Electrolyte disorders
Case-based discussion

2018/6/7
APSN/JSN CME Course 2018

Division of Nephrology
St. Luke’s International Hospital
Raku Son M.D., PGY6
Today’s cases

Case1
77F
Left leg pain
Na 112

Case2
39M
Seizure
Na 117

Case3
73M
General malaise
Na 120
Today’s cases

Case 1
77F
Left leg pain
Na 112
Case 1: 77F c/o Left leg pain

3 days PTA, Pt fell down on stairs at home
Hip X-ray showed left femoral neck fracture
Admitted to Orthopedics, waiting for the operation

On admission, Na was 128 mEq/L
Admission day 6 (2 days before the scheduled ope),
  Na dropped down to 116 mEq/L
Ortho started N/S 1L/day
Admission day 7, Na remained 112 mEq/L

Nephrology was consulted
Case 1: 77F c/o Left leg pain

Height 155 cm, Weight 45 kg, BMI 18.7

Vitals: Temp 36.8°C, BP 130/80 mmHg, HR 70 bpm, RR 16/min, SpO2 97% (room air)

Neuro: A&Ox3, CN II-XII intact, muscle strength 5/5

Head: no dry mouth mucous membranes, no JVD

Lung: CTA b/l, no wheezes

Heart: S1/S2 WNL, RRR, no m/r/g

Ext: pitting edema on left LE, good skin turgor

Chest X-ray: WNL

Echocardiogram: nl LV contraction, IVC 10/7 mm
Case 1: 77F c/o Left leg pain

<table>
<thead>
<tr>
<th>CBC</th>
<th>Chemi</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC 8300/μl</td>
<td>TP 6.2 g/dl</td>
</tr>
<tr>
<td>Hb 9.7 g/dl</td>
<td>Alb 2.4 g/dl</td>
</tr>
<tr>
<td>Hct 27.1%</td>
<td>Na 112 mEq/L</td>
</tr>
<tr>
<td>PLT 54.5万/μl</td>
<td>K 4.1 mEq/L</td>
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<tr>
<td></td>
<td>CL 95 mEq/L</td>
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<tr>
<td></td>
<td>Ca 7.4 mg/dl</td>
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<tr>
<td></td>
<td>IP 2.3 mg/dl</td>
</tr>
<tr>
<td></td>
<td>Mg 1.8 mg/dl</td>
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<tr>
<td></td>
<td>HCO₃ 18.4 mmol/L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Immune/Endocrine</th>
<th>Urinalysis</th>
<th>Urine chemi</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP 4.18 mg/dl</td>
<td>OB (-)</td>
<td>Na 128 mEq/L</td>
</tr>
<tr>
<td>TSH 3.170 μIU/ml</td>
<td>Uro (±)</td>
<td>K 14 mEq/L</td>
</tr>
<tr>
<td>Free T4 1.54 ng/dl</td>
<td>Pro (-)</td>
<td>CL 134 mEq/L</td>
</tr>
<tr>
<td>Free T3 1.9 pg/ml</td>
<td>WBC (1+)</td>
<td>Cre 16 mg/dl</td>
</tr>
<tr>
<td>Cortisol 20.79 μg/dl</td>
<td>Glu (-)</td>
<td>UA 13 mg/dl</td>
</tr>
<tr>
<td></td>
<td>ケトン (-)</td>
<td>Osm 334 mOsm/kg</td>
</tr>
</tbody>
</table>

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<td>SG 1.009</td>
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</tr>
<tr>
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</tr>
<tr>
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Case 1: 77F c/o Left leg pain

Q1. What are the possible diagnoses at this point?

• A: Low solute intake

• B: Hypovolemic hyponatremia

• C: Syndrome of inappropriate secretion of antidiuretic hormone (SIADH)

• D: Diuretic-induced hyponatremia
Case 1: 77F c/o Left leg pain

- Differential chart of hypotonic hyponatremia

Traditionally start with volume status evaluation
Utility of clinical volume evaluation

• Clinical volume status assessment is uncertain

  concentrations than did normovolemic patients. Clinical assessment correctly identified only 47 percent of hypovolemic patients and 48 percent of normovolemic patients. Thus, clinical assessment was of unsatisfactory; clinical prediction of hypovolemia was also characterized by low sensitivity (41.1%), but acceptable specificity (80%). In the polydipsia


