Quantifying the Dose

Print:

Medical Assistant Math - Quantifying the Dose

Industry Sector: Healthcare
Content Area: Mathematics
Core Topic: Conversions

Expand All | Collapse All

Common Core State Standards

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Adult Basic Education Standards

Number Sense

Standard N-1: Represent and use numbers in a variety of equivalent forms in contextual situations
Standard N-2: Understand meanings of operations and how they relate to one another
Standard N-3: Compute fluently and make reasonable estimates

Patterns and Functions in Algebra

Standard P-2: Articulate and represent number and data relationships using words, tables, graphs, rules, and equations
Standard P-3: Recognize and use algebraic symbols to model mathematical and contextual situations

Geometry and Measurement

Standard G-4: Understand measurable attributes of objects and the units, systems, and processes of measurement and apply appropriate techniques, tools, and formulas to determine measurements.

Industry Overview

Healthcare in America

From neonatal nurses to radiology technologists, medical coders to medical office assistants, health educators to home care aides, the healthcare industry provides a vast and diverse array of services to individuals at every stage of life. Providing nearly 17 million jobs and accounting for an estimated $18 million of the U.S. GDP in 2009, healthcare is the nation's largest industry. In Massachusetts, in particular, healthcare accounts for more than 15% of employment (compared with 12% nationally), accounting for approximately one in six jobs. With an aging baby boomer population that is living longer, there is greater demand for more and higher quality preventative and long-term healthcare across the United States. With eight of the 30 fastest growing occupations, healthcare is predicted to be one of the fastest growing industries both nationwide and in Massachusetts between now and 2020.

Careers in Healthcare

The healthcare industry includes a vast array of jobs related to planning, managing, and providing therapeutic services, diagnostic services, health informatics, support services, and biotechnology research and development. This industry includes five career pathways:

- therapeutic services, which includes professionals who work directly with patients to improve their health by providing direct care and treatment for patients (for example, a nurse or a physical therapist assistant);
- diagnostic services, which includes professionals who plan and conduct tests to detect and diagnose diseases and injuries, and use test results to plan treatment (for example, a radiologic technologist or a sonographer, who perform diagnostic imaging examinations, such as X-rays or ultrasounds);
- health informatics, which includes professionals who compile and manage health information and records (for example, a medical records and health information technician, who organizes and manages patient databases; higher-level positions, such as administrators of healthcare facilities or departments, are also included in this pathway);
- support services, which includes professionals who provide assistance to other medical professionals, allowing them to do their jobs in diagnosing and treating patients or supporting therapies (for example, food service workers and nutritionists ensure that patients' meals are healthy and meet dietary guidelines); and
- biotechnology research and development, which include careers that involve bioscience research; while many of these professions require doctoral or medical degrees, some entry-level opportunities in the field require only an associate degree (for example, food and agricultural science technicians).

Mathematics and Communication Skills Needed in Healthcare

The growing complexity of the healthcare industry, including changing technologies, requires workers to continuously upgrade their skills. In addition to technical skills specific to their job, mathematics and literacy skills are crucial for success in all occupations across the healthcare industry.

Communication: First and foremost, no matter the job, good healthcare practitioners are committed to giving patients the best care available and keeping abreast of health research and developments in the field. All workers need to be able to read medical journals and understand medical terminology and vocabulary, as well as read and write literate emails to co-workers/supervisors. Many healthcare jobs also require the ability to read and interpret charts and access and interpret electronic medical records in order to provide quality care.

Many health careers, especially—but not exclusively—those in therapeutic services—involve interacting with patients and their families, in some cases working with people who may be sick, disabled, or dying. Even support staff in a medical office or hospital require effective oral communication skills as well as compassionate interpersonal skills such as the ability to listen and talk to patients to assess needs. Effective communication with colleagues as well as patients is crucial. Healthcare is increasingly a group activity, in which a patient's recovery depends on how well all members of a

healthcare team perform specific function, and how well they communicate and collaborate with one another.

