Chapter 53: Drug-Induced Acute Kidney Injury: Not a Cute Consequence Level II

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LEARNING OBJECTIVES

After completing this case study, the reader should be able to:

- Evaluate clinical and laboratory findings in a patient with acute kidney injury (AKI).
- Select pharmacotherapy for treatment of complications associated with AKI.
- Assess appropriateness of aminoglycoside serum concentrations in relation to efficacy and toxicity.
- Develop strategies to prevent drug-induced AKI, including the selection of pharmacologic alternatives that do not adversely affect kidney function.
- Adjust drug dosages based on kidney function to maximize efficacy and minimize adverse events.

PATIENT PRESENTATION

Chief Complaint

Not available

HPI

Wilbur Elliott is a 79-year-old man who originally presented to the hospital 1 month ago with symptoms of heart failure that required open heart surgery for mitral valve replacement. His surgery was complicated by a 1-hour hypotensive episode, with BP of 70/50 mm Hg during surgery. Three days postoperation, purulent drainage was noted from the surgical site, and he was subsequently diagnosed with mediastinitis. At that time, he was in septic shock with severe hypotension. He was found to have Serratia bacteremia (blood cultures × 4 positive for Serratia marcescens, sensitive to gentamicin, piperacillin, cefepime, ceftriaxone, and ciprofloxacin; resistance was noted to ampicillin). Therapy was initiated with gentamicin and cefepime. Thus far, he has completed day 21 of a 6-week course of antibiotics. A gradual increase in his BUN and serum creatinine concentrations from baseline has been noted (Table 53-1), and signs of volume overload are present.
TABLE 53-1
Scr, BUN, and Serum Gentamicin Concentrations During Hospitalization

<table>
<thead>
<tr>
<th>Postoperative Day</th>
<th>Scr (mg/dL)</th>
<th>BUN (mg/dL)</th>
<th>Gentamicin (mcg/mL)</th>
<th>Gentamicin Dosages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peak&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Trough&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1.5</td>
<td>21</td>
<td>6.3</td>
<td>1.1</td>
</tr>
<tr>
<td>7</td>
<td>1.8</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2.1</td>
<td>31</td>
<td>6.9</td>
<td>1.8</td>
</tr>
<tr>
<td>14</td>
<td>2.7</td>
<td>38</td>
<td>8.3</td>
<td>2.5</td>
</tr>
<tr>
<td>17</td>
<td>3.1</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>3.2</td>
<td>50</td>
<td>9.4</td>
<td>2.7</td>
</tr>
</tbody>
</table>

BUN, blood urea nitrogen; Scr, serum creatinine.

<sup>a</sup>Serum drug concentrations drawn 30 minutes after a 30-minute infusion.

<sup>b</sup>Serum drug concentrations drawn immediately before a dose.

PMH

Mechanical mitral valve replacement surgery 28 days ago
Type 2 DM
CKD
Dyslipidemia
Osteoarthritis
HTN
Heart failure
Depression

FH

Father had type 2 DM.

SH

Denies smoking or alcohol; retired coal miner (11 years ago)
**Meds**

Gentamicin (see Table 53-1 for dosages and serum drug concentrations; gentamicin is currently on hold)

Cefepime 2 g IVPB Q 12 H

Warfarin 5 mg PO once daily

Enalapril 10 mg PO twice daily

Metoprolol succinate XL 50 mg PO daily

Furosemide 40 mg PO Q 12 H

Atorvastatin 20 mg PO daily

Escitalopram 10 mg PO daily

Glipizide 10 mg PO daily

Spironolactone 12.5 mg PO daily (currently on hold)

Ibuprofen 400 mg PO Q 4–6 H PRN pain (started today for joint pain)

All

NKDA

**ROS**

Currently complains of trouble breathing, weakness, general malaise, and pain in right hand. No fever or chills.

**PE**

Gen

Confused-appearing man in mild distress

VS

BP 125/75 mm Hg, P 68 bpm, RR 26, T 37.7°C; current Wt 176 lb (80 kg); admission Wt 165 lb (75 kg), Ht 5'9" (175 cm)

Skin

Surgical incision site healing with no drainage

HEENT

PERRLA, EOMI, poor dentition

**Neck/Lymph Nodes**

(+) JVD

**Chest**
Basilar crackles

CV

S₁, S₂ normal, no S₃, irregular rhythm

Abd

Soft, nontender, (+) BS, (-) HSM

Genit/Rect

(-) Masses

MS/Ext

2+ sacral edema; some tenderness and limited motion in right hand

Neuro

A&O to person and place, but not to time

Labs (Current)