• More physiology-based approach was suggested


• Physiology-based algorithm by inexperienced Drs performed better than senior Drs

Case 1: 77F c/o Left leg pain

- New diagnostic algorithm of hypotonic hyponatremia
  
  **Start with U-Osm and U-Na**

```
Urine osmolality

≤ 100 mOsm/kg
> 100 mOsm/kg

Urine sodium concentration

≤ 30 mmol/l
> 30 mmol/l

Low effective arterial blood volume

Diuretics or kidney disease?

No
```

## Case1: 77F c/o Left leg pain

- **Osmoregulation vs volume regulation**

<table>
<thead>
<tr>
<th>What is sensed</th>
<th>Effectors</th>
<th>Osmoregulation</th>
<th>Volume regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-Osm</td>
<td>ADH</td>
<td></td>
<td>ECV (effective circulating volume)</td>
</tr>
<tr>
<td>ADH</td>
<td>U-Osm</td>
<td></td>
<td>① Sympathetic N (norepinephrine)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>② ANP</td>
<td>③ ADH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>④ Renin-Angiotensin-Aldosterone</td>
<td>④ Renin-Angiotensin-Aldosterone</td>
</tr>
<tr>
<td>thirst</td>
<td>U-Na</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case1: 77F c/o Left leg pain

- New diagnostic algorithm of hypotonic hyponatremia

\[ \downarrow \text{ADH by osmoregulation} \]
appropriate in low osmolality

Case 1: 77F c/o Left leg pain

- Osmoregulation vs volume regulation

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<th>What is affected</th>
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<tr>
<td>P-Osm</td>
<td>ADH</td>
<td>U-Osm, thirst</td>
</tr>
<tr>
<td>ECV (effective circulating volume)</td>
<td>Sympathetic N (norepinephrine), ANP, ADH, Renin-Angiotensin-Aldosterone</td>
<td>U-Na</td>
</tr>
</tbody>
</table>

Hypovolemic hyponatremia is consistent with ↑ U-Osm and ↓ U-Na
Case 1: 77F c/o Left leg pain

- New diagnostic algorithm of hypotonic hyponatremia

\[ \uparrow \text{ADH} \uparrow \text{U-Na reabsorption by volume regulation appropriate in low ECV} \]

Case 1: 77F c/o Left leg pain

- Osmoregulation vs volume regulation

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<td></td>
<td>2. ANP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. ADH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Renin-Angiotensin-Aldosterone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U-Na</td>
<td>U-Na</td>
</tr>
</tbody>
</table>
Case 1: 77F c/o Left leg pain

- New diagnostic algorithm of hypotonic hyponatremia

Either inappropriate 

osmoregulation 
or volume regulation

Case 1: 77F c/o Left leg pain

Q1. What are the possible diagnoses at this point?

- A: Low solute intake
- B: Hypovolemic hyponatremia
- C: Syndrome of inappropriate secretion of antidiuretic hormone (SIADH)
- D: Diuretic-induced hyponatremia
Case 1: 77F c/o Left leg pain

Q1. What are the possible diagnoses at this point?

- A: Low solute intake
- B: Hypovolemic hyponatremia
- C: Syndrome of inappropriate secretion of antidiuretic hormone (SIADH)
- D: Diuretic-induced hyponatremia
Q2. Pt didn’t take any diuretics and was diagnosed as SIADH. Now orthopedics doctor asks to correct this Na of 112 mEq/L as fast as possible. What is the best treatment option?

- A: Water restriction < 1L
- B: 3% NaCl 80ml infusion over 20 min, repeat till Na rises by 5 mEq/L
- C: Increase N/S to 1.5L/day
- D: Call attending
Case 1: 77F c/o Left leg pain

- Algorithm for the management of hyponatraemia

Case 1: 77F c/o Left leg pain

- Treatment options of SIADH

**7.4.3. Patients with SIAD**

- **7.4.3.1.** In moderate or profound hyponatraemia, we suggest restricting fluid intake as first-line treatment (2D).
- **7.4.3.2.** In moderate or profound hyponatraemia, we suggest the following can be considered equal second-line treatments: increasing solute intake with 0.25–0.50 g/kg per day of urea or a combination of low-dose loop diuretics and oral sodium chloride (2D).
- **7.4.3.3.** In moderate or profound hyponatraemia, we recommend against lithium or demeclocycline (1D).
- **7.4.3.4.** In moderate hyponatraemia, we do not recommend vasopressin receptor antagonists (1C).
- **7.4.3.5.** In profound hyponatraemia, we recommend against vasopressin receptor antagonists (1C).
### Case 1: 77F c/o Left leg pain

