

Dosage Calculation

MANY VARIABLES are considered in calculating medical dosages. Dosage involves determination of the amount, frequency, and the number of doses to fill a prescription. You will learn and practice conversion formulas to help you become efficient at calculating dosages. Since pharmacies do not always have the prescribed dosage in stock, the pharmacy technician needs to perform dosage calculations to fill prescriptions.



Objectives:



1. Calculate dosages based on body weight and body surface area (BSA).
2. Calculate dosages for various age groups (e.g., infants, children, adults, and the elderly).

Key Terms:



body surface area (BSA)
dosage regimen
dose
dosing range
solution
suspension

Medical Dosages

Medical dosages vary based on a person's age, weight, severity of illness, etc. As a result, it is necessary to know how to calculate the proper dose.

DOSE

A **dose** is a measured or calculated amount of medication that a patient receives to treat a medical condition. The frequency of the medication depends on the characteristics of a drug

and the severity of the patient's illness. The total dose is the amount of medication taken during the course of therapy.

Dosage Regimen

The **dosage regimen** is a schedule for administering medicine, which includes the amount of medicine, the number of doses per day, the time between doses, and the duration of treatment.

For a urinary tract infection, the dosage regimen may be nitrofurantoin 100 mg by mouth two times daily for three days. If the total daily dose is 100 mg ($50 \text{ mg} \times 2$), then the total dose would be 300 mg ($100 \text{ mg daily} \times 3 \text{ days}$). Several factors determine the size of a dose, such as the drug's potency, its physical and chemical properties, and the dosage form. Dosage forms can be tablet, injection, suppositories, and liquids.

Solution

A **solution** is a liquid preparation that contains medication dissolved in a liquid, which is usually water. If the solution is listed on the bottle as syrup, it contains sugar and a tincture—a medicinal extract—soaked in alcohol to extract oils or other useful substances. The alcoholic content of a tincture is an important consideration in medication given to infants, youth, and diabetics.

Suspension

A **suspension** is medicine mixed with a liquid, usually water, in which the drug does not dissolve; it remains in the form of small particles. It is important to shake a suspension before it is given to the patient to evenly distribute particles that have settled to the bottom.

CALCULATING DOSAGES

Calculating patient dosages is one of the most important responsibilities of a pharmacist. A few steps are involved in calculating and checking a patient's dose. You must begin by knowing a dosage range that will provide an approximate idea of how much medication to give. A **dosage range** is a guideline supplied by the drug manufacturers; it is based on studies that have found the correct range for effective treatment. Some examples of how this information is listed are mg/kg/dose, and mg/m².

Many resources and references contain dosing guidelines. Some of the most widely used are:

- ◆ Facts and Comparisons®
- ◆ Lexi-comp Drug Information®
- ◆ Micromedex®

These references are available as hard copies and online, but online access requires a subscription. By subscription, Lexi-comp® is a useful online dosing application that can be transmitted to smartphones or other portable devices (e.g., ITouch®, Palm®, and Pocket PC®). Hard copies of at least one dosing reference can usually be found in pharmacies. It is safest to use references specific to the patient population needing the dose. Neonatal, pediatric, and geriatric patients have specific needs.

Patient's Weight

You must know the patient's weight to calculate the correct dosage. With this information, you can calculate the amount of drug the patient should receive in each dose and how much drug is needed to fill the prescription.

Example 1: A patient is to receive a chemotherapy medication (cyclophosphamide) for breast cancer.

According to Micromedex® guidelines, the following dose is recommended: 50 mg/kg intravenously (IV) in divided doses for 5 days. The patient weighs 190 pounds.

Calculate the dose required:

$$\frac{50 \text{ mg}}{\text{kg}} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times 190 \text{ lb} = 4,320 \text{ mg (rounded) total dose}$$

$$50 \div 2.2 \times 190$$

Example 2: An antibiotic (daptomycin) is to be given at a dose of 5 mg/kg/day for 7 days. What is the patient's daily dose if she weighs 245 pounds?

$$\frac{5 \text{ mg}}{\text{kg}} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times 245 \text{ lb} = 560 \text{ mg (rounded) IV daily for 7 days}$$

$$(5 \div 2.2 \times 245)$$

Dose Checking

A common scenario is to check the dose in a reference source rather than calculating the dose. The steps are essentially the same as calculating the formula. If the technician is filling a prescription for an adult female for cephalexin 500 mg four times daily, 40 mg should be dispensed. The dose should be checked in a reference. According to Lexi-comp Drug Information®, the dose should be 250 to 1,000 mg every 6 hours.

