CHAPTER TEN: SELECTED CLINICAL CALCULATIONS

Objectives

- • Calculate heparin doses and infusion rates from medication orders and standardized protocols.
- • Calculate ideal body weight and apply in dose determinations.
- • Calculate estimated creatinine clearance rates and apply in dose determinations.
- • Convert blood serum chemistry values from *mg/dL* to *mmol/L* (international system).

Heparin-Dosing Calculations

- Heparin slows clotting time.
- Salt forms of heparin, such as heparin sodium, are standardized to contain 140 USP Heparin Units in each milligram.
- Heparin salts are administered as sterile aqueous solutions by
  - intravenous infusion,
  - intermittent intravenous injection,
  - subcutaneous injection
- for the prophylaxis and treatment of venous thrombosis.
- The commercial preparations, available in single-use syringes and multiple-dose vials, indicate on their labeling the number of USP Heparin Units of activity contained per milliliter.

- Heparin is the fundamental treatment in acute venous thromboembolism; however, its use carries with it, the risk of hemorrhage.

- Patients especially at risk include
  - elderly patients,
  - postsurgical patients,
  - patients with a history of peptic ulcers, severe renal or hepatic failure,
  - and patients who recently have taken other medications that affect blood clotting time.

- When heparin sodium is administered in therapeutic amounts, its dosage is adjusted according to the results of tests measuring the patient’s level of blood coagulation, or partial thromboplastin time (PTT).
- In general, the PTT value should be maintained at 1.5 to 2 times the patient’s pretreatment PTT value or, when the whole blood-clotting time is evaluated, approximately 2 to 3 times the control value.

- The dose varies depending on the circumstances.
- Bolus doses, given by direct intravenous injection, may be followed by intravenous infusion as a heparin drip.
- Low-dose heparin administration provides effective prophylaxis (rather than therapeutic effects) in a variety of surgical procedures.
- Patients receive 5000 units given by deep subcutaneous injection 2 hours before surgery and an additional 5000 units every 8 to 12 hours thereafter as required

- Medium-dose heparin, indicated for patients with active phlebitis, with pulmonary embolism, and in hip replacement surgery, has a dosage range of 20,000 to 60,000 units per day, generally by intravenous infusion.

- High-dose heparin is indicated in patients with massive pulmonary embolism. Doses of 60,000 to 120,000 units are given by continuous intravenous infusion for the first day and then decreased to medium-dose heparin after 24 hours.

- Figure 10.1 presents a hospital form for an adult weight-based heparin protocol. The form
- allows physicians' orders for bolus doses, as well as protocols for low-dose and high-dose intravenous heparin infusions. The values given in this figure may differ from heparin protocols at other institutions.

- Pharmacists must follow those used within their institutions of practice. It is important to note that a variety of low-molecular-weight heparins are also used as antithrombotic agents: for example,
- enoxaparin sodium (LOVENOX) and dalteparin sodium (FRAGMIN).

CITY HOSPITAL

ADULT WEIGHT-BASED HEPARIN PROTOCOL

Standard Heparin IV Premixed Solution is 25,000 units in 250 mL (100 units per mL)
Initial laboratory tests (draw before starting heparin): PTT, PT, CBC with platelet count
Day 2 and every 3 days thereafter. CBC with platelet count
PTT six (6) hours after heparin drip is started
PTT six (6) hours after every change in heparin administration rate or bolus dose of heparin
Once a therapeutic PTT level is reached, do a PTT six (6) hours later
After two (2) consecutive therapeutic PTT levels are obtained, do a PTT daily at 0600
Discontinue all IM medications and other IM injections

Patient ______ MAY ______ MAY NOT receive drugs containing aspirin.

Patient ______ MAY ______ MAY NOT receive drugs containing non-steroidal antiinflammatory agents.

______ For a PTT Value of 50 to 70 seconds (LOW-DOSE HEPARIN PROTOCOL)	
______ No Bolus Dose	Start heparin drip at a rate of
______ Bolus with 70 units of heparin per kg (limit 10,000 units)	______ 15 units per kg per hr
______ Bolus with ______________ units of heparin	or ______ units per kg per hr

PTT Value	Heparin Dose Adjustments
<35 seconds	Bolus with 70 units per kg and increase infusion rate by 4 units per kg per hour
35 to 49 seconds	Bolus with 40 units per kg and increase infusion rate by 2 units per kg per hour
50 to 70 seconds	No change in heparin infusion rate
71 to 99 seconds	Decrease infusion rate by 1 unit per kg per hour
100 to 120 seconds	Decrease infusion rate by 2 units per kg per hour
>120 seconds	Hold heparin infusion for 1 hour; when restarted, decrease heparin infusion rate by 3 units per kg per hour