- Rational of treatment of SIADH

<table>
<thead>
<tr>
<th>Solute load</th>
<th>Normal Min U-Osm 50 (mOsm/kg)</th>
<th>Mild CKD Min U-Osm 150 (mOsm/kg)</th>
<th>Advanced CKD Min U-Osm 250 (mOsm/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mOsm</td>
<td>6</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>600 mOsm</td>
<td>12</td>
<td>4</td>
<td>2.4</td>
</tr>
<tr>
<td>1200 mOsm</td>
<td>24</td>
<td>8</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Urine volume = \[
\frac{\text{Solute load}}{\text{Urine concentration}}\]
## Case 1: 77F c/o Left leg pain

- Rational of treatment of SIADH

<table>
<thead>
<tr>
<th>Osmoregulation</th>
<th>Normal Min U-Osm 50 (mOsm/kg)</th>
<th>Mild SIADH U-Osm 300 (mOsm/kg)</th>
<th>Severe SIADH U-Osm 600 (mOsm/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solute load</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 mOsm</td>
<td>6</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>600 mOsm</td>
<td>12</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1200 mOsm</td>
<td>24</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

### Treatment:

1. **Water restriction**
2. **Increase solute intake**
3. **Diuretics** (Loop or vaptans)
Case 1: 77F c/o Left leg pain

- 30-40% SIADH patients respond to fluid restriction as monotherapy
  

- The initial U-Osm < 400 mOsm/kg was observed in all patients treated only by fluid restriction
  
Q2. Pt didn’t take any diuretics and was diagnosed as SIADH. Now orthopedics doctor asks to correct Na as fast as possible. What is the best treatment option?

- A: Water restriction < 1L
- B: 3% NaCl 80ml infusion over 20 min, repeat till Na rises by 5 mEq/L
- C: Increase N/S to 1.5L/day
- D: Call attending

Case 1:

45kg U-Osm 334
45×10 mOsm/334 ÷1.35L
Q2. Pt didn’t take any diuretics and was diagnosed as SIADH. Now orthopedics doctor asks to correct Na as fast as possible. What is the best treatment option?

- **A: Water restriction < 1L**
- **B: 3% NaCl 80ml infusion over 20 min, repeat till Na rises by 5 mEq/L**
- **C: Increase N/S to 1.5L/day**
- **D: Call attending**

Case1:
45kg U-Osm 334
45×10 mOsm/334 ≈ 1.35L
Today’s cases

Case 2
39M
Seizure
Na 117
Case 2: 39M c/o Seizure

Pt found unconsciousness lying down on the floor. According to his wife, Pt had PMH of alcohol abuse and drunk alcohol 3L/day and diabetes mellitus on PO medications.

In the ER, one episode of generalized tonic-clonic seizure occurred, which resolved by 5 mg diazepam. Lab test revealed Na 117 and N/S 60ml/hr started. Head CT scan was negative.

Nephrology was consulted.
Case2: 39M c/o Seizure

170 cm, 62 kg, BMI 21.5

Vitals; Temp 37.3°C, BP 140/90 mmHg, HR 90 bpm, RR 20/min, SpO2 95% (room air)

Neuro; E1VM2M3, PERRL

Head; wet mouth mucous membranes, no JVD

Lung; CTA b/l, no wheezes

Heart; S1/S2 WNL, RRR, no m/r/g

Ext; no pitting edema, good skin turgor

Chest X-ray n.p.

