Heparin-Dosing calculations

- **Heparin** is a heterogeneous group of muco-polysaccharides that have anticoagulant properties (slows clotting time).
- Heparin salt, as heparin sodium, are standardized to contain 140 USP heparin Units in each milligram.
- Heparin salts administered as sterile aqueous solutions by intravenous infusion, intermittent intravenous injection, or deep subcutaneous injection for the prophylaxis and treatment of venous thrombosis.
**Heparin-Dosing calculations**

- Dosage of Heparin sodium is adjusted according to the level of blood coagulation or partial thromboplastin time (PTT).
- Doses from 5000 Units up to 120,000 Units (patients with massive pulmonary emboli).
- In pediatric use, initial dose 50 mg/kg by IV drip, followed by maintenance doses of 100 mg/kg every 4 hours or 20,000 units/m²/24 hours.
- A variety of low-molecular-weight heparins (fragments of heparins) are also used as antithrombotic agents e.g. enoxaprin sodium (Lovenox) and dalteparin sodium (FRAGMIN).

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**Example:** An intravenous infusion contained 20,000 units of heparin sodium in 1000 ml of D5W. The rate of infusion was set at 1600 units per hour for a 160-lb patient. Calculate

a) the concentration of heparin sodium in the infusion, in units/ml
b) the length of time the infusion would run, in hours
c) the dose of heparin sodium administered to the patient, on units/kg/minute basis.

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<tr>
<th>Step</th>
<th>Formula</th>
<th>Calculation</th>
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<tbody>
<tr>
<td>a)</td>
<td>$X = \frac{20000 \times 1}{1000}$</td>
<td>$X = 20$ units/ml</td>
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<tr>
<td>b)</td>
<td>$X = \frac{20000 \times 1}{1600}$</td>
<td>$X = 12.5$ hours</td>
</tr>
<tr>
<td>c)</td>
<td>$X = \frac{20000 \times 1}{750}$</td>
<td>$X = 26.67$ units/minute</td>
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Low-Molecular-Weight Heparin-Dosing calculations

**Example:** The recommended dose of dalteparin sodium (FRAGMIN) for patients undergoing hip replacement surgery is 2500 international units (IU) within 2 hours before surgery, 2500 IU 4 to 8 hours after surgery, and 5000 IU daily x 5 to 10 days, starting on the postoperative day.

How many millilitres from a vial containing 10,000 IU/ml should be administered

- **a)** before surgery
- **b)** After surgery
- **c)** The day following the surgery

**a)** 10,000 units → 1 ml
2500 units → X ml
SO \[X = \frac{2500 \times 1}{10000} = 0.25 \text{ ml}\]

**b)** same as **a)** = 0.25 ml

**c)** 10,000 units → 1 ml
5000 units → X ml
SO \[X = \frac{5000 \times 1}{10000} = 0.5 \text{ ml}\]

Example Calculations of Ideal Body Weight

- To maintain a specific drug concentration in the blood for proper therapeutic effect. Dose of drug depends, in part, on the weight of the patient and the volume of body fluids which the drug is distributed. It is important for estimation of Vd particularly for some polar drugs that are not well distributed in adipose tissue.

Ideal body weight (IBW) is calculated as follows:

**For males:**

IBW = 50 kg + 2.3 kg for each inch of patient height over 5 feet
IBW = 110 lb + 5 lb for each inch over 5 feet

**For females:**

IBW = 45.5kg + 2.3 kg for each inch of patient height over 5 feet
IBW = 100 lb + 5 lb for each inch over 5 feet
Example Calculations of Ideal Body Weight

• Calculate the ideal body weight for a male patient weighing 164 lb, and measuring 5 ft. 8 in. in height.

\[
IBW = 110 \text{ lb} + (8 \times 5 \text{ lb.}) \\
= 110 \text{ lb.} + 40 \text{ lb.} = 150 \text{ lb.}, \text{ answer.}
\]

• Calculate the ideal body weight for a female patient weighing 60 kg and measuring 160 cm in height.

\[
160 \text{ cm} = 63 \text{ in.} = 5 \text{ ft. 3 in.} \\
IBW = 45.5 \text{ kg} + (3 \times 2.3 \text{ kg}) \\
= 45.5 \text{ kg} + 6.9 \text{ kg} = 52.4 \text{ kg, answer.}
\]

Dosage Calculations Based on Creatinine Clearance

Drugs are eliminated from the body through two major mechanisms
Hepatic (liver) metabolism and Renal (kidney) excretion.
• Polar drugs are eliminated predominantly by renal excretion.
• The kidneys receive about 20% of the cardiac output and filter approximately 125 ml per minute of plasma. If the function is lost drug clearance will decrease.
• The filtration rate of the kidney can be estimated by a number of methods. One of the most useful, is the estimation of the creatinine clearance rate (CrCl) through the use of empiric formulas.
• Creatinine is break-down product of muscle metabolism, produced in a constant rate depends on the muscle mass and eliminated by renal filtration (kidney).
• The normal adult value of serum creatinine is 0.7-1.5 mg/dl
Dosage Calculations Based on Creatinine Clearance