______ For a PTT Value of 70 to 99 seconds (HIGH-DOSE HEPARIN PROTOCOL)	
______ No Bolus Dose	Start heparin drip at a rate of
______ Bolus with 70 units of heparin per kg (limit 10,000 units)	______ 18 units per kg per hr
______ Bolus with ______ units of heparin	or ______ units per kg per hr

PTT Value	Heparin Dose Adjustments
<35 seconds	Bolus with 70 units per kg and increase infusion rate by 4 units per kg per hour
35 to 49 seconds	Bolus with 40 units per kg and increase infusion rate by 3 units per kg per hour
50 to 70 seconds	Increase infusion rate by 2 units per kg per hour
71 to 99 seconds	No change in heparin infusion rate
100 to 120 seconds	Decrease infusion rate by 1 unit per kg per hour
>120 seconds	Hold heparin infusion for 1 hour; when restarted, decrease heparin infusion rate by 2 units per kg per hour
DATE	TIME M.D.

IGURE 10.1 Example of hospital form for adult weight-based heparin protocol. *(Courtesy of Flynn Warren, College f Pharmacy, The University of Georgia, Athens, GA.)*

Example Calculations of Heparin Dosing

- ***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; and***
- ***(c) the dose of heparin sodium administered to the patient, on a unit/kg/minute basis.***

(a) $\dfrac{20{,}000 \text{ units}}{1000 \text{ mL}} = 20 \text{ units/mL}$, *and*

(b) $\dfrac{20{,}000 \text{ units}}{1600 \text{ units/hour}} = 12.5 \text{ hours}$, *and*

(c) $160 \text{ pounds} = 72.7 \text{ kg}$

$12.5 \text{ hours} = 750 \text{ minutes}$

$\dfrac{20{,}000 \text{ units}}{750 \text{ minutes}} = 26.67 \text{ units/minute}$

$\dfrac{26.67 \text{ units/minute}}{72.7 \text{ kg}} = 0.37 \text{ units/kg/minute}$, *answers.*

- *A patient weighing 80 kg was given an initial bolus dose of heparin and a heparin drip for the first 6 hours. Using Figure 10.1 and the low-dose heparin protocol, what was the total amount of heparin administered in this period?*

Bolus dose [70 units/kg]: 70 units X 80 (kg) = 5600 units

Heparin drip [15 units/kg/hr]: 15 units X 80 (kg) X 6 (hours) = 7200 units

Thus, 5600 units + 7200 units = 12,800 units, *answer.*

Example Calculations of Low-Molecular-Weight Heparin Dosing

- 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 5 to 10 days, starting on the postoperative day. How
- many milliliters from a vial containing 10,000 IU/mL should be administered (a) before surgery,
- (b) after surgery, and (c) the day following surgery?

CASE IN POINT 10.1

CASE IN POINT 10.1[5]**:** A 198-lb. hospitalized patient is placed on a high-dose heparin protocol. The patient requires a bolus injection followed by a heparin infusion. The hospital follows the protocol shown in Figure 10.1.

The hospital pharmacist has heparin available for bolus doses containing 5000 units per milliliter in 5-mL vials and heparin for intravenous infusion in 250-mL infusion bags each containing 25,000 units of heparin.

(a) How many milliliters of the 5000 units/mL injection should the pharmacist recommend as a bolus dose?

(b) How many milliliters per hour of the heparin infusion should the pharmacist instruct the nurse to deliver, based on the standard drip protocol?

(c) If the intravenous set is programmed to deliver 60 drops per milliliter, what should be the flow rate, in drops per minute, to deliver the mL/hr required in answer (b)?

(d) How long will the 250-mL infusion bag last, in hours?

Dosage Calculations Based on Creatinine Clearance

- **Dose of a Drug.** The two major mechanisms by which drugs are eliminated from the body are through
  - hepatic (liver) metabolism and
  - renal (kidney) excretion.
- When renal excretion is the major route, a loss of kidney function will dramatically affect the rate at which the drug is cleared from the body.
- Polar drugs are eliminated predominantly by renal excretion and are generally affected by decreased kidney function.
- With many drugs, it is important to reach and maintain a specific drug concentration in the blood to realize the proper therapeutic effect.

- The initial blood concentration attained from a specific dose depends, in part, on the weight of the patient and the volume of body fluids in which the drug is distributed.
- The ideal body weight (IBW) provides an excellent estimation of the distribution volume, particularly for some polar drugs that are not well distributed in adipose (fat) tissue.
- These calculations have been used clinically with the aminoglycoside antibiotics and with digoxin to determine doses and to predict blood levels.
- The IBW may be calculated readily through the use of the following formulas based on the patients's height and sex.