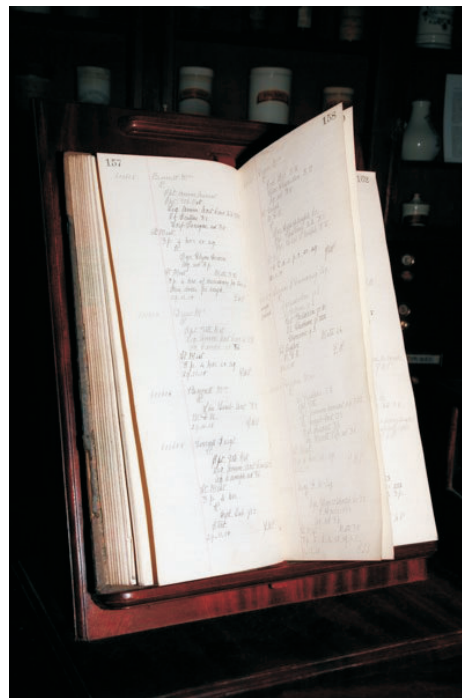


FIGURE 1. Antique apothecary medicinal remedy book.

Body Surface Area

Body surface area (BSA) is the total area of the body, figured using the patient's height and weight. Several calculations can be made to determine BSA, but the most commonly used is the DuBois & DuBois formula, which is calculated as follows:

$$\text{BSA (m}^2\text{)} = 0.007184 \times \text{weight (kg)}^{0.425} \times \text{height (cm)}^{0.725}$$

The average body surface area varies with age and gender.

- ◆ Adult men: 1.9 m²
- ◆ Adult women: 1.6 m²
- ◆ Children (9 years): 1.07 m²
- ◆ Children (10 years): 1.14 m²
- ◆ Children (12 to 13 years): 1.33 m²

Chemotherapy Agents

Few prescriptions utilize BSA, but the main drug class that uses BSA calculation is chemotherapy agents. To calculate BSA, the same steps as calculating dose by body weight should be used. A reference should be consulted for the dosing guideline (listed in mg/m²). Also, the patient's height in cm and weight in kg are necessary to calculate the BSA. The dose specified in the dosing guideline needs to be multiplied by the BSA in m² for the desired dose.

One possible dosing regimen for stomach cancer is a combination of two chemotherapy drugs: docetaxol and cisplatin. The patient weighs 137 lb and is 5 feet and 5 inches. Per the reference Microdex®, the dose for docetaxol is 75 mg/m², and the dose for cisplatin is 750 mg/m² given intravenously for 5 days every 3 weeks. Using the DuBois & DuBois formula:

Calculate the patient's weight in kg:

$$137 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 62.3 \text{ kg}$$

Calculate the patient's height in cm:

$$\begin{aligned} 5 \text{ feet } 5 \text{ inches} &= 65 \text{ inches} \\ 65 \text{ inches} \times \frac{2.54 \text{ cm}}{1 \text{ inch}} &= 165.1 \text{ cm} \end{aligned}$$

Calculate the patient's BSA:

$$\begin{aligned} \text{BSA (m}^2\text{)} &= 0.007184 \times \text{weight (kg)}^{0.425} \times \text{height (cm)}^{0.725} \\ 0.007184 \times (62.5 \text{ kg})^{0.425} \times (165.1 \text{ cm})^{0.725} &= 1.68 \text{ m}^2 \end{aligned}$$

Calculate doses:

$$\text{Docetaxol: } \frac{75 \text{ mg}}{\text{m}^2} \times 1.68 \text{ m}^2 = 126 \text{ mg}$$

$$\text{Cisplatin: } \frac{750 \text{ mg}}{\text{m}^2} \times 1.68 \text{ m}^2 = 1,260 \text{ mg}$$

Calculate Dosages for Various Age Groups

Dosages vary according to the patient age groups, differing between infants, children, adults, and the elderly. Dosing for infants is quite different than dosing for other age groups. The need for accuracy cannot be overstated. One multiplication or decimal error could lead to serious injury or death. Because of this, to prevent errors, many pharmacies adopt a double-check system in infants and children when calculating doses.

NEWBORN DOSAGES

Most dosing is per body weight. For example, if a newborn baby boy of normal gestational age has a fever and requires antibiotics, the physician calls the pharmacy and wants to know how much of the antibiotic cefotaxime would be required for this 6 lb 12 oz baby.