Echocardiogram; nl LV contraction, IVC 7/3 mm
# Case 2: 39M c/o Seizure

## CBC
- WBC: 15800/μl
- Hb: 12.8 g/dl
- Hct: 34.0%
- PLT: 18.1万/μl

## Chemi
- TP: 6.0 g/dl
- Alb: 3.7 g/dl
- BUN: 5.5 mg/dl
- Cre: 0.58 mg/dl
- T-BIL: 1.1 mg/dl
- AST: 28 IU/L
- ALT: 13 IU/L
- LDH: 206 IU/L
- ALP: 208 IU/L
- γ-GTP: 15 IU/L
- CK: 732 U/L
- Na: 117 mEq/L
- K: 3.4 mEq/L
- CL: 86 mEq/L
- Ca: 8.5 mg/dl
- IP: 1.7 mg/dl
- Mg: 1.7 mg/dl
- HCO₃: 14.3 mmol/L

## Immune/Endocrine
- CRP: 0.51 mg/dl
- TSH: 2.8 μIU/ml
- Free T4: 1.37 ng/dl
- Free T3: 3.0 pg/ml
- Cortisol: 24.43 μg/dl

## Urinalysis
- SG: 1.010
- pH: 6.0
- OB: (1+)
- Uro: (±)
- Pro: (-)
- WBC: (-)
- Glu: (-)
- ケトン: (-)
- Na: 104 mEq/L
- K: 13 mEq/L
- CL: 76 mEq/L
- Glu: 15 mg/dl
- Pro: 4 mg/dl
- UN: 179 mg/dl
- Cre: 37 mg/dl
- UA: 58 mg/dl
- Osm: 363 mOsm/kg
Case 2: 39M c/o Seizure

Q3. What is the appropriate treatment?

- A: Water restriction < 1.5L
- B: 3% NaCl 120ml infusion over 20 min, repeat till Na rises by 5 mEq/L
- C: Increase N/S to 120ml/hr
- D: Start tolvaptan 7.5 mg
Case 2: 39M c/o Seizure

- Algorithm for the management of hyponatraemia

Case 2: 39M c/o Seizure

- Indications for hypertonic saline

  Hypotonic hyponatraemia

  Acute or severe symptoms?

  - Yes
    Consider immediate treatment with hypertonic saline (Section 7)
  - No

  Acute or Severe = hypertonic saline

  7.1.1.1. We recommend prompt i.v. infusion of 150 ml 3\% hypertonic over 20 min (1D).
  7.1.1.2. We suggest checking the serum sodium concentration after 20 min while repeating an infusion of 150 ml 3\% hypertonic saline for the next 20 min (2D).
  7.1.1.3. We suggest repeating therapeutic recommendations 7.1.1.1 and 7.1.1.2 twice or until a target of 5 mmol/l increase in serum sodium concentration is achieved (2D).

  Target $\Delta Na = 5$ mEq/L

Case 2: 39M c/o Seizure

- Prescription of 3% NaCl
  400 ml N/S + 120 ml 10% NaCl
- Infuse either 150 ml or 2ml/kg over 20min

- Estimation of ΔNa after 2ml/kg 3% NaCl

\[ \text{Na}_{\text{pre}} + \Delta \text{Na} = \frac{\text{Na}_{\text{pre}} \times \text{TBW}}{\text{TBW}} + \frac{2\text{ml/kg} \times \text{BW} \times 0.03 \times 17}{2\text{ml/kg} \times \text{BW}} \]

Small enough to dismiss

\[ \div \text{Na}_{\text{pre}} + \frac{2\text{ml/kg} \times \text{BW} \times 0.03 \times 17}{\text{BW} \times 0.6} \]

\[ \Delta \text{Na} \div 2 \times 0.03 \times 17/0.6 \div 1.7 \text{ mEq/L} \]
Case2: 39M c/o Seizure

Q3. What is the appropriate treatment?

- A: Water restriction < 1.5L
- B: 3% NaCl 120ml infusion over 20 min, repeat till Na rises by 5 mEq/L
- C: Increase N/S to 120ml/hr
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Case 2: 39M c/o Seizure

Q3. What is the appropriate treatment?

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• B: 3% NaCl 120ml infusion over 20 min, repeat till Na rises by 5 mEq/L

• C: Increase N/S to 120ml/hr

• D: Start tolvaptan 7.5 mg
Case 2: 39M c/o Seizure

Q4. N/S 60ml/hr was continued. After 2 doses of 3% NaCl 120 ml infusion, Na raised from 117 to 124. Pt urine volume increased from 40ml/hr to 500 ml/hr. Urine test came back with U-Na 18 mEq/L, U-K 3 mEq/L, U-Cl 25 mEq/L. What’s the appropriate reaction?