For males:

IBW = 50 kg + 2.3 kg for each inch of patient's height over 5 feet

or, in pounds

110 lb. + 5 lb. for each inch over 5 feet

For females:

IBW = 45.5 kg + 2.3 kg for each inch of patient height over 5 feet

or, in pounds

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 lb. + (8 × 5 lb.)
110 lb. + 40 lb. = 150 lb, *answer.*

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

160 cm = 63 in. = 5 ft. 3 in.
IBW = 45.5 kg + (3 × 2.3 kg)
45.5 kg + 6.9 kg = 52.4 kg, *answer.*

1 in = 2.54 cm
1 feet= 12 in.

Note: In instances in which the IBW is determined to be greater than the actual body weight, the latter is used in dosage calculations.

- The kidneys receive about 20% of the cardiac output (blood flow) and filter approximately 125 mL per minute of plasma.
- As kidney function is lost, the quantity of plasma filtered per minute decreases, with an accompanying decrease in drug clearance.
- The filtration rate of the kidney can be estimated by a number of methods.
- One of the most useful, however, is the estimation of the creatinine clearance rate (CrCl) through the use of the following empiric formulas based on the patient’s age, weight, and serum creatinine value.

- Creatinine, which is a break-down product of muscle metabolism, is generally produced at a constant rate and in quantities that depend on the muscle mass of the patient.
- The normal adult value of serum creatinine is 0.7 to 1.5 mg/dL.
- The creatinine clearance rate represents the volume of blood plasma that is cleared of creatinine by kidney filtration per minute.
- It is expressed in milliliters per minute.

By the Jelliffe equation:[6–7]
For males:

$$\text{CrCl} = \frac{98 - 0.8 \times (\text{Patient's age in years} - 20)}{\text{Serum creatinine in mg/dL}}$$

For females:

$$\text{CrCl} = 0.9 \times \text{CrCl determined using formula for males}$$

By the Cockcroft-Gault equation:[8]
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:

$$\text{CrCl} = 0.85 \times \text{CrCl determined using formula for males}$$

Example Calculations of Creatinine Clearance

- *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.*

Adjusting Creatinine Clearance for Body Surface Area.

- It is sometimes desirable to adjust the calculated creatinine clearance for body surface area to account for this possible variable in determining drug dosage.

- This adjustment is accomplished through the use of a nomogram of body surface area (BSA), as described previously in Chapter 8, and the following formula:

$$\frac{\text{BSA}}{1.73} \times \text{CrCl} = \text{Adjusted CrCl}$$

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 Chapter 8, the patient's BSA is determined to be 1.50 m^2. Thus,

$$\frac{1.50\ \text{m}^2}{1.73\ \text{m}^2} \times 40\ \text{mL/min} = 34.7\ \text{mL/min, adjusted CrCl,}\ \textit{answer.}$$

- Normal creatinine clearance rate may be considered 100 mL per minute.
- Thus, in the preceding example, the patient would exhibit 25% to 35% of normal creatinine clearance.
- The creatinine clearance rate method for determining drug dose is used with various categories of drugs in which renal function is a factor.

- Such dosing is routine, for example, for aminoglycoside antibiotics including gentamicin, tobramycin, and amikacin.

- Once the creatinine clearance rate and the ideal body weight have been calculated, the *loading*
- *dose* (initial dose) required to reach a certain drug concentration in the patient and the *maintenance*
- *dose* needed to maintain the specified concentration can be calculated.

*To calculate the **loading dose (LD)**, perform the following:*

LD = IBW in kg or lb. × Drug dose per kg or lb.

*To calculate the **maintenance dose (MD)**, perform the following:*

For the "normal" patient:

$$\text{MD} = \text{IBW (kg)} \times \text{Dose per kg per dosing interval}$$

For the renally impaired patient:

$$\text{MD} = \frac{\text{CrCl (patient)}}{\text{CrCl (normal)}} \times \text{Dose for “normal” patient}$$

- *Determine the loading and maintenance doses of gentamicin for a 76-year-old male patient weighing 190 lb. with a height of 6 feet and having a serum creatinine of 2.4 mg/dL.*

- *The physician desires a loading dose of 1.5 mg/kg of ideal body weight and a maintenance dose of 1.0 mg/kg of ideal body weight to be administered every 8 hours after the initial dose.*

1 in = 2.54 cm
1 feet= 12 in.