According to Neofax®, a drug reference specifically for neonates and most optimal for neonatal dosing, the dose for this baby would be 100 mg/kg/day divided every 8 hours intravenously. Convert the baby's weight to kg:

First convert the ounces to lb:

$$12 \text{ oz} \times \frac{1 \text{ lb}}{16 \text{ oz}} = \frac{12}{16} = 0.75 \text{ lb}$$

$$\text{Add } 0.75 \text{ lb to } 6 \text{ lb} = 6.75 \text{ lb}$$

Convert lb to kg:

$$6.75 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 3.1 \text{ kg}$$

Calculate the daily dose:

$$100 \frac{\text{mg}}{\text{kg}} \times 3.1 \text{ kg} = 310 \text{ mg}$$

Calculate the dosage regimen:

$$310 \text{ mg/day divided by } 3 = 103 \text{ mg IV every 8 hours}$$

YOUTH DOSAGES

Dosing for children is also mainly by body weight. For instance, you have a prescription for Tylenol with Codeine® elixir, 1 to 2 tsp orally every 4 hours as needed for pain for a 6-year-old, 35-pound female who just had her appendix removed. Lexi-Comp® Pediatric Dosing reference recommends a dosing range of 0.5 to 1 mg/kg/dose; Tylenol with Codeine® elixir contains 12 mg of codeine in each 5 ml of elixir. Lexi-Comp® dosing reference recommends a dosing range of 0.5 to 1 mg/kg/dose for codeine in children under 6 years of age.

Convert the weight from lb to kg:

$$35 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 15.9 \text{ kg}$$

Double-check the dose. The dosing range is 0.5 to 1 mg/kg/dose.

$$\frac{0.5 \text{ mg}}{\text{kg}} \times 15.9 \text{ kg} = 7.95 \text{ mg} \quad \text{to} \quad 1 \frac{\text{mg}}{\text{kg}} \times 15.9 \text{ kg} = 15.9 \text{ mg}$$

The dose ordered for this girl is 1 to 2 tsp. Using conversions, calculate how many mg of codeine are in the ordered dose:

$$1 \text{ tsp} \times \frac{5 \text{ ml}}{1 \text{ tsp}} \times \frac{12 \text{ mg}}{5 \text{ ml}} = 12 \text{ mg in 1 tsp and 24 mg in 2 tsp}$$

According to the reference, 1 tsp is within the recommended range, but 2 tsp would be too much. In this case, it would be the pharmacist's responsibility to call the prescribing physician and recommend a smaller dose of 0.5 to 1 tsp every 4 hours as needed for pain.

**TABLE 1. Common Pharmacy Conversions
(AP = Apothecary; AV = Avoirdupois)**

Measurement	Equivalent
Volume	
1 L	1,000 ml
1 lb (AV)	16 oz
1 cup	8 oz
1 fl oz	30 ml
1 tsp	5 ml
1 TBS	15 ml
1 TBS	0.5 fl oz
1 pt	480 ml
1 pt	16 oz
2 pt	1 qt
4 qt	1 gal
1 cup	8 fl oz = 240 ml
1 gal	3,840 ml
Weight	
1 kg	1,000 g
1 mg	1,000 mcg
1 g	1,000 mg
1 oz	30 g
16 oz	1 lb (AV)
1 lb	454 g
1 kg	2.2 lb
1 gr	64.8 mg
1 oz	480 gr
Length	
1 inch	2.54 cm
1 mile	~ 1.6 km
1 m	39.37 in
1 km	1,000 m
1 m	1,000 cm
1 cm	1,000 mm



ON THE JOB...

CAREER CONNECTION: Drug Reference Books

Widely used Facts and Comparisons®, Lexi-comp Drug Information®, and Micromedex® provide pharmacists with assistance in calculating prescription dosages. Drugs are divided into pharmacological groups that include generic and trade names for prescription and over-the-counter medications. These resources provide charts and tables that assist pharmacists in calculating prescribed dosages.

In addition, these references have current information regarding medication side effects, effects on mental status, pregnancy risk factors, drug interactions, anticipated treatment results, and patient information. They include information on Body Mass Index, abbreviations, symbols, treatment for specific disorders (e.g., allergic reactions or addiction disorders) and guidelines on safe prescription writing.