Mathematics: From reading charts to interpreting data to measuring and administering correct medicine, basic mathematics skills are essential for providing quality care across most healthcare occupations. Nurses, for example, use mathematics for calculations in all areas of their duties. They use mathematics to calculate dosages, caloric requirements for individual patients, calibrate equipment, and interpret lab results. Charts and patient data are often presented as decimals or percentages, and a nurse must be able to convert between the two, thus requiring competency in understanding and using ratios, proportions and percentages.

Much of modern medicine is based on statistics, and all workers in the industry should have a basic understanding of how statistics are used to influence medical trends. Nurses, for example, need to be aware of the statistics behind prescribing medications and possible side effects or complications. They might use statistics to counsel patients on diagnoses or prognoses, or in gathering patient histories.

Career Opportunities in Healthcare with Education from Community Colleges

Massachusetts Community Colleges play a crucial role in preparing students for careers in health sciences across all sectors of the industry—therapeutic services, diagnostic services, informatics, and support services. All 15 community colleges offer pathways to nursing careers, the largest occupation in the healthcare industry. Additionally, Massachusetts Community Colleges offers associate degree and certificate programs that prepare students to enter occupations across all sectors of the industry, for example:

- *Therapeutic services:* registered nurse, practical nurse, nursing assistant, certified nurse's aide, massage therapist, fitness trainer and instructor, dental hygienist, dental assistant, pharmacy technician, physical therapist assistant, occupation therapy assistant, respiratory assistant, medical assistant
- *Diagnostic services:* radiologic technologist and technician, radiographer, surgical technologist, sonographer, phlebotomist, paramedic, polysomnographic technologist and technician, medical and clinical laboratory technician, magnetic resonance imaging technologist, nuclear medicine technologist, veterinary technologist
- *Informatics:* Medical record and health information technician, medical coder, medical interpreter, medical biller, medical transcriptionist, health educator

Recent Career Opportunities in Massachusetts

The following is a sample of healthcare job listings in Massachusetts that require an associate's degree or certificate:

- Registered Nurse (RN), AmeriCare At Home, Boston, MA [show]
- Medical Technologist, Emerson Hospital, Concord, MA [show]
- Ultrasound Technologist, Brockton, MA [show]
- Licensed Practical Nurse, Hologic, East Watertown, MA [show]

Employment Outlook for Healthcare

America's aging population is now nearing or entering retirement (opening new jobs), and will continue to require more services and the increased use of innovative medical technology for diagnosis and treatment. As a result, healthcare is one of the fastest growing industries both nationwide and in Massachusetts, where growth is even higher than nationally. For example, in 2010, Baystate Health of Springfield, which employs more than 10,000 across its Western Massachusetts system, said that it would likely need to hire about 15,000 people between 2010 and 2020 to replace retiring workers and meet increased demand.

One important factor in the healthcare industry is the financial pressure on hospitals to focus on efficiency and profitability, which results in discharging patients as soon as possible. These financial pressures, along with increased healthcare coverage under federal law, will likely result in a growth in out-patient services in the healthcare industry, such as rehabilitation clinics, long-term care facilities, and home care programs. As a result, occupations experiencing the largest growth include home care aides, physical and occupation therapist assistants, dental hygienists, and medical assistants.

Emerging careers in Health/Information Technology (HIT): Estimates based on data from the Bureau of Labor Statistics (BLS), Department of Education, and independent studies indicate a shortfall of approximately 51,000 qualified Health IT (HIT) workers who will be required over the next five years to meet the needs of hospitals and physicians as they move to adopting an electronic healthcare system, facilitated by the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009. The HITECH Act is a key component of healthcare reform. The Act encompasses interoperable electronic health records (EHRs) including computerized systems to order tests and medications, and support systems to aid clinical decision making and the development of a national health information network to permit the secure exchange of electronic health information among providers. The Congressional Budget Office estimates that the incentive mechanisms in the HITECH Act will increase HIT adoption rates from 45 percent to about 70 percent for hospitals and from 65 percent to approximately 90 percent for physicians. To support job growth in this emerging career field and ensure the adoption of EHRs, new types of workers are needed to facilitate information exchange across healthcare providers and public health authorities, and assist in redesigning workflows within healthcare settings to maximize the quality and efficiency benefits of EHRs, while maintaining privacy and security of health information and records. To that end, the Department of Health and Human Services has embarked on an initiative to build the HIT workforce with community colleges as the primary training ground for these new workers: (1) Practice workflow and information management redesign specialists; (2) Clinician/practitioner consultants; (3) Implementation support specialists; (4) Implementation managers; (5) Technical/software support staff; and (6) Trainers. The average hourly earnings for community college program graduates are expected to be in the target range of between $12.46/hour to $20.25/hour.