IBW= 110 lb. + 5 lb. for each inch over 5 feet

IBW = 110 lb. + (5 lb. x 12)= 170 lb. or 77.3 kg

$$CrCl = \frac{98 - 0.8 \times (\text{Patient's age in years} - 20)}{\text{Serum creatinine in mg/dL}}$$

$$CrCl = \frac{98 - 0.8 \times (76 - 20)}{2.4\ (\text{mg/dL})}$$ = 22.2 ml/ minute

$$\text{LD} = \text{IBW in kg or lb.} \times \text{Drug dose per kg or lb.}$$

$$\text{LD} = 77.3\ \text{kg} \times 1.5\ \text{mg/kg} = 116\ \text{mg}, \textit{ answer.}$$

$$\text{MD} = \text{IBW (kg)} \times \text{Dose per kg per dosing interval}$$

MD for "normal" patient:

$$= 77.3\ \text{kg} \times 1.0\ \text{mg/kg every 8 hours}$$
$$= 77.3\ \text{mg every 8 hours}$$

MD for renally impaired patient:

$$= \frac{22.2\ \text{mL per minute}}{100\ \text{mL per minute}} \times 77.3\ \text{mg}$$
$$= 17.2\ \text{mg every 8 hours}, \textit{ answer.}$$

Use of Creatinine Clearance Dosage Tables.

- For certain drugs, tables of dosage guidelines may be presented in the labeling/literature to adjust for impaired renal function.
- For example, the usual dose of the anti-infective drug ceftazidime (antibiotic) is 1 g every 8 to 12 hours, with dosage adjusted based on the location and severity of the infection and the patient’s renal function.
- For adult patients with impaired renal function, guidelines for dosage based on creatinine clearance with adjustment for body surface area are given in Table 10.1.

- *Using the table of dosage guidelines for ceftazidime and adjusting for body surface area, determine the dose and daily dose schedule for a patient weighing 70 kg, measuring 70 in. in height, and having a creatinine clearance (CrCl) of 48 mL per minute.*

Using the nomogram in Chapter 8, the patient is determined to have a BSA of 1.87 m^2. Applying the formula for the adjustment of CrCl based on BSA, the patient's CrCl is then determined:

$$\frac{1.87\ m^2}{1.73\ m^2} \times 48\ mL/min = 51.9 \text{ or } 52\ mL/min$$

The dosage table and the adjusted CrCl indicate a dosage of:

1 g every 8 to 12 hours, *answer.*

TABLE 10.1 CREATININE CLEARANCE DOSING GUIDELINES FOR CEFTAZIDIME (IV OR IM)[a]

RENAL FUNCTION	CREATININE CLEARANCE ($mL/min/1.73m^2$)	DOSE	FREQUENCY
Normal to mild impairment	100–51	1 g	q8–12h
Moderate impairment	50–31	1 g	q12h
Severe impairment	30–16	1 g	q24h
Very severe impairment	15–6	500 mg	q24h
Essentially none	<5	500 mg	q48h

[a] Table modified from product literature for FORTAZ (ceftazidime), GlaxoSmithKline, Research Triangle Park, NC, 2007.

CALCULATIONS CAPSULE

Creatinine Clearance Equations[6–9]

Jelliffe equation

For males:

$$CrCl = \frac{98 - 0.8 \times (\text{Patient's age in years} - 20)}{\text{Serum creatinine in mg/dL}}$$

For females:

$$CrCl = 0.9 \times \text{CrCl determined by equation for males}$$

Cockcroft-Gault equation

For males:

$$CrCl = \frac{(140 - \text{Patient's age in years}) \times \text{pt. wt., kg}}{72 \times \text{Serum creatinine in mg/dL}}$$

For females:

$$CrCl = 0.85 \times \text{CrCl determined using formula for males}$$

Adjusting CrCl for body surface area

$$\frac{BSA}{1.73} \times CrCl = \text{Adjusted CrCl}$$

Schwartz equation

For pediatric and adolescent patients:

$$CrCl = \frac{k \times \text{Patient's height (cm)}}{\text{Serum creatinine (mg/dL)}}$$

Where k is a proportionality constant ranging from 0.33 (for neonates) to 0.70 (for adolescent males)

CASE IN POINT 10.2[5]: A 35-year-old male patient weighing 180 lb. and standing 5 ft. 8 in. tall has been diagnosed with AIDS. His physician prescribes lamivudine (EPIVIR) as a component of his treatment program and knows that the dose of the drug must be adjusted based on the patient's renal function. Laboratory tests indicate that the patient's serum creatinine is 2.6 mg/dL and has held at the same level for 5 days.

(a) Calculate the patient's ideal body weight (IBW) and use in subsequent calculations if the IBW is lower than the patient's actual weight.

(b) Calculate the patient's CrCl by the Cockcroft-Gault equation.