A: Decrease N/S from 60ml/hr to 30ml/hr
B: Start 5%DW 500 ml/hr
C: Give desmopressin
D: Put in NG tube and give water at 1L/hr
Case 2: 39M c/o Seizure

- Limit ΔNa to avoid overcorrection

7.1.2.4. We recommend limiting the increase in serum sodium concentration to a total of 10 mmol/l during the first 24 h and an additional 8 mmol/l during every 24 h thereafter until the serum sodium concentration reaches 130 mmol/l (1D).


Overcorrection

Limit ΔNa 8-10mEq/L

Acute or severe hyponatremia

Case2: 39M c/o Seizure

- Risks of overcorrection are not well established, but clinically suggested below

<table>
<thead>
<tr>
<th>TABLE 2. Risk factors for excessive “autocorrection” of hyponatremia, upon resolution of excessive AVP secretion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syndrome of inappropriate antidiuretic hormone secretion related to nausea, vomiting, hypoxia or medications</td>
</tr>
<tr>
<td>Brain edema</td>
</tr>
<tr>
<td>Excessive fluid intake, when combined with stress/excessive AVP release (eg, marathon runners)</td>
</tr>
<tr>
<td>Stress</td>
</tr>
<tr>
<td>Neurological disease</td>
</tr>
<tr>
<td>Nociceptive stimuli</td>
</tr>
<tr>
<td>Cortisol deficiency</td>
</tr>
<tr>
<td>Thiazide diuretics</td>
</tr>
</tbody>
</table>

Case2: 39M c/o Seizure

- Risks of development of ODS

<table>
<thead>
<tr>
<th>TABLE 1. Risk factors for the development of ODS</th>
</tr>
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<tbody>
<tr>
<td>Hyponatremia &gt;48 hr</td>
</tr>
<tr>
<td>Initial serum sodium &lt;105 mEq/L</td>
</tr>
<tr>
<td>Development of hypernatremia during treatment</td>
</tr>
<tr>
<td>Rapid (&gt;0.5 mEq·L⁻¹·hr⁻¹) and/or large increase (&gt;25 mEq/L per 48 hr) in serum sodium</td>
</tr>
<tr>
<td>Severe malnutrition (low blood urea nitrogen)</td>
</tr>
<tr>
<td>Alcoholics</td>
</tr>
<tr>
<td>Advanced liver disease</td>
</tr>
<tr>
<td>Hypokalemia</td>
</tr>
<tr>
<td>Hypoxemia</td>
</tr>
<tr>
<td>Use of diuretics (especially thiazides)</td>
</tr>
<tr>
<td>Cancer</td>
</tr>
<tr>
<td>Seizure on presentation</td>
</tr>
</tbody>
</table>

- Some experts prefer ΔNa 8 mEq/L if ODS risks high


Case 2: 39M c/o Seizure

- **Choices to avoid overcorrection**
  
  7.5.1.3. We recommend consulting an expert to discuss if it is appropriate to start an infusion of 10 ml/kg body weight of electrolyte-free water (e.g. glucose solutions) over 1 h under strict monitoring of urine output and fluid balance (1D).

  7.5.1.4. We recommend consulting an expert to discuss if it is appropriate to add i.v. desmopressin 2 μg, with the understanding that this should not be repeated more frequently than every 8 h (1D).

- Large amount of 5%DW can potentially cause hyperglycemia, which needs continuous insulin, leading to hypokalemia in situation of increased urine volume

- We prefer add desmopressin together once urine volume > 200ml/hr in our institution
Case 2: 39M c/o Seizure

- Q4. N/S 60ml/hr was continued. After 2 doses of 3% NaCl 120 ml infusion, Na raised from 117 to 124. Pt urine volume increased from 40ml/hr to 500 ml/hr. Urine test came back with U-Na 18 mEq/L, U-K 3 mEq/L, U-Cl 25 mEq/L. What’s the appropriate reaction?

  - A: Decrease N/S from 60ml/hr to 30ml/hr
  - B: Start 5%DW 500 ml/hr
  - C: Give desmopressin
  - D: Put in NG tube and give water at 1L/hr
Case2: 39M c/o Seizure

Q4. N/S 60ml/hr was continued. After 2 doses of 3% NaCl 120 ml infusion, Na raised from 117 to 124. Pt urine volume increased from 40ml/hr to 500 ml/hr. Urine test came back with U-Na 18 mEq/L, U-K 3 mEq/L, U-Cl 25 mEq/L. What’s the appropriate reaction?