These references assist pharmacists in making safer and faster decisions based on clinical information and manufacturers' recommendations. They can be accessed in hardcover or online. With a membership fee and password access, the entire reference systems are available on any 3G cellular or WiFi connection on any web browser, including iPhone®, iTouch®, iPad™, DROID™, and Blackberry®

ADULT DOSAGES

Dosing for adults is different because many drugs are not dosed according to body weight. There is often a dosage range from which to choose since one dose is not always right for every patient. Dose checking examples are listed below:

An adult male with a bronchitis infection has a prescription for cefuroxime 500 mg twice daily for 10 days. How do you calculate his dosage?

1. Check a dosing reference to determine a dosage range. According to Lexi-comp® Drug Information, the adult dose for this medication is 250 to 500 mg daily for 10 days.
2. Verify that the prescription dose is within the reference guidelines and is, therefore, appropriate and safe to fill.

A young adult female who weighs 150 lb has a new diagnosis of seizures and is started on a medication called phenytoin. How do you determine an appropriate dose?

1. Per Micromedex® her dose would be 300 mg/day or 5 to 6 mg/kg/day in two equal doses. Calculate her weight in kg.

$$150 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 68.2 \text{ kg}$$

2. Calculate her dose based on body weight:

$$5 \text{ mg/kg/day} \times 68.2 \text{ kg} = 341 \text{ mg/day}$$

This medication is available in 100 mg capsules, so an appropriate starting dose would be 300 or 400 mg divided into 2 doses or 200 mg (2 of the 100 mg capsules) twice daily.

ELDERLY DOSAGE GUIDELINES

Dosing the elderly requires other considerations. Drugs are broken down by the liver and eliminated by the kidneys. If these organs are not working properly, drugs can accumulate in the body and cause harmful side effects. With age, the liver and the kidneys begin to decline. Therefore, dosing in this population should start with a low dose and slowly increase to the dose needed for the desired effect. Blood pressure medication may be given to a patient with hypertension; glucose levels are checked in a diabetic patient; and heart rhythm must be considered in a patient who has abnormal heart rhythm.

An elderly female patient wants to fill a prescription for paroxetine 30 mg daily for depression. What is your procedure?

1. According to Lexi-Comp® Dosing reference, the dosing for this medication in an elderly patient would be the following: Initially 10 mg/day; increase if needed by 10 mg/day increments at intervals of at least 1 week; maximum dosage 40 mg/day.
2. Although the dose on this patient's prescription would be high for an initial dose, it is within the recommended range. It would be important to find out if this patient has built up to this dose or if this is a new medication.

Summary:



Calculating patient dosages is one of the most important responsibilities of a pharmacist. You will use algebra to calculate how to fill the prescription with available medication. The patient's dosage regimen is a schedule for administering medication, which includes the amount of medicine, the number of doses per day, the time between doses, and the duration of treatment.

The dosage range is a guideline for quantity and duration of treatment, supplied by drug manufacturers, based on studies that have found the correct range for effective treatment. Along with your calculations, you can reference dosage information in pharmacy reference books, available in hard copy and online.

Some important dosage considerations are the patient's body surface area and age. The frequency and strength of medication depend on the characteristics of a drug and the severity of the patient's illness. If you find a physician's prescription is too

strong according to dosage guidelines, you are obligated to inform the diagnosing physician of the correct dosage.

Checking Your Knowledge:



1. Define dosage regimen.
2. Why must caution be used in giving a solution to certain patients?
3. What is unique about a suspension?
4. Where can you find information about dosage ranges for patients?
5. How is body surface area determined?

Expanding Your Knowledge:



To perform conversion formulas in calculating prescriptions, you must know how to convert English measurements to metric equivalents. Using TABLE 1 above, convert the following into metric volume:

4 fl oz, 6 TBS, 3 pt, 4 qt, 2 gal

Convert the following into metric weight:

3 kg, 4 gal, 2 lb, 2 oz

Convert measurement into metric length:

3 inches, 2 miles, 2 km, 1 cm

Web Links:



Dosage

http://www.ehow.com/how_2120904_calculate-dosage.html

Calculations

<http://www.nursingtimes.net/nursing-practice/clinical-zones/prescribing/how-to-calculate-drug-dosage-accurately-advice-for-nurses/199884.article>

Body Surface Area Calculation

<http://www.halls.md/body-surface-area/bsa.htm>

Solutions and Suspensions

<http://chemistry.about.com/od/lecturenotes13/a/colloids.htm>