Overview of the Issue
This lecture will review basic concepts of fluid therapy in adult ruminant animals. Topics covered will include intravenous and oral fluids, how to make your own fluids, and blood transfusions.

Objectives of the Presentation
1) What is the problem?
2) What solution will most likely correct the problem?
3) How much is needed?
4) Route and rate of administration?

Key Etiologic and Pathophysiologic Points

- **Adult Cattle: Generalizations**
  - Anorexic adult ruminants tend to become alkalotic
    - With-holding feed for several days
    - Mild hypokalemia
  - Cattle w/ GI problems: hypochloremic, hypokalemic metabolic alkalosis
  - Cattle/small ruminants with grain overload, choke/dysphagia, urinary or severe GI obstructions: Acidosis

- **Assessment of Fluid Deficits**

It can be difficult to assess the hydration status of an adult ruminant. The chart below gives some guidelines for assessment.

- **Mentation**
- **Mucous membrane color**
  - Pink $\rightarrow$ Normal
  - Pale $\rightarrow$ Either Shock or Anemia (check PCV)
  - Bright Pink $\rightarrow$ Increased capillary circulation
  - Red to Brick Red $\rightarrow$ Poor capillary perfusion
  - Grey-Blue $\rightarrow$ Severe shock & cyanosis
  - Tacky or Dry $\rightarrow$ shock (dehydration)

- **Capillary refill time**
  - $>2$ seconds $\rightarrow$ shock

- **Pulse quality**
- **Heart rate**
- **Peripheral perfusion**
Guide for Estimating Dehydration in Adult Ruminants

<table>
<thead>
<tr>
<th>Dehydration Level</th>
<th>Signs of Dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Dehydration (6-8%)</td>
<td>slight eyeball recession, skin tent slightly prolonged (2-4 seconds), mucous membranes moist</td>
</tr>
<tr>
<td>Moderate Dehydration (8-10%)</td>
<td>eyes obviously sunken, skin tent obviously prolonged (4-8 seconds), mucous membranes tacky</td>
</tr>
<tr>
<td>Severe Dehydration (10-12%)</td>
<td>eyes severely sunken into orbits, skin remains tented indefinitely, mucous membranes dry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Animal Weight</th>
<th>Volume (liters) of Fluids Required to Correct % Dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds (kg)</td>
<td>5%</td>
</tr>
<tr>
<td>500 (227)</td>
<td>11</td>
</tr>
<tr>
<td>750 (341)</td>
<td>17</td>
</tr>
<tr>
<td>1000 (455)</td>
<td>23</td>
</tr>
<tr>
<td>1500 (682)</td>
<td>34</td>
</tr>
<tr>
<td>1750 (795)</td>
<td>40</td>
</tr>
<tr>
<td>2000 (909)</td>
<td>45</td>
</tr>
</tbody>
</table>

Fluid therapy in adult cattle generally can
- Guess and Re-Assess
  - Initial Plan: Guess
    - % dehydration
    - Maintenance + Ongoing losses
      - Lactation
      - Diarrhea
  - Treat Deficit
  - Re-assess
- What types of fluids should be given?
Adult ruminants almost always become alkalotic. This means that alkalinizing solutions (LRS, isotonic bicarbonate) are rarely indicated in these animals. When treating dehydrated cattle, it is important to remember to maintenance needs of the animal in addition to correcting the dehydration. Acidifying solutions (most useful in adult animals) include 0.9% NaCl and Ringer’s solution.

Oral Fluids

- How much?
  - Oral replacement
    - 5-10 gallons (19 – 38 L)
      - 1-4 L (small ruminants)
  - IV replacement
    - Maximum
      - 40 mL/kg/h (adults)
        - 14g catheter
        - Difficult to exceed 7 L/h
    - IV fluid therapy is indicated in the following conditions:
      - > 8% dehydration
      - Acute blood loss
      - Clinical evidence of shock
      - Animals with obstructive GI disease
      - Animals that are endotoxemic
  - Maintenance Requirement
    - Non-lactating adult ruminant:
      - 35-50 ml/kg/day (1000 lb cow = 22.7 L)
        - 1.5-2 ml/kg/hr
    - Lactation
      - 50 ml/kg/day + Ongoing losses
        - Eg: 44 lbs milk = 20 L