Resources:

Healthcare Employment Outlook:

- Massachusetts Career Information System: Massachusetts-specific information on careers which can be used to look at different industries, occupations within those industries, and the skills and education needed to work in these jobs
- WorkKeys Occupational Profiles
- Bureau of Labor Statistics

Healthcare Career Information:

- Top 5 Reasons to Work in the Healthcare Field, About.com
- Break Into a Healthcare Career, About.com
- Healthcare Initiatives, US Department of Labor
- Six Healthcare Careers that are Booming, Yahoo! Education
- Career Clusters in Health Sciences, National Association of State Directors of Career Technical Education Consortium
- Explore Health Careers, American Dental Education Association

Massachusetts Healthcare Job Listings:

- Massachusetts Healthcare Jobs, Jobs.net
- Healthcare Jobsite, Beyond.com

Workplace Scenario (8th Grade Level)

You work as a clinical medical assistant in an urgent care facility. You support several doctors who work in the clinic. During the day, you talk to and work with patients, other staff, and the doctors. It is your job to note every patient interaction and procedure in the medical record. This record is used for ongoing patient care and for insurance and patient billing.

Another job you are required to do is to figure out dosages for drugs and shots. You then enter the dosages correctly in the record. Often, you must make mathematical calculations. You convert numbers between the metric system and U.S. customary (non-metric) system. For example, you usually weigh the patient. The patient's weight is used to determine the correct dosage for medicines and shots. For this reason, you must be certain the weight is accurate. Dosage is typically measured in metric units, such as milligrams. You then need to convert from pounds, the non-metric unit for

weight, to kilograms, the metric unit for weight. You can convert pounds to kilograms by dividing the number of pounds by 2.2 - the number of pounds in 1 kilogram. You also need to make sure to use the correct abbreviation to show the number system being used. For example, a man's weight of 264 pounds is abbreviated 264 lbs. The conversion of that weight is entered in the chart as 120 kilograms or 120 kg.

As a medical assistant, you also give shots as directed by the doctor. For example, the doctor orders: "MedX 2mg IM." You know to read this order as "1.5 grams of intramuscular injection" of a particular medicine. You will also need to determine how many cubic centimeters (ccs) you should draw into the syringe. This is based on **recommended dosage** and the **concentration** of the medication.

You are often able to use a conversion chart such as the one below to make your calculations.

1000 g = 1 kg	1000 mg = 1 g
1000 mcg = 1 mg	1 ml = 1 cc
5 ml = 1 tsp. (t.)	15 ml = 1 tbsp. (T.)
30 ml = 1 oz.	2.2 lb = 1 kg
2.5 cm = 1 inch	1000 ml = 1 L

You will need to read conversion charts like these accurately and frequently in your job. You also will need to make the necessary conversions between mass, volume, and concentration.

Workplace Scenario (High School Level)

As a clinical medical assistant in an urgent care facility, you support several doctors who work in the clinic. During the day, you talk to and work with many people, such as patients, other staff, and the doctors. It is your job to note every patient interaction and procedure in the medical record, which is used for ongoing patient care and for insurance and patient billing.

Another job you are required to do is to figure out dosages for drugs and shots and enter the dosages correctly in the record. Often, you must make mathematical calculations and convert numbers between the metric system and U.S. customary (non-metric) system. For example, in addition to taking blood pressure and temperature, one of the first things you need to do is to weigh the patient. Since the patient's weight is used to determine the correct dosage for medicines and shots, you must be certain the weight is accurate. Since dosage is typically measured in metric units, such as milligrams, you need to convert from pounds, the non-metric unit for weight, to kilograms, its metric equivalent. You can convert pounds to kilograms by dividing the number of pounds by 2.2 - the number of pounds in 1 kilogram. You also need to make sure to use the correct abbreviation to show what number system is being used. For example, a man's weight of 264 pounds is abbreviated 264 lbs and the conversion of that weight is entered in the chart as 120 kilograms or 120 kg.

