AZOTEMIA & ACUTE KIDNEY INJURY

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FIRST-TIME DIAGNOSIS OF AZOTEMIA OR ACUTE-ONSET AZOTEMIA

INVESTIGATION
Assess USG

HYPERSTHENURIA PRESENT
(dogs, ≥1.030; cats, ≥1.035)?

YES

TREATMENT
If prerenal dehydration/azotemia confirmed (eg, skin tenting, tacky mucous membranes, elevated serum albumin concentration), initiate fluid therapy to rehydrate patient (Table 2)

Azotemia resolves?

YES

Volume-responsive azotemia

DIAGNOSIS
Prerenal azotemia superimposed on inability to concentrate urine (eg, diabetes mellitus, hypoadrenocorticism, hypercalcemia, pyometra)

NO

NO

PROBABLE RENAL AZOTEMIA

TREATMENT
Reassess adequacy of volume replacement after 24 and 48 hours; continue fluid therapy

INVESTIGATION
Rule out CKD and acute-on-chronic kidney disease (Table 1)

TREATMENT
Initiate fluid therapy (if not already started) to rehydrate patient (Table 2)

Azotemia resolves?

YES

Suspect AKI and pursue therapy (page 30)

AKI = acute kidney injury
CKD = chronic kidney disease
USG = urine specific gravity
Suggested Reading


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**TABLE 1**

**HISTORY, EXAMINATION, & LABORATORY FINDINGS OF CKD & AKI**

<table>
<thead>
<tr>
<th>Findings</th>
<th>CKD</th>
<th>AKI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight loss, poor coat, poor body condition</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Small, irregular kidneys (on radiography or palpation)</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Nonregenerative anemia</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Acidosis/hyperkalemia</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Oliguria/anuria</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Small, irregular kidneys with hyperechoic cortices with or without loss of corticomedullary junction (on ultrasonography)</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Chronic history of polyuria/polydipsia or stage 1 CKD</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Urine sediment changes compatible with tubular cell damage (eg, granular casts, renal tubular epithelial cells)</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Relatively severe signs for magnitude of azotemia</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

*+ = presence more likely; - = presence less likely

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**TABLE 2**

**EXAMPLE OF FLUID VOLUME REQUIREMENTS FOR A 20-KG DOG WITH 8% DEHYDRATION & AKI**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficit needs (8% × 20 kg over 6 hours)</td>
<td>= 1600 mL (replace over 4-6 hours)</td>
</tr>
<tr>
<td>Maintenance (60 mL/kg/day)</td>
<td>= 1200 mL/day</td>
</tr>
<tr>
<td>Continuing losses (dog vomits 4 times at 100 mL/episode)</td>
<td>= 400 mL/day</td>
</tr>
<tr>
<td>Total</td>
<td>= 3200 mL/day (deficit replaced over 4-6 hours if possible)</td>
</tr>
</tbody>
</table>

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**TABLE 3**

**HYPOTHETICAL COMPARISON OF TOTAL FLUID NEEDS IN NORMAL, OLIGURIC, & POLYURIC DOGS**

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Oliguric</th>
<th>Polyuric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insensible fluid needs</td>
<td>20 mL/kg/day</td>
<td>20 mL/kg/day</td>
<td>20 mL/kg/day</td>
</tr>
<tr>
<td>Sensible fluid needs (urine output)</td>
<td>40 mL/kg/day</td>
<td>6 mL/kg/day</td>
<td>165 mL/kg/day</td>
</tr>
<tr>
<td>Total</td>
<td>60 mL/kg/day</td>
<td>26 mL/kg/day</td>
<td>185 mL/kg/day</td>
</tr>
</tbody>
</table>
**AKI SUSPECTED**

**INVESTIGATION**
Perform complete minimum database (ie, CBC, serum chemistry profile with electrolytes, urinalysis with sediment examination, BP)

**DIAGNOSTICS**
- Leptospirosis serum titers and urine leptospirosis PCR
- Urine culture, UP:C
- Abdominal ultrasonography to find obstruction caused by nephrolithiasis, evidence of pyelonephritis, or abdominal effusion

**TREATMENT**
- Leptospirosis serum titers and urine leptospirosis PCR
- Urine culture, UP:C
- Abdominal ultrasonography to find obstruction caused by nephrolithiasis, evidence of pyelonephritis, or abdominal effusion

**INVESTIGATION**
Rule out CKD via imaging, history, and physical examination (*Table 1*, page 29)

**CAUSE KNOWN?**

**NO**

**TREATMENT**
Fluid therapy

**STEP 1**
Choose replacement fluids (eg, lactated Ringer solution, 0.9% NaCl [if hyperkalemic])

**STEP 2**
Estimate dehydration % (eg, skin tenting, capillary refill time, central venous pressure); determine timeline for correction (eg, 4-6 hours; *Table 2*, page 29)

**STEP 3**
Determine if electrolyte supplementation needed (eg, KCl ≤0.5 mEq/kg/hr)

**STEP 4**
Initiate fluid therapy
- Measure body weight every 4-6 hours
- Quantify urine output if possible (*Table 3*, page 29)

**STEP 5**
Reassess
- If weight loss occurs, calculate kg lost × 1000 and add to current fluid rate; recheck weight in 4-6 hours
- Base fluid therapy volume on urine output

**STEP 6**
Monitor for signs of overhydration (eg, increased bronchovesicular sounds, tachycardia, serous nasal discharge, chemosis, weight gain, increased central venous pressure)
- Recheck creatinine and electrolytes every 6-24 hours

**YES**

**TREATMENT**
Treat underlying condition (eg, toxicity, thromboembolism)

**ANURIA**
- Urine output 0 mL/kg/hr, despite adequate rehydration
- Cautious use of volume expansion and/or diuretics because of no proven benefit
- Reassess
- Prognosis poor, especially if no response to therapy and worsening azotemia

**OLIGURIA**
- Urine output <0.5 mL/kg/hr after rehydration
- Cautious use of volume expansion and/or diuretics because of no proven benefit
- Reassess
- Prognosis guarded, unless converted to polyuria, for which prognosis improves with response to rehydration

**POLYURIA**
- Urine output >1 mL/kg/hr
- Base fluid rate on output and body weight gain or loss
- Prognosis is fair-to-good, especially with resolving azotemia

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AKI = acute kidney injury  
BP = blood pressure  
CKD = chronic kidney disease  
PCR = polymerase chain reaction  
UP:C = urine protein:creatinine  
USG = urine specific gravity