(c) Select the appropriate dose of lamivudine from the dosing schedule:

Creatinine Clearance	Initial Dose	Maintenance Dose
<5 mL/min	50 mg	25 mg once daily
5–14 mL/min	150 mg	50 mg once daily
15–29 mL/min	150 mg	100 mg once daily
30–49 mL/min	150 mg	150 mg once daily

Case in Point 10.2

(a) IBW = 50 kg + (2.3 × 8 in) = 68.4 kg, *answer.*

Patient's actual weight = 180 lb. ÷ 2.2 lb./kg = 81.8 kg

(b) $$\text{CrCl} = \frac{[(140 - 35) \times 68.4\ \text{kg}]}{72 \times 2.6\ \text{mg/dL}} = \frac{7182}{187.2} = 38.37\ \text{mL/min},$$

answer.

(c) Dose = 150 mg initially and 150 mg maintenance dose once daily, *answer.*

Clinical Laboratory Tests

TABLE 10.2 EXAMPLES OF NORMAL RANGES OF SERUM CHEMISTRY VALUES[a]

LABORATORY TEST	*NORMAL* VALUES (RANGE, IN US UNITS)	CONVERSION FACTOR (MULTIPLY)		INTERNATIONAL SYSTEM[b]
Albumin	3.6–5.1 g/dL	10	=	36–51 g/L
Calcium	8.6–10.3 mg/dL	0.25	=	2.2–2.6 mmol/L
Cholesterol, total	125–200 mg/dL	0.026	=	3.25–5.2 mmol/L
HDL cholesterol	> or = 40 mg/dL	0.026	=	> or = 1.04 mmol/L
LDL cholesterol	<130 mg/dL	0.026	=	<3.38 mmol/L
Glucose	65–99 mg/dL	0.055	=	3.58–5.45 mmol/L
Triglycerides	<150 mg/dL	0.011	=	<1.65 mmol/L
Creatinine	0.5–1.4 mg/dL	88.4	=	44.2–123.8 µmol/L
Urea Nitrogen (BUN)	7–25 mg/dL	0.357	=	2.50–8.93 mmol/L

[a] *Normal* values shown may vary between test laboratories and may be referred to as "reference," "healthy," or "goal" values.

[b] The international system is generally expressed in mmol (or other units) per liter.

Example Calculations Involving Clinical Laboratory Tests

- *If a patient is determined to have a serum cholesterol level of 200 mg/dL, (a) what is the equivalent*
- *value expressed in terms of milligrams percent, and (b) how many milligrams of cholesterol would be*
- *present in a 10-mL sample of the patient's serum?*

(a) 200 mg/dL = 200 mg/100 mL = 200 mg%, *answer.*

$$\text{(b)}\quad \frac{200\ (\text{mg})}{x\ (\text{mg})} = \frac{100\ (\text{mL})}{10\ (\text{mL})}$$

$$x = 20\ \text{mg, } \textit{answer.}$$

a)
dL= 100 ml
200 in 100ml
X in 100 ml

X= 200 mg/ 100 ml
= 200%

b)
200 mg in 100 ml
X mg in 10

X= 2000/ 100= 20 mg

- *If a patient is determined to have a serum cholesterol level of 200 mg/dL, what is the equivalent*
- *value expressed in terms of millimoles (mmol) per liter?*
- Molecular Weight (m.w. of cholesterol) 387

Molecular Weight (m.w. of cholesterol) = 387
1 mmol cholesterol = 387 mg
200 mg/dL = 2000 mg/L

$$\frac{387 \text{ (mg)}}{2000 \text{ (mg)}} = \frac{1 \text{ (millimole)}}{x \text{ (millimoles)}}$$

x = 5.17 mmol/L, *answer.*

1 mmole = 387 mg
X mmole in 2000 mg/ L

X= 2000/ 387= 5.17 mmol/ L

From table 10.2
Multiple factor of cholesterol = 0.026

200 mg/dL x 0.026= 5.2 mmol

Therapeutic Drug Monitoring

- Also termed ***drug therapy monitoring***, this process often includes the analysis of blood serum
- samples to ensure optimum drug therapy.
- This is especially important for categories of drugs
- in which the margin between safe and toxic levels is narrow. Data are available indicating these
- levels

Drug-Specific Clinical Equations

- For certain clinical conditions, there are equations that are useful for determining patient requirements.
- For example, the following is used in determining the amount of iron required to bring
- hemoglobin (Hb) values to normal levels:

$$\text{Iron required (mg)} =$$
$$\text{Body weight (lb.)} \times 0.3 \times \left[100 - \frac{\text{Hb (g/dL)} \times 100}{14.8\ \text{g/dL}}\right]$$

Example:

- *Using the equation for determining iron deficiency, calculate the number of milliliters of an iron*
- *dextran solution containing 50 mg/mL of iron to be administered to a 150-lb. patient with a hemoglobin*
- *value of 10 g/dL*.