As a medical assistant, you also give shots as directed by the doctor. For example, the doctor orders: "MedX 2mg IM." You know to read this order as "1.5 grams of intramuscular injection" of a particular medicine. Based on **recommended dosage** and the **concentration** of your available medication, you will need to determine how many cubic centimeters (ccs) you should draw into the syringe and give to the patient.

Often in this field, you are able to use a conversion chart such as the one below to make your calculations.

1000 g = 1 kg	1000 mg = 1 g
1000 mcg = 1 mg	1 ml = 1 cc
5 ml = 1 tsp. (t.)	15 ml = 1 tbsp. (T.)
30 ml = 1 oz.	2.2 lb = 1 kg
2.5 cm = 1 inch	1000 ml = 1 L

You will need to read conversion charts like these accurately and frequently in your job as a medical assistant. You also will need to use math to make the necessary conversions between mass, volume, and concentration.

Core instructional context

Unit conversion is a daily practice in medicine, and that is for several reasons.

First, you may need to solve problems involving very large and very small quantities, which usually entail different units. For instance, you may need to use the mass of the patient to determine the mass or volume of medicine that should be administered in a dose.

Second, doctors often need to convert between mass and volume. Since liquid medicine usually consists of the active substance dissolved in water, converting from mass to volume relies on another quantity: **concentration**, or how much mass of a substance is dissolved in a given volume of water.

Third, you may be converting between hours and days to calculate how much medicine to give a patient over a given time frame.

Finally, both metric and non-metric units are used in medicine, so conversion between units like pounds and kilograms often needs to take place.

Typical Properties
In medical unit conversion problems, there are four properties you end up working with –

1) **weight (lbs)**, which is how much gravity pulls on an object – this is routinely used when referring to the weight of patients.

2) **mass (kg or mg)**, the amount of matter or "stuff" in an object or substance, or how much of it you are using – this is typically used when calculating the mass of medicine to administer based on the weight of the patient.

3) **volume (ccs or ml)**, the amount of space something takes up; this is usually used when referring to the volume of liquid medicine.

4) **concentration (mg/ ml or mg/ccs),** or how much mass of a substance is dissolved in a given volume of water – this is used when converting between mass of medication and volume of a liquid dose.

You also may be converting units of time, since doses may be given every x number of hours or days.

Mass vs. Weight
It's important to note that technically, mass and weight are two different properties. Mass is the amount of matter in an object, whereas weight is how much gravity pulls on that object. It is true that the mass of an object directly determines weight, but you can only convert between mass and weight if gravity is constant. For instance, while your mass would be the same on the earth and on the moon, your weight on the moon would be 1/6 your weight on earth, because the strength of the moon's gravitational field is 1/6 that of earth's.


mass and weight
Image Source: http://www.daviddarling.info/images/mass_and_weight.gif

Since health care facilities are currently only on earth, we can assume that one's mass is proportional to one's weight, and that 1 kg is always equal to 2.2 pounds. For this reason, we can convert our unit for weight (pounds) to mass (in kilograms) by simply dividing by 2.2 lbs per kg.

Practice Problem #1: A toddler weighs 22 lbs. What is the weight in kg?

Answer: 22 lbs ÷ 2.2 lbs / kg = 10 kg.

Because weight and mass are proportional on earth, kilograms (kg) may be referred to as "weight" of the patient even though this unit technically refers to mass.

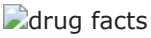
Finding the recommended dose in mg
When calculating dosage, two metric units for mass, kilograms (kg) and milligrams (mg), come into play. You may already know that a kilogram is 1,000 grams, and a gram is 1,000 milligrams. While it is reasonable to measure the weight of a patient in kilograms (kg), it is more reasonable to measure the mass of a dose in mg, since the mass of medicine in a patient's dose is pretty small compared to the patient's mass.

