Critical Thinking:
Nursing Calculations
Part 1

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Note: All dosages given are for adults unless otherwise stated. The information on medications contained in this course is not meant to be prescriptive or all-encompassing. You are encouraged to consult with physicians and pharmacists about all medication issues for your patients.

Acknowledgements

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Purpose and Objectives

The purpose of *Critical Thinking: Nursing Calculations Part I* is to provide information about basic facts and principles of calculations related to conversions between different measurement systems.

After successful completion of this course, you will be able to:

1. Identify reasons why nurses need to maintain competency in performing selected calculations even though technology and pharmacy support relieves nurses of performing calculations in many situations.
2. Describe selected basic concepts, facts and principles of algebra and mathematics.
3. Perform calculations correctly using:
   A. Formula (where applicable)
   B. Ratio and proportion
4. Identify advantages and disadvantages of the different calculation methods:
   A. Formula (where applicable)
   B. Ratio and proportion
5. Convert correctly between selected units of measure:
   A. Within the metric system
   B. Between United States customary measures and the metric system
   C. Between selected cooking measures and the metric system
   D. Between Celsius (centigrade) and Fahrenheit temperature scales

Introduction

As a healthcare professional, medication safety is a critical part of your job. Patient's safety and lives may depend on receiving the correct dose of medications. This two-part series of courses reviews basic skills related to safely calculating medication dosages.

Part 1 of the series deals with the metric system and conversions to and from the metric system. Part 2 considers calculations related to medications.

Learning to master the metric system and related calculations may seem basic, but much of what we learned about the principles of calculations may have been forgotten. In this first part of the series, a general review of metric terms will reinforce what the terms mean. Basic calculations related to the metric systems and conversions to and from the metric system will be addressed.

Keys to Calculation Success

Some of those "Top Ten" reasons may apply to your work situation – at least partially. To add further support to the list, initiatives directed toward improving medication safety recommend that calculations be performed by computer algorithm rather than by practitioners using calculators or paper and pencil (Durham, 2015). HOWEVER, responsible professionals cannot afford to become complacent and place blind trust in technology - particularly nurses, who assume accountability for all

drugs they administer. The Institute for Safe Medication Practices (ISMP) recommends the use of redundancies, such as independent double checks, of high alert medications due to the increased risk for patient harm (ISMP, 2014). This includes independent calculations for dose and rates of medication. The list of high alert medications can be found at http://www.ismp.org/tools/institutionalhighAlert.asp

Top Ten Reasons Why Healthcare Professionals Don't Think They Need to Maintain Competency in Calculations

1. The computer does it.
2. The pharmacy does it.
3. The IV infusion pump does it.
4. We have charts and tables that do it.
5. The drug companies take care of it.
6. We use unit dose.
7. It's just a nursing school exercise.
8. We have a unit – based pharmacist.
9. Math is just not one of my strengths.
10. It's not a good use of my time.

Did You Know?

One cross-sectional study was done with 203 nurses to examine medication knowledge and the risk of medical errors. Participants were from acute care hospitals and primary care settings. As part of the study, each was provided a test on pharmacology, drug management, and drug calculations. The study showed that the participants had a 39% moderate risk and 11% high risk for pharmacology knowledge, 33% moderate risk and 26% high risk with drug management, and 32% moderate risk and 7% high risk with drug calculations (Simonsen, Johansson, Daehlin, Osvik, & Farup, 2011).

Relying on Technology

As previously mentioned, relying on technology alone can be detrimental to patients. Nurses are the often the last measure to keep patients safe. High risk medications and high risk populations, such as neonatal patients or those on chemotherapy are particularly at risk. Accurate calculations of medications are vital. In addition, the considerations of converting values to the metric system to input into devices, such as intravenous (IV) pumps is essential (American Association of Health-System Pharmacists, 2015; National Association of Neonatal Nurses, 2011). Examples of errors include inputting the patient's height (cm) into a pump rather than the weight (kg) (ISMP, 2011).

Keys to Calculation Success

To prepare and administer medications safely, healthcare professionals must avoid total dependence on technology to perform calculations.

Safe practitioners question themselves to eliminate risks of harm to patients.