A: Decrease N/S from 60ml/hr to 30ml/hr
B: Start 5%DW 500 ml/hr
C: Give desmopressin
D: Put in NG tube and give water at 1L/hr

Case2 ΔNa 7 mEq/L
High risks of ODS
PMH of DM with Glu 150
Today’s cases

Case 3
73M
General malaise
Na 120
Case 3: 73M c/o General malaise

- Diagnosed as Stage IV NSCLC with brain metastases 1 year ago
- Failed 1\textsuperscript{st} line therapy and started on nivolumab 4 months ago
- General malaise noticed 1 week ago
- On regular follow-up, \textbf{Na 120 mEq/L} revealed
- No history of excess drink

- Nephrologist was consulted
Case3: 73M c/o General malaise

• 165 cm, 66.2 kg, BMI 24.3

• Vitals; Temp 36.2°C, BP 130/70 mmHg, HR 90 bpm, 16/min, SpO2 96% (room air)

• Neuro; A&Ox3, CN II-XII intact

• Head; wet mouth mucous membranes, no JVD

• Lung; CTA b/l, no wheezes

• Heart; S1/S2 WNL, RRR, no m/r/g

• Ext; no pitting edema, poor skin turgor

• Chest X-ray; known left lung mass

• Echocardiogram; nl LV contraction, IVC 8/4 mm
### Case 3: 73M c/o General malaise

<table>
<thead>
<tr>
<th>CBC</th>
<th>WBC: 6000/μL</th>
<th>Hb: 14.1 g/dl</th>
<th>Hct: 40.2%</th>
<th>PLT: 32.7万/μL</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Chemi</th>
<th>TP: 6.4 g/dl</th>
<th>Alb: 3.3 g/dl</th>
<th>Na: 120 mEq/L</th>
<th>K: 3.9 mEq/L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BUN: 8.0 mg/dl</td>
<td>Cre: 0.73 mg/dl</td>
<td>K: 87 mEq/L</td>
<td>Cl: 87 mEq/L</td>
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<tr>
<td></td>
<td>T-BIL: 1.1 mg/dl</td>
<td>AST: 30 IU/L</td>
<td>Ca: 9.2 mg/dl</td>
<td>IP: 2.6 mg/dl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ALT: 13 IU/L</td>
<td>Mg: 1.7 mg/dl</td>
<td>Mg: 1.7 mg/dl</td>
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<tr>
<td></td>
<td></td>
<td>LDH: 204 IU/L</td>
<td>HCO₃: 24.5 mmol/L</td>
<td>P-Osm: 240 mOsm/L</td>
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<td></td>
<td></td>
<td>ALP: 179 IU/L</td>
<td>UA: 6.8 mg/dl</td>
<td>TG: 128 mg/dl</td>
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<tr>
<td></td>
<td></td>
<td>γ-GTP: 15 IU/L</td>
<td>Glu: 181 mg/dl</td>
<td>Glu: 181 mg/dl</td>
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<tr>
<td></td>
<td></td>
<td>CK: 45 U/L</td>
<td>Glu: 181 mg/dl</td>
<td>Osm: 467 mOsm/kg</td>
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<tr>
<th>Urine chemi</th>
<th>Na: 117 mEq/L</th>
<th>K: 33 mEq/L</th>
<th>Cre: 151 mg/dl</th>
<th>UA: 53 mg/dl</th>
<th>Osm: 467 mOsm/kg</th>
</tr>
</thead>
</table>

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**CBC**
- WBC: 6000/μL
- Hb: 14.1 g/dl
- Hct: 40.2%
- PLT: 32.7万/μL