Using recommended dosage to determine amount of medicine
Normally when administering medication, there is a recommended dosage in "mg/kg" that depends on the patient's weight in kg. You don't need to convert the patient's mass from kg to mg – that would be impractical – but you do need to use the dosage:weight ratio provided to determine the mass of medicine you can give the patient.

Practice problem #2: A patient weighs 150 kg. He is taking a medicine once a day, and the dose is 3 mg/kg. How much medicine should be given to the patient?

Answer: 150 kg × 3 mg / kg = 450 mg of medicine.

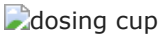

digital scale
In laboratory settings, an analytic balance is used to weigh out the mass of a solid substance with a high level of precision.


drug facts

Because many medications administered in health care settings are already dissolved in water, the amount of dissolved medicine in a given volume needs to be determined using the information on the bottle. More on that coming up!

Understanding Volume
Whereas mass indicates how much of a substance there is, volume is how much space a substance takes up. In medicine, volume is usually measured in cubic centimeters (ccs) or milliliters (ml). What is a real world point of reference for these units? Well, think of how large a centimeter (cm) is. Now imagine a cube that is 1 cm in width, one cm in height, and one cm in length – that would be a cubic centimeter, or a cc.

Here is a real world point of reference for milliliters. A big bottle of soda is often 2-liters. A bottle half that volume would be one liter, and a milliliter is 1/1000 of that. Those measuring cups in children's medicine usually hold 10 to 25 millilters (ml).

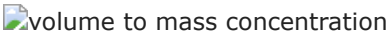

dosing cup
These cups are designed for measuring liquid in milliliters.
Image Source: http://www.poison.org/poisonpost/fall2011/306.jpg

Medication in liquid form is often measured in ccs, as well as milliliters (ml). *Fortunately, a milliliter is exactly the same volume as a cc.*

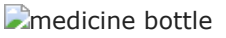
Converting from Mass to Volume

In medicine you are likely to treat patients with a medication dissolved in water, known as a **solution.**

When converting from mass to volume, remember that the mass of medicine in a given solution depends on the concentration – or the mass of medicine per unit volume. When medication is dissolved in water, its particles are spread throughout the water at a particular concentration. The amount of mass dissolved determines the concentration, or how crowded the particles are in this given volume of water.


volume to mass concentration

The label on a bottle of medication will usually tell you the concentration in mg / ml, or how many milligrams are in how many milliliters, and mg / cc, or how many milligrams of medication are in a cubic centimeter. *Because a milliliter (ml) is the same thing as cubic centimeter (cc) so mg / ml is the same thing as mg / cc.*



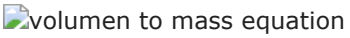
The concentration of this medication, as well as the
total volume in the bottle, is displayed on the box it comes in.
Image Source: http://www.medicines.org.uk/services/internalservices/TICTACImages/3/1/22081f.png

Practice Problem #3: A patient takes 5 ml of a 4 mg/ ml solution of medication. What is the mass of medication the patient is taking?

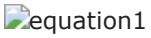
Answer: 5 ml × 4 mg/ ml = 20 mg of medication.

Converting Volume to Mass.

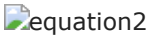
Suppose there is an order for a dose in mass, and all you know is the concentration of medicine. How do you find the volume to administer? Here we do the reverse, and divide mass by concentration to get volume. In other words,



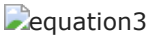
Now suppose you need to a give a patient 100 mg of an elixir. The label on the bottle of this particular medication displays its concentration as a fraction: 27 mg/5 ml. One option to find the volume to administer is to divide by the fraction:



But writing a fraction within a fraction can be sort of cumbersome. Fortunately, the denominator 5 in 27/5 becomes a multiplier, since you are dividing by 100 mg by 27/5. So you can rewrite the equation like this:



Because dividing and multiplying can be visually easier than dividing by a fraction, a typical formula used in nursing is this:



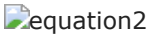
Wherein the concentration is actually dose available divided by volume available. In the above problem,

Dose ordered = 100 mg

And because concentration is 27 mg/ 5 ml,

Dose available = 27 mg
Volume available = 5 ml.

Amount to administer is once again:



Practice problem #4. You need to give 550 mg of acetaminophen, and the concentration is 100 mg per 5 ml. How much medication would you give? Use the above formula for liquids.

List your knowns:

Dose ordered = 550 mg
Concentration = 100 mg/5 ml

From concentration, we can find dosage available and volume available.

Dosage available = 100 mg
Volume available = 5 ml

How do we get the amount to give?

equation4

Answer: This is how much you give:

equation5

5) What is the % concentration of a 75 mg/ ml solution?

Answer: Now instead of multiplying by the density of water (1000 mg/ ml), we divide by it.

equation6 Convert this to percent by multiplying by 100, and you get 7.5. Note that dividing 75 by 10 gives you the same answer.

Converting between % concentration and mg/ ml
Another way to represent concentration is with percent. For instance, you may be asked to provide the proper dose of medication using a solution of 2% glucose. It is important to be able to convert between % and mg/cc.

Suppose you have a 1% solution of medicine. What does this mean?

The percent concentration concept is based on the idea that there is 1000 mg of water for every milliliter (ml). This is water's **density**. (How much mass is packed into a given space.) Let's say that 10 mg of a medication is dissolved in one ml of water. Because the density of water is 1000 mg per ml, and 10 mg of 1000 mg is 1%, this is a 1% solution. Essentially 1% of this solution is ***not*** water, but the medication.

Problem Solving Tip: If you know the % in a solution, what you are really doing is taking the percent of 1000 mg, since you have 1000 mg of water for every ml. So if you are working with 4% solution, you multiply the decimal equivalent of our percent by the density of water (1000 mg/ ml):

4 % = 0.04 × 1000 mg/ ml = 40 mg/ ml

A shortcut is to multiply our percentage by 10 to get mg/ ml. So 2% will translate into 20 mg/ ml, and 0.5% will translate into 5 mg/ ml. If you know mg/ ml and need to convert to percent, you can do the reverse and divide by ten.

Problem: You are asked to mix up a 3% solution of medication. What is the concentration in mg/ ml?

Answer: Remember that the density of water is 1000 mg/ ml, so we are looking at 3% of 1000 mg/ ml. We multiply 0.03 × 1000 mg/ ml. This is 30 mg/ ml. Note that multiplying 3 by 10 gives you the same answer.

Practice Problem #5: What is the % concentration of a 35 mg/ ml solution?

Answer: Now instead of multiplying by the density of water (1000 mg/ ml), we divide by it.

equation7 Convert this to percent by multiplying by 100, and you get 3.5%. Note that dividing 35 by 10 gives you 3.5% as well.

Contextualized learning activities

1. Measuring and Converting. Using scales and containers that measure volume, students should practice measuring mass and volume of real substances and converting between units. After finding the measurement in one unit, such as milliliters (ml), students should convert to another unit, such as liters (L). Students can also convert between metric units (grams) to metric units (kilograms).

Notes on equipment:
Calculators and the conversion chart appearing earlier in this activity will be helpful.

Scales for measuring mass could be kitchen scales, triple beam balances, or analytical balances.

Containers for measuring volume could be graduated cylinders, measuring cups, beakers, flasks, or other measuring spoons.

2. Mixing Solutions. Using basic kitchen equipment (measuring cup, kitchen scale, measuring spoons) or lab equipment, have students mix up basic solutions of Gatorade or another colored substance in varying concentrations (1%, 10%, 50%), so they can calculate concentration in percent and mg/ ml, as well as visually see differences in concentration.

Using a kitchen scale, triple beam balance, or analytical balance, students can weigh out household substances (baking soda, sugar, etc.) in milligrams. Then, they can dissolve these solutions in a set volume of water, starting with 100 ml. So for a 2mg/ ml solution, they would add 200 mg of substance.

3. Patient Case Studies. For a set of patients with weights and a set of medications with dosage amounts, students will play the role of medical assistants and determine the volume of medication to administer over a given day based on dosage. Patient summaries may be a paragraph or more and should list the age, height, and weight of the patient as well as recommended medication. They may also include information about the patient's tolerance for the medication(s) in question so students can determine whether to use the maximum, minimum, or moderate doses.

4. Online Calculations. Students will explore online dosage calculators and use them to check their work on practice problems and patient case studies.

Liquid Dosage Calculator
http://www.manuelsweb.com/dose.htm

Additional Dosage Calculators:
http://www.manuelsweb.com/nrs_calculators.htm

5. Role Playing. Students will play the role of the medical assistant and explain dosage to another student playing a patient's family member.

D. Worked Examples

Problem 1: Determining dosage range based on patient weight
1. A patient who needs stitches in his hand weighs 182 lbs. He needs a shot of lidocaine in his hand in order for the doctor to put in the stitches. Given that the usual dose is 3-5 mg / kg body weight. You prepare 60 ccs of 0.5% lidocaine solution. Does this fall within the acceptable range of anesthesia you should prepare?

We can determine if this is an acceptable amount of anesthesia using the known values in this equation: the patient's weight and the usual dosage range. First, we convert the patient's weight in lbs to kg. One method is to multiply by the number of kg per pound.

182 lbs. × (0.453592 kg / lbs) = 82.5 kg

Alternatively, you can divide by the number of pounds per kg.

182 lbs. ÷ 2.20462 = 82.5 kg

Since the usual dose is 3-5 mg / kg in body weight, let's first multiply 82.5 by the lowest dosage amount to determine the minimum dose needed in mg.

82.5 kg × 3 mg/kg = 247.5 mg

Now, let's multiply the weight by the highest dosage amount to determine the maximum does possible in mg.

82.5 kg × 5 mg/kg = 412.5 mg

So the dose range is **247.5 to 412.5 mg**. Let's convert the minimum and maximum values from milligrams to cubic centimeters (ccs).

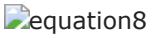
Recall that the lidocaine solution is 0.5%. Also, remember these facts:

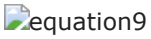
100% is equivalent to 100 g in 100cc (because density of water is 1 g/cc)

so 0.5% is 0.5g in 100 cc, or **500 mg** in 100 cc.

So the ratio of mg to cc is 5:1.

We know the solution is 0.5% so to convert to





The range is 49.5 to 82.5 ccs, so the 60 ccs of lidocaine solution falls within this range and would be an appropriate amount.

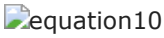
2a. A doctor orders five mg/lb of patient weight every 12 hours of a particular medication. However, our supply of the drug X is 0.9 g/ ml of solution. The patient is 72.7 kg. How many ml of solution do we have to give to the patient per dose?

Figure out the dosage in terms of ml.

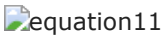
Convert kg to lbs.

1 kg = 2.2 lbs.

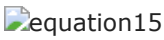
Convert 5 mg per pound (lbs) to to mg per kilogram (kg). If you are not sure whether to multiply or divide, remember that kilograms are larger than pounds, so you should have more mg per kg than mg per pounds. Also, notice we have pounds (lbs) in the denominator of the first number and in the numerator of the second number, so the pounds cancelling is also an indicator that this is correct.



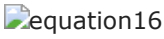
Now, because concentration is grams per milliliter, convert kg to grams.



Finally, convert grams of medicine per kg to milliliters of medicine per kg using the concentration of medicine, which is 0.9 g/ ml. Notice we flip the concentration from  to  effectively dividing  by 0.09, because we want to cancel grams and bring in milliliters.



Now we have a workable conversion factor for the patient's weight (72.7 kg). Let's use that to solve the problem!



2b. How much solution in milliliters should be administered over the course of 2 days?

Two doses in a day, so we have four doses. 0.889 ml × 4 = 3.556 ml.

A Khan Academy Video for this problem with a complete spoken explanation can be found at http://www.youtube.com/watch?v=ScvuRb6vsz4

3. In determining the amount in a dose, you forget to convert the patient's weight from pounds to kg and you dose the medication based on pounds. Did you give too much or too little medicine?

Since you have a larger number that you think is kg, and you are multiplying amount per kg by weight, you gave too much medicine.

4. A doctor orders 200 mg of Rocephin to be taken by a 15.4 lb infant every 8 hours. The medication label shows that 75-150 mg/kg per day is the appropriate dosage range. Is this doctor's order within the desired range?

a) Convert the baby's weight from 15.4 lb to kg.

15.4 ÷ 2.2 = 7 kg

b) 7 kg × 75 mg/kg = 525 mg (minimum desired dosage)

c) 7kg × 150 mg/kg = 1,050 mg (Maximum require dosage)

24 hours in one day and the medication is ordered every 8 hours.

24 hrs / 8 hrs = 3 times per day doctor ordered medication

200 mg × 3 = 600 mg ordered per day

600 mg is within the desired range of 525 – 1,050 mg.

YES! The doctor has ordered dosage within the desired range.
http://www.dosagehelp.com/dosage_by_weight.ht ml

5. Solumedrol 1.5 mg/kg is ordered for a child weighing 74.8 lb. Solumedrol is available as 125 mg / 2 ml. How many ml must the nurse administer?

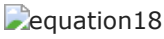
Convert 74.8 lbs to kg.

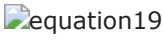
74.8 ÷ 2.2 = 34 kg (mass of patient)

34 kg × 1.5 mg/kg = 51 mg (mass of medicine needed).

We know there is 125 mg for every 2 ml. We need to convert from mass to volume so we put 2 ml on top, and 125 mg at the bottom.

Another approach is to use the equation below, which uses three quantities: how much is ordered, the unit of volume being used, and how much mass is available in that given unit of volume.





E. Contextualized Problems

Work the five problems in the Core Instructional Context Section as a class.

Contextualized test items

1. A child weighs 44 lbs. What is the weight in kg?

Answer: 44 lbs ÷ 2.2 lbs / kg = 20 kg.

2. A patient weighs 75 kg. He is taking a medicine once the day, and the dose is 6 mg/kg. How much medicine should be given to the patient?

Answer: 75 kg × 6 mg / kg = 450 mg of medicine

3. A patient takes 10 ml of a 3 mg/ ml solution of medication. What is the mass of medication the patient is taking?

Answer: 10 ml × 3 mg/ ml = 30 mg of medication.

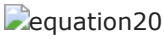
4. You need to give 650 mg of acetaminophen to a patient, and the concentration is 120 mg per 5 ml. How much medication would you give? Use the above formula for liquids.

List your knowns:

Dose ordered = 650 mg
Concentration = 120 mg/5 ml

From concentration, we know that the dosage available is 120 mg and volume available is 5 ml.

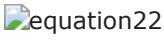
How do we get the amount to give?



Answer: This is how much you give. 

5. What is the % concentration of a 75 mg/ ml solution?

Answer: Divide 75 mg/ ml by the the density of water (1000 mg/ ml) to get the answer.


Convert this to percent by multiplying by 100, and you get 7.5%.

2a. A doctor orders six milligrams of medication per pound of patient weight (6 mg /lb) every 12 hours. Our supply of the drug X is 50 mg/ ml of solution. The patient is 68 kg. How many ml of solution do we have to give to the patient per dose?

Figure out the dosage in terms of ml.

Step 1: Convert kg to lbs.

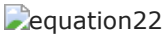
1 kg = 2.2 lbs.

68 kg × 2.2 lbs/kg = 150 lbs

Step 2: Find the amount in milligrams to give the patient every 12 hours.

150 lbs × 6 mg/lbs = 900 mg

Step 3: Convert milligrams to milliliters using the concentration of 1.1 g/ ml.



You would give the patient 18 ml per dose.

Contextualized project

1) Interview a medical assistant. Ask about the most challenging math used on the job and where is it applied.

2) Shadow a medical assistant for a given span of time and record the calculations and measurements that he/she makes during the day.

3) Write up a report on one of the above lab activities that includes calculations.

Additional or extension activities, multimedia, readings and/or resources

Medical Assistant Career Video

A Day in the Life of a Medical Assistant

Prepare for Intramuscular Injection

Prepare for Intradermal Injection

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