$$\text{Iron required (mg)} = \text{Body weight (lb.)} \times 0.3 \times \left[100 - \frac{\text{Hb (g/dL)} \times 100}{14.8\ \text{g/dL}}\right]$$

$$\begin{aligned}
\text{Iron required (mg)} &= 150 \times 0.3 \times \left[100 - \frac{10 \times 100}{14.8}\right] \\
&= 150 \times 0.3 \times 32.4 \\
&= 1458\ \text{mg}
\end{aligned}$$

$$\text{by proportion, } \frac{50\ \text{mg}}{1458\ \text{mg}} = \frac{1\ \text{mL}}{x\ \text{mL}}$$

$$x = 29\ \text{mL}, \textit{ answer.}$$

Examples

A hospital pharmacy order calls for 5000 units of heparin to be administered to a patient, twice daily, subcutaneously, for the prevention of thrombi. The pharmacist has on hand a vial containing 10,000 Heparin Units/mL. How many milliliters of the injection should be administered for each dose?

When a PTT was performed on the patient described in “Case in Point 10.1,” the patient’s value was 40 seconds. Based on the high-dose protocol (Fig. 10.1), calculate (a) the needed bolus dose, in units, and (b) the new infusion rate, in mL/hr, using the heparin solution with 25,000 units/250 mL.

______ For a PTT Value of 70 to 99 seconds (HIGH-DOSE HEPARIN PROTOCOL)	
______ No Bolus Dose	Start heparin drip at a rate of
______ Bolus with 70 units of heparin per kg (limit 10,000 units)	______ 18 units per kg per hr
______ Bolus with ______________ units of heparin	or ______ units per kg per hr

PTT Value	Heparin Dose Adjustments
<35 seconds	Bolus with 70 units per kg and increase infusion rate by 4 units per kg per hour
35 to 49 seconds	Bolus with 40 units per kg and increase infusion rate by 3 units per kg per hour
50 to 70 seconds	Increase infusion rate by 2 units per kg per hour
71 to 99 seconds	No change in heparin infusion rate
100 to 120 seconds	Decrease infusion rate by 1 unit per kg per hour
>120 seconds	Hold heparin infusion for 1 hour; when restarted, decrease heparin infusion rate by 2 units per kg per hour
DATE	TIME M.D.

IGURE 10.1 Example of hospital form for adult weight-based heparin protocol. *(Courtesy of Flynn Warren, College f Pharmacy, The University of Georgia, Athens, GA.)*

A) 40 unites per kg from table 10.1
Wt of patient= 90

90 x 40= 3600 unit

B) New infusion rate= 18+3= 21 unit/kg/hr

90x 21= 1890 unit/kg/hr

25000 in 250 ml
1890 IU ----x

X= 1890 x 250 / 25000= 18.9 ml/hr

Determine the loading and maintenance doses of tobramycin for a 72-year-old female patient weighing 187 lb. and measuring 5 ft. 3 in. in height with a serum creatinine of 2.8 mg/dL. The loading dose desired is 1.0 mg/kg of ideal body weight and 1.66 mg/kg of ideal body weight every 8 hours as the maintenance dose (adjusted for renal impairment).

For Female
IBW= 100 lb. + 5 lb. for each inch over 5 feet

100+ 5 x 3= 115 lb= 52.27 kg = 52.3 kg

$$CrCl = \frac{98 - 0.8 \times (\text{Patient's age in years} - 20)}{\text{Serum creatinine in mg/dL}}$$

= 98- 0.8 (72-20)/ 2.8) = 20.14 ml/ minutes
For female 0.9 x 20.14= 18.126 ml/ miutes

$$LD = \text{IBW in kg or lb.} \times \text{Drug dose per kg or lb.}$$

LD= 52.3 x 1 = 53.3 mg

$$MD = \text{IBW (kg)} \times \text{Dose per kg per dosing interval}$$

MD= 52.3 x 1.66 = 86.818 mg for normal patient

For the renally impaired patient:

$$MD = \frac{CrCl\ (\text{patient})}{CrCl\ (\text{normal})} \times \text{Dose for "normal" patient}$$

= 18.126 mg/ dL / 100 mg/dL x 86.818 mg = 15.73 mg every 8 hrs

Further examples

Table 10.7 • CATEGORIES OF CHOLESTEROL AND TRIGLYCERIDE BLOOD LEVELS[a]