Key Points

- Alkalosis
  - Surgical Conditions Causing Alkalosis in Adult Ruminants
    - LDA
    - Abomasal volvulus
    - Vagal indigestion
    - Traumatic reticuloperitonitis
    - Peritonitis
    - Almost any condition that results in anorexia and gastrointestinal stasis
  - Fluid Therapy for Alkalosis
- Alkalosis treated with excess anions (less cations)
- Cl- and K+ rich solutions
- Metabolic alkalosis generally accompanied by hypochloremia, hypokalemia
- Acidifying (Low SID)
  - Normal Saline
    - 0.9%
  - Hypertonic Saline
    - 7.2%
    - Follow w/ isotonic oral or IV fluids
  - Ringer’s

- Acidosis
  - More common in calves
    - Dehydration
    - Diarrhea
  - Surgical Conditions that Cause Acidosis Commonly
    - Grain Overload
    - Choke
    - Urinary Tract Disease
    - Small Intestinal Obstruction/Strangulation
    - Alkalosis first, then acidosis in later stages
  - Fluid Therapy for Acidosis
    - Alkalinizing (High SID)
      - Sodium Bicarbonate
        - Isotonic = 1.3%
    - Lactated Ringers
    - Normosol
    - Multisol
    - Metabolizable bases:
      - Lactate, acetate, gluconate
      - Lactate should not be used in adults with grain engorgement

- What about urinary disease?
  - Best initial fluid therapy?
    - NaCl
      - No K+
        - Add dextrose @ 2.5% if hyperkalemia present
      - Treats other electrolyte abnormalities
        - Hyponatremia, hypochloremia
      - Helps to resolve azotemia (post-renal)
Types of Fluids

- Purchased
  - 50 mL – 5 L
- Home Brews
  - Used distilled water
  - Sterile/non-pyrogenic
  - Weigh out salts and store in zip-loc bags
  - Mix when needed

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl</td>
<td>140 g (7g/L)</td>
</tr>
<tr>
<td>KCl</td>
<td>25 g (1.25g/L)</td>
</tr>
<tr>
<td>CaCl₂</td>
<td>10 g (0.5g/L)</td>
</tr>
<tr>
<td>H₂O (distilled)</td>
<td>20L</td>
</tr>
</tbody>
</table>

- Isotonic Saline (0.9%)
  - Non-Iodized Table Salt
    - 9 g per liter
    - 34 g per gallon
- Hypertonic Saline
  - 72g NaCl per liter
- Isotonic Sodium Bicarbonate (1.3%)
  - Baking Soda
    - 13 g (13cc) per liter
    - 50 g (50cc) per gallon
- Potassium Supplementation
  - Normal Dietary Intake
    - Best supplement is orally
    - Up to 0.2 – 0.4 g KCl/kg BW/day
  - IV Fluids
    - Additional 10-40 mEq K⁺/L
  - Fluid Rate Dependent
  - NO MORE THAN 0.5mEq/kg/hr

Shock and Blood Loss
Conditions likely to lead to shock and/or blood loss in adult ruminants include chronic gastrointestinal parasitism, trauma, and severe gastrointestinal disturbances.

- Treatment
Hypertonic Saline (7.2%)
- Shock
  - Hemorrhagic
  - Septic
- Hypertonic (1500 to 2100 mOsm/L)
- 4 ml/kg Bolus
- Increased Vascular Volume
- Increased Cardiac Output
- Increased Renal and Peripheral Perfusion
- Cellular Dehydration
  - Do you use in the face of dehydration?
  - Provide additional fluid source
    - Oral vs IV

Crystalloids
- Shock Fluid Dose
  - 80-90 ml/kg given as ¼ boluses to effect
  - Quick Calculation – Add a 0 to the BW in pounds for each ¼ shock bolus

Colloids (Calves/Small Ruminants)
- Large Molecular Weight
- Stay in Vascular Compartment longer than crystalloids.
  - ↑ Oncotic Pressure
  - ↑ Blood Volume
  - ↑ Blood Pressure
- Hetastarch
  - 5-10 ml/kg IV
  - About $45 per 500ml

Whole Blood Transfusion
- Transfusion Volume
  - 3 ml/kg will raise the PCV by about 1%
  - 10 ml/kg initial transfusion volume
    - 1% BW
- Transfusion Rate
  - Pre-Transfusion TPR
  - 0.1 ml/kg over 5-10 minutes
  - Reevaluate Clinical Parameters
  - Continue at up to 20ml/kg/hr

Amount of Blood to Transfuse: \[
\frac{BW_R \times 0.08 \times (\text{Desired PCV} - PCV_R)}{\text{Donor PCV}}
\]
Selected References