Clinical Practice: Frequently Asked Question

Q: Looking for a method to calculate IV fluid replacement for children and adults for the NPO hours, operative and post anesthesia period?

A:

A: ADULT FLUID REPLACEMENT

Three-part formula for calculating fluid to be replaced intraoperatively:

1. Deficit—defined as the time the patient is NPO to the time surgery begins
   Formula is the maintenance rate X the number of hours the patient has been NPO
   Also account for fluid losses from NG suctioning and bowel preps

2. Maintenance—defined as the time of incision to closure:
   Based on the 4 – 2 – 1 formula
   - 4 mL/kg/hr for 0-10 kg weight
   - 2 mL/kg/hr for the next 10 kg weight
   - 1 mL/kg/hr for each kg greater than or equal to 20

   Example:
   Weight in kg = 70
   4 mL/kg/hr for the first 10 kg = 40
   2 mL/kg/hr for the next 10 kg = 20
   1 mL/kg/hr for each kg greater than or equal to 20 = 50
   40 + 20 + 50 = 110 mL/hr

   A shortcut for patients weighing greater than or equal to 20 kg is weight in kg + 40
   Example:
   Weight in kg = 70 + 40 = 110 mL/hr

3. Surgical losses
   - Blood
     - Replace 3-4 mL crystalloid/ml blood loss or 1 mL colloid/1 mL blood loss
     - Replace blood at 1 mL/1 mL loss + crystalloid or colloid
   - Evaporation from open wound
   - Third-spacing from fluid redistribution

Estimation of Evaporation and Third-Space Losses—additional maintenance fluid based on amount of tissue trauma
   1. Minimal procedure, e.g. herniorrhaphy 2-4 mL/kg/hr
   2. Moderate procedure, e.g. cholecystectomy 4-6 mL/kg/hr
   3. Major procedure, e.g. bowel resection 6-8 mL/kg/hr

Schedule for Replacement During the Surgical Procedure:
First hour: 1/2 the deficit + maintenance + replacement for blood loss
Second hour: 1/4 the deficit + maintenance + replacement for blood loss
Third hour: 1/4 the deficit + maintenance + replacement for blood loss
Example:
80 kg patient scheduled for total hip replacement, NPO for 10 hours
Deficit = 10 hours NPO X 120 = 1200 mL
Maintenance = 120 mL/hr
Blood loss replacement (EBL = 300 mL) = 3 ml crystalloid X 300 = 900 mL
1st hour = 600 (1/2 the deficit) + 120 (maintenance*) + 300 mL LR (blood loss replacement) = 1020 mL
2nd hour = 300 (1/4 the deficit) + 120 (maintenance*) + 300 mL LR (blood loss replacement) = 720 mL
3rd hour = 300 (1/4 the deficit) + 120 (maintenance*) + 300 mL LR (blood loss replacement) = 720 mL
Total = 2460 mL
*Additional fluid may be added to the hourly maintenance to account for evaporation and tissue trauma losses
Estimated adult blood volumes
Male = 70-75 mL/kg
Female = 55-67 mL/kg

B: PEDIATRIC FLUID REPLACEMENT

Fluid Resuscitation Guidelines

- Start fluid resuscitations
  - 20 mL/kg of isotonic crystalloid (Normal saline or Lactated ringers)
  - Bolus over 5-20 minutes
  - Repeat boluses of 20 mL/kg as needed to restore blood pressure and perfusion
  - Adjust rate according to cause of shock state

- Do not administer fluids containing glucose

- Blood and blood products are recommended for replacement of volume loss in pediatric trauma patients with inadequate perfusion despite administration of 2-3 boluses of 20 mL/kg of isotonic crystalloid (PALS, 2006)

HOURLY MAINTENANCE FLUID REQUIREMENTS FOR INFANTS AND CHILDREN

<table>
<thead>
<tr>
<th>Body Weight (kg)</th>
<th>Hourly Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10 kg</td>
<td>4 mL/kg/hr for each kg body weight</td>
</tr>
<tr>
<td>11-20 kg</td>
<td>40 mL/hr + 2 ml/kg/hr for each kg 11-20 kg</td>
</tr>
<tr>
<td>greater than or equal to 20 kg</td>
<td>60 mL +1 mL/kg/hr for each kg greater than or equal to 20 kg</td>
</tr>
</tbody>
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Based on 1 mL of fluid per 1 kcal of calorie expenditure.
Estimated blood volume (EBV)
Infant: 80-90 mL/kg
Child: 70-80 mL/kg
Maximal allowable blood loss should not exceed 20% of EBV, depending on pre-op hematocrit

References:


This FAQ has been reviewed and updated July 2019