Blood Level (Fasting)	Clinical Category
Total cholesterol (TC) levels:	
<200 mg/dL	Desirable
200–239 mg/dL	Borderline high
240 mg/dL and above	High
Low-density cholesterol (LDL):	
<100 mg/dL	Optimal
100–129 mg/dL	Near optimal
130–159 mg/dL	Borderline high
160–189 mg/dL	High
190 mg/dL and above	Very high
High-density cholesterol (HDL):	
<40 mg/dL	Low level/increased risk
40–50 mg/dL (men); 50–59 mg/dL (women)	Average level/average risk
60 mg/dL and above	High level/less than average risk
Triglycerides (TRG):	
<150 mg/dL	Desirable
150–199 mg/dL	Borderline high
200–499 mg/dL	High
500 mg/dL and above	Very high

- *Calculate the TC:HDL ratio when the total cholesterol is 240 mg/dL and the HDL cholesterol is 60 mg/dL, and identify if the ratio is within the desirable range.*

- 240 mg/dL:60 mg/dL = **4:1**

- The ratio is less than the maximum desired level of 5:1

200 mg/dL: 40 mg/dL.

- There are two “cholesterol ratios” that are considered clinically relevant to risk assessment for cardiovascular disease.
- One is the ratio of total cholesterol to HDL cholesterol, the target being 5:1 Or less. (200 mg/dL: 40 mg/dL)
- The other ratio used in assessing risk is LDL:HDL with the target being 3:1 or less (100 mg/dL: 40 mg/dL)

- (3) *If 160 mg/dL is a patient's current LDL level and the desired level is 100 mg/dL, calculate the*
- *percent reduction required.*

Difference in values: 160 mg/dL − 100 mg/dL = 60 mg/dL

Difference as a percent of current level: $\frac{60 \text{ mg/dL}}{160 \text{ mg/dL}} \times 100\% = \mathbf{37.5\%}$

- A patient has an HDL of 50 mg/dL, an LDL of 150 mg/dL, and a TG of 85 mg/dL. Calculate the
- (a) TC:HDL ratio and
- (b) LDL percent reduction required for a goal of 100 mg/dL.

(a) 4.34:1 = TC:HDL ratio
(b) 33.33%

a) TC = 85/5+ 50+ 150= 217 mg/dL

217 mg/ 50 mg/dL= 4.34: 1

b) 150-100= 50 mg/dL

(50 mg/dL/150 mg/dL) x 100= 33.33%

- **Total cholesterol** is calculated by adding triglyceride level divided by five, HDL, and LDL levels

(i.e., TC = TG/5 + HDL +LDL).

- The usual adult dose of levofloxacin is a 500-mg initial dose followed by subsequent doses of 250 mg every 24 hours for 10 days.
- For patients with a CrCl of less than 19 mL/min, doses following the initial dose are administered every 48 hours.
- How many 250-mg levofloxacin tablets should be dispensed to a 75-year-old, 160-lb female patient with a serum creatinine of 1.32 mg/dL?
- (Use the Cockcroft-Gault equation to determine creatinine clearance.)

Cockcroft-Gault equation

For males:

$$CrCl = \frac{(140 - \text{Patient's age in years}) \times \text{pt. wt., kg}}{72 \times \text{Serum creatinine in mg/dL}}$$

For females:

$$CrCl = 0.85 \times \text{CrCl determined using formula for males}$$

Wt. of patient in kg = 160/2.2= 72.73 kg

CrCl = (140-75) x 72.73/ 72 x 1.32
= 4727.45/ 95.04= 49.74 ml/ minutes

CrCl for female= 49.74 x 0.85= 42.28 ml/min.

For the patient with CrCl 19 ml/ min. needs (1 of 500 mg + 10 of 250) 12 levofloxacin tablets of 250 mg every 48 hrs.

For patient with CrCl 42.28 mg/min needs 12 tablets of 250 mg

- Using Table below, what would be the dose and dosage schedule of ceftazidime for an 84-year-old
- male patient weighing 60 kg, measuring 66 inches in height, and having a serum creatinine level of
- 4.22 mg/dL? (Use the Cockcroft-Gault equation to determine creatinine clearance.)

TABLE 10.1 CREATININE CLEARANCE DOSING GUIDELINES FOR CEFTAZIDIME (IV OR IM)[a]

RENAL FUNCTION	CREATININE CLEARANCE ($mL/min/1.73m^2$)	DOSE	FREQUENCY
Normal to mild impairment	100–51	1 g	q8–12h
Moderate impairment	50–31	1 g	q12h
Severe impairment	30–16	1 g	q24h
Very severe impairment	15–6	500 mg	q24h
Essentially none	<5	500 mg	q48h

[a] Table modified from product literature for FORTAZ (ceftazidime), GlaxoSmithKline, Research Triangle Park, NC, 2007.

