in serum $[\text{Na}^+]$ to $134 \text{ mmol/L}$ over $48 \text{ hours}$
- Patient engaged with physiotherapy/rehab
- Over $3 \text{ days}$ serum $[\text{Na}^+]$ rose to $139 \text{ mmol/L}$; tolvaptan stopped
Learning Points

1. Emergency treatment of acute symptomatic hyponatremia needed

2. Treatment of acute hyponatremia associated with lower risk of osmotic demyelination during treatment

3. Acute elevation of serum $[\text{Na}^+]$ of 4 to 6 mmol/L reduces risk of cerebral edema and early mortality

4. Reversal of hyponatremia not only potentially life saving, but also allowed earlier engagement with rehab and earlier hospital discharge