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>139 mEq/L</td>
</tr>
<tr>
<td>Hgb</td>
<td>9.7 g/dL</td>
</tr>
<tr>
<td>Ca</td>
<td>8.6 mg/dL</td>
</tr>
<tr>
<td>K</td>
<td>3.7 mEq/L</td>
</tr>
<tr>
<td>Hct</td>
<td>29.5%</td>
</tr>
<tr>
<td>Mg</td>
<td>2.1 mg/dL</td>
</tr>
<tr>
<td>Cl</td>
<td>103 mEq/L</td>
</tr>
<tr>
<td>Pkt</td>
<td>303 × 10³/mm³</td>
</tr>
<tr>
<td>Phos</td>
<td>4.4 mg/dL</td>
</tr>
<tr>
<td>CO₂</td>
<td>24 mEq/L</td>
</tr>
<tr>
<td>WBC</td>
<td>8.6 × 10³/mm³</td>
</tr>
<tr>
<td>INR</td>
<td>2.7</td>
</tr>
<tr>
<td>BUN</td>
<td>50 mg/dL</td>
</tr>
<tr>
<td>(BUN 19 mg/dL on admission)</td>
<td></td>
</tr>
<tr>
<td>SCr</td>
<td>3.2 mg/dL</td>
</tr>
<tr>
<td>(SCr 1.5 mg/dL on admission)</td>
<td></td>
</tr>
<tr>
<td>Glu</td>
<td>119 mg/dL</td>
</tr>
</tbody>
</table>

UA

Color, yellow; character, hazy; glucose (-); ketones (-); SG 1.010; pH 5.0; protein 30 mg/dL; coarse granular casts 5–10/lpf; WBC 0–3/hpf; RBC 0–2/hpf; no bacteria; nitrite (-); osmolality 325 mOsm; urinary sodium 45 mEq/L; creatinine 33 mg/dL, FEₐ₉ 3.1%

Repeat Blood Cultures Today

Negative

Fluid Intake/Output and Daily Weights
Assessment

AKI with extracellular fluid expansion

QUESTIONS

Collect Information

1.a. What subjective and objective information indicates the presence of AKI with extracellular fluid expansion?

1.b. What additional information is needed to fully assess this patient's AKI?

Assess the Information

2.a. Assess the severity of AKI based on the subjective and objective information available. Assessment of AKI includes the stage and category of AKI (prerenal, intrinsic, postrenal), as well as estimation of creatinine clearance.

2.b. Create a list of the patient's drug therapy problems and prioritize them. Include assessment of medication appropriateness, effectiveness, safety, and patient adherence.

Develop a Care Plan

3.a. What are the goals of pharmacotherapy in this case, including goal(s) related to drug dosage adjustments in AKI?

3.b. What nondrug therapies might be useful for this patient?

3.c. What feasible pharmacotherapeutic alternatives are available for treating AKI?

3.d. Create an individualized, patient-centered, team-based care plan to optimize medication therapy for this patient's AKI and other drug therapy problems. Include specific drugs, dosage forms, doses, schedules, and durations of therapy.

Implement the Care Plan

4.a. What information should be provided to the patient to enhance compliance, ensure successful therapy, and minimize adverse effects?

4.b. Describe how care should be coordinated with other healthcare providers.

Follow-up: Monitor and Evaluate

5.a. What clinical and laboratory parameters should be used to evaluate the therapy for achievement of the desired therapeutic outcome and to detect or prevent adverse effects?
Develop a plan for follow-up that includes appropriate time frames to assess progress toward achievement of the goals of therapy.

ADDITIONAL CASE QUESTIONS

1. What risk factors did the patient have for gentamicin-induced AKI?

2. What therapeutic interventions could have been initiated to decrease the likelihood of developing drug-induced AKI?

3. Could extended-interval gentamicin dosing have minimized the likelihood of nephrotoxicity?

SELF-STUDY ASSIGNMENTS

1. Create a list of medications that can cause AKI and that should be avoided in patients at risk for AKI.

2. Assume that Mr Elliott's serum creatinine is 1.4 mg/dL at 1 month after discharge. At what point would you restart his medications for treatment of heart failure?

CLINICAL PEARL

A “triple whammy” effect on kidney function can be seen what patients are administered angiotensin converting enzyme inhibitors or angiotensin receptor antagonists, diuretics, and nonsteroidal anti-inflammatory drugs, especially in the elderly.

REFERENCES