- **Creatinine clearance rate (CrCl, ml/min):**
  - Is the volume of blood plasma that is cleared of creatinine by kidney filtration per minute.
- **Calculated by**
  1. **Jellife equation:**
     - **For males:** \( \text{CrCl} = \frac{98 - 0.8 \times \text{patient's age in years} - 20}{\text{serum creatinine in mg/dl}} \)
     - **For females:** \( \text{CrCl} = 0.9 \times \text{CrCl determined using formula for males} \)
  2. **Cockcroft-Gault equation**
     - **For males:** \( \text{CrCl} = \frac{(140 - \text{patient's age in years}) \times \text{Body weight in kg}}{72 \times \text{serum creatinine in mg/dl}} \)
     - **For females:** \( \text{CrCl} = 0.85 \times \text{CrCl determined using formula for males} \)

3. **Sanaka equation** *(for patients over 60 years of age):*
   - **For males:** \( \text{CrCl} = \frac{\text{patient's weight (kg)} \times [19 \times \text{Plasma albumin (g/dl)} + 32]}{100 \times \text{serum creatinine (mg/dl)}} \)
   - **For females:** \( \text{CrCl} = \frac{\text{patient's weight (kg)} \times [13 \times \text{Plasma albumin (g/dl)} + 29]}{100 \times \text{serum creatinine (mg/dl)}} \)

4. **Schwartz equation** *(for pediatric and adolescent patients from neonates to 17 years of age):*
   \[ \text{CrCl} = \frac{k \times \text{patient's height (cm)}}{\text{serum creatinine (mg/dl)}} \]

   *K is proportionality constant ranging from 0.33 (for neonates) to 0.7 (for adolescent males)*
Dosage Calculations Based on Creatinine Clearance

• Adjusting creatinine clearance for body surface area:
  Is accomplished through the use of a nomogram of body surface area (BSA), as described previously in Chapter 8, and the following formula:
  \[
  \frac{BSA\ (m^2)}{1.73} \times CrCl = Adjusted\ CrCl
  \]

• Example:
  If a patient weighing 120 lb. and measuring 60 in. in height has a calculated creatinine clearance of 40 mL per minute, adjust the CrCl based on body surface area?
  Using the nomogram in Ch. 8, the patient’s BSA is determined to be 1.5 m²
  • Adjusted CrCl = (1.5/1.73) X 40 = 34.7 mL/min

Dosage Calculations Based on Creatinine Clearance

• Example:
  Determine the creatinine clearance rate for an 80-year-old male patient weighing 70 kg and having a serum creatinine of 2 mg/dL. Use both the jelliffe and Cockcroft-Gault equations.

1- Jellife equation:
  \[
  CrCl = \frac{98-0.8 \times (patient\ 's\ age\ in\ years-20)}{semen\ creatinine\ in\ mg/dL} \\
  CrCl = \frac{98-0.8 \times (80-20)}{2} = \frac{98-48}{2} = 25\ mL/min
  \]

2- Cockcroft-Gault equation
  \[
  CrCl = \frac{(140 - \text{patient's age in years}) \times \text{Body weight in kg}}{72 \times \text{serum creatinine in mg/dL}} \\
  CrCl = \frac{(140 - 80) \times 70}{72 \times 2 \ (mg/dL)} = \frac{60 \times 70}{144} = 29.2\ mL/min
  \]
Clinical laboratory tests (chemistries) analyze samples for chemicals as, glucose, cholesterol, total lipids, creatinine, bilirubin, sodium, potassium, carbon dioxide and other substances, including drugs following their administration.

- The usual amount of a chemical substance is a common range, e.g. glucose in serum is 65-99 mg/dL and for creatinine is 0.5-1.4 mg/dL.
- Units may change from mg/dL to SI units of millimoles per liter (mmol/L) of blood plasma.

**Example:**
If a patient is determined to have a serum cholesterol level of 200 mg/dL, what is the equivalent value expressed in terms of mmol/L.

\[
\text{M.W. of cholesterol} = 387 \\
1 \text{ mmol} = 387 \text{ mg} \quad \text{and} \quad 200 \text{ mg/dL} = 2000 \text{ mg/L} \\
387 \text{ mg} \quad \rightarrow \quad 1 \text{ mmol} \\
2000 \text{ mg} \quad \rightarrow \quad X \text{ mmol} \quad X = 5.17 \text{ mmol/L}
\]

**Practice Problems**

✓ Page 163: 1 and 3.
✓ Page 164: 5, 7, 9, 11, 13, 15, 17.
✓ Page 165: 19.