**Chemistry**
- TP: 6.4 g/dl
- Alb: 3.3 g/dl
- Na: 120 mEq/L
- K: 3.9 mEq/L
- CL: 87 mEq/L
- BUN: 8.0 mg/dl
- Cre: 0.73 mg/dl
- T-BIL: 1.1 mg/dl
- AST: 30 IU/L
- ALT: 13 IU/L
- LDH: 204 IU/L
- ALP: 179 IU/L
- γ-GTP: 15 IU/L
- CK: 45 U/L
- P-Osm: 240 mOsm/L
- Ca: 9.2 mg/dl
- IP: 2.6 mg/dl
- Mg: 1.7 mg/dl
- HCO₃: 24.5 mmol/L
- UA: 6.8 mg/dl
- TG: 128 mg/dl
- Glu: 181 mg/dl

**Urinalysis**
- SG: 1.012
- Ob: (-)
- pH: 6.0
- Uro: (+)
- Pro: (-)
- WBC: (-)
- Glu: (-)
- ケトン: (-)

**Urine chemistry**
- Na: 117 mEq/L
- K: 33 mEq/L
- Cre: 151 mg/dl
- UA: 53 mg/dl
- Osm: 467 mOsm/kg
Case3: 73M c/o General malaise

Q5. What is the most likely diagnosis?

A: Hypovolemic hyponatremia
B: SIADH
C: Low solute intake
D: Not sure at this point
Case 3: 73M c/o General malaise

- Hyponatremia in cancer patients is common
- Don’t forget possibilities listed below

<table>
<thead>
<tr>
<th>Etiology of hyponatremia</th>
<th>Clinical examples specific to the cancer patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudohyponatremia</td>
<td>Paraproteinemias</td>
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<tr>
<td>Reduced water excretion</td>
<td>Underlying CKD or AKI</td>
</tr>
<tr>
<td>Decreased circulating volume</td>
<td>Nausea, vomiting, nasogastric suctioning, and diarrhea; hematemesis or hematochezia (gastrointestinal malignancies or steroid-induced ulcer disease)</td>
</tr>
<tr>
<td>Decreased effective circulating volume</td>
<td>Underlying or new onset of CHF, cirrhosis, ascites, severe hypoalbuminemia, veno-occlusive disease</td>
</tr>
<tr>
<td>SIADH</td>
<td>Tumor release of ADH: SCLC and head and neck cancer</td>
</tr>
<tr>
<td></td>
<td>Chemotherapy: cyclophosphamide, cisplatin/carboplatin, vincristine, vinblastine</td>
</tr>
<tr>
<td></td>
<td>Other drugs: SSRIs, NSAIDs</td>
</tr>
<tr>
<td>Nonosmotic stimuli for ADH</td>
<td>Pain, nausea, vomiting</td>
</tr>
<tr>
<td>Salt wasting</td>
<td>Cisplatin</td>
</tr>
</tbody>
</table>

Brain (including pituitary), thyroid, adrenal metastases

Q5. What is the most likely diagnosis?

- A: Hypovolemic hyponatremia
- B: SIADH
- C: Low solute intake
- D: Not sure at this point
Q5. What is the most likely diagnosis?

A: Hypovolemic hyponatremia

B: SIADH

C: Low solute intake

D: Not sure at this point
Case 3: 73M c/o General malaise

Q6. Cortisol was 1.31 μg/dL. What is the cause of his adrenal insufficiency?

• A: Nivolumab
• B: Nivolumab
• C: Nivolumab
• D: or not
Case 3: 73M c/o General malaise

- Anticytotoxic anti-T-cell antigen-4 antibodies (anti-CTLA4) or anti-programmed cell death-protein antibodies (anti-PD-1) approved for melanoma, NSCLC and renal cell carcinoma.

- Immune-related adverse event (irAE) in immune checkpoint inhibitors are reported including hypophysitis, thyroid dysfunction, adrenal insufficiency and type 1 DM.

- Hypophysitis 0.1-6.4%, hyperthyroidism 0.6-8.0%, hypothyroidism 3.8-13%, adrenal insufficiency 1-3%.

Case3: 73M c/o General malaise

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• A: Nivolumab

• B: Nivolumab

• C: Nivolumab

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CT scan r/o adrenal metastases
Brain MRI r/o hypophysitis
normal ACTH and thyroid function
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Take home message

• Na of urine is the key for differentials
• Important is symptom, not number
• Goal for severe hyponatremia is ΔNa 5
• Avoid overcorrection by 5%DW or DDAVP
• Thyroid and adrenal functions should be checked in all hyponatremia Pt
• Always review meds in hyponatremia Pt
Take home message

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