1 inch= 2.54 cm

Cockcroft-Gault equation

For males:

$$CrCl = \frac{(140 - \text{Patient's age in years}) \times \text{pt. wt., kg}}{72 \times \text{Serum creatinine in mg/dL}}$$

CrCl = (140-84) x 60/ 72 x 4.22= 11.06 ml/ min.

Adjusting CrCl for body surface area

$$\frac{BSA}{1.73} \times CrCl = \text{Adjusted } CrCl$$

$$\text{Patient's BSA } (m^2) = \sqrt{\frac{\text{Patient's height (cm)} \times \text{Patient's weight (kg)}}{3600}}$$

$$BSA = \sqrt{66 \times 2.54 \times 60 / 3600}$$

= 1.67

Adjusting CrCl= 1.67/ 1.73 = 10.67 ml/ min.

From the table the dose is 500 mg every 24 hrs.

10. Using the creatinine clearance dosing table in this chapter and the nomogram for body surface area in Chapter 8, what would be the dose and dosage schedule of ceftazidime for a patient weighing 50 kg, measuring 66 in. in height, and having a creatinine clearance (unadjusted for BSA) of 31 mL per minute?

BSA= 1.52

Adjusting CrCl for body surface area

$$\frac{BSA}{1.73} \times CrCl = \text{Adjusted } CrCl$$

1.52/ 1.73 x 31= 27.3 ml/ min.

1 g ceftazidime every 24 hours

Among clinical recommendations to prevent cardiovascular disease in women is the maintenance of lipid levels as follows: low-density lipoproteins (LDL) <100 mg/dL; high-density lipoproteins (HDL) >50 mg/dL; and triglycerides (TG) <150 mg/dL.[13] Which of the following meet these criteria?

(a) LDL <2.6 mmol/L
(b) HDL >1.3 mmol/L
(c) TG <1.65 mmol/L
(d) all of the above

100 x 0.026
50 x 0.026
150 x 0.011

TABLE 10.2 EXAMPLES OF NORMAL RANGES OF SERUM CHEMISTRY VALUES[a]

LABORATORY TEST	*NORMAL* VALUES (RANGE, IN US UNITS)	CONVERSION FACTOR (MULTIPLY)		INTERNATIONAL SYSTEM[b]
Albumin	3.6–5.1 g/dL	10	=	36–51 g/L
Calcium	8.6–10.3 mg/dL	0.25	=	2.2–2.6 mmol/L
Cholesterol, total	125–200 mg/dL	0.026	=	3.25–5.2 mmol/L
HDL cholesterol	> or = 40 mg/dL	0.026	=	> or = 1.04 mmol/L
LDL cholesterol	<130 mg/dL	0.026	=	<3.38 mmol/L
Glucose	65–99 mg/dL	0.055	=	3.58–5.45 mmol/L
Triglycerides	<150 mg/dL	0.011	=	<1.65 mmol/L
Creatinine	0.5–1.4 mg/dL	88.4	=	44.2–123.8 μmol/L
Urea Nitrogen (BUN)	7–25 mg/dL	0.357	=	2.50–8.93 mmol/L

[a] *Normal* values shown may vary between test laboratories and may be referred to as "reference," "healthy," or "goal" values.
[b] The international system is generally expressed in mmol (or other units) per liter.

d

14. Complete the following table, comparing serum cholesterol (m.w. 386) levels expressed equivalently in milligrams per deciliter and in millimoles per liter:

mg/dL	mmol/L
Good:	Good:
170	(a)
(b)	4.91
Borderline:	Borderline:
(c)	5.69
240	(d)
High:	High:
(e)	6.46

(a) 4.40 mmol/L
(b) 189.53 mg/dL
(c) 219.63 mg/dL
(d) 6.22 mmol/L
(e) 249.36 mg/dL

a) 1 mmol = 386 mg
X = 170 mg/dL = 1700 mg/L

X= 1700/386= 4.4 mmol/ L

b) 1 mmol= 386 mg
4.91 mmol/ L = x
X= 4.91 x 386= 1895.3 mg/ L = 189.53 mg/dL

c) 1 mmol= 386 mg
5.69 mmol/ L = x
X= 5.69 x 386= 2196.3 mg/ L = 219.63 mg/dL

d) 1 mmol = 386 mg
X = 240 mg/dL = 2400 mg/L

X= 2400/386= 6.22 mmol/ L

e) 1 mmol= 386 mg
6.46 mmol/ L = x
X= 6.46 x 386= 2493.6 mg/ L = 249.36 mg/dL

A blood alcohol level of 80 mg/dL is considered to diminish driving performance. Express this value in terms of percentage.

80 mg/dL = 80 mg/ 100 ml

80 mg in 100 ml
X mg in 100 ml

X= 80%