Sample questions include:

- I set the pump to infuse at 125 mL/h – is what I see in the drip chamber consistent with that rate?
- This dose is ten times what I usually see for this type of patient – could a decimal point be out of place?
- How could one mg/kg amount to that large a dose for such a small patient?
- If I prepare that dose with these tablets, I'll be giving the patient 10 tablets – does that make sense?
- If you input "170" into the pump; this would mean that the patient's weight is 374 lbs. Does that look right?

Keys to Calculation Success

A safe practitioner maintains a state of risk-awareness – continuously assuring that there's nothing wrong with or any alteration from prescribed plan of care for the patient.

Just as hospitals have emergency generators to supply electrical power in the event of power outage, the healthcare professional must be prepared to back up some of the technology involved in safe administration of medications – to know how to calculate IV drip rates, for example.

Unit dose preparation by drug manufacturers and by pharmacists helps to assure safety. Occasions may arise when unit dose preparations are not available, when the pharmacist cannot respond as quickly as necessary or when limited pharmacy resources restrict unit dose preparation by pharmacists.

Even when all medication systems are functioning well; when the technology works and pharmacy support is optimal, the nurse remains responsible for safe administration of medications directly to patients. To fulfill this responsibility, the nurse must maintain competency in basic medication calculations (Durham, 2015).

Keys to Calculation Success

Of the medical errors reported, approximately 32% are medication errors (Anderson & Townsend, 2010). It is estimated that over one million medication errors occur each year (Leapfrog Hospital Survey, 2011). Research findings implicate calculation errors as the reason for many medication errors.

In addition, it was reported that errors in preparing and administering IV medications account for many of all medication errors and pediatric patients are three times more likely to experience medication errors than adults (Anderson & Townsend, 2010).

Test Yourself

Which of the following statements is true?

A. Nurses can rely on technology to prevent medication errors
B. Medication errors account for approximately 10% of medical errors
C. Approximately one million medication errors occur each year

Keys to Calculation Success

For most drug calculation problems, there is more than one method for arriving at the correct answer.

During your basic training, you undoubtedly learned at least one approach for each type of problem. This course will give you an opportunity to refresh your previous knowledge of calculations and gain new insights and techniques for approaching calculations.

Keys to Calculation Success

To use this series most effectively:

1. At intervals throughout the course you will find “Abbreviation Alerts!” Although abbreviations do not enter into the calculation procedure directly, unclear abbreviations have been implicated in medication errors. Safety experts at the Institute for Safe Medication Practices (ISMP), the Joint Commission (TJC) and the National Coordinating Council for Medication Errors (NCCMERP) have recommended that healthcare professionals discontinue the use of certain common abbreviations. Follow these recommendations when documenting in medical records and in communication among health team members. Encourage prescribers and colleagues to follow these recommendations.
2. The safest approach to drug calculation is to use the same method for the same type of problem each time you perform a calculation. While you are studying and working the problems in this course, try out alternative approaches to the calculations. You may find advantages to some of the methods that you have not used previously.

Keys to Calculation Success

To use this series most effectively:

3. Work through the topics in the order in which the course presents them. Explanations for certain mathematical and algebraic concepts appear early in the course. If you skip around amongst topics of the course, you will lose the benefit of explanation and the practice along the way.
4. Practice the problems that the course presents. When it comes to learning calculations, there is no substitute for active practice. Reading through the examples and solutions will not be sufficient to refine your skills.
5. Take it slow! The recommended speed for this series is slow and steady. Complete just one section at a sitting and take time to work through the examples and practice problems.
6. You may find some of the basic information extremely elementary. If you do, Bravo! Use the course as an opportunity to validate your skill and to add a few new insights to your approaches to calculations.

Conversions

The most common conversions needed for drug calculations involve:

- Conversions within the metric system, such as milligrams (mg) to micrograms (mcg).
- Conversions between selected units of the U.S. Customary System and metric units, such as ounces (oz.) to milliliters (mL).
- Conversions between selected units of cooking measures and metric units, such as teaspoons (tsp.) to milliliters (mL).
- Conversions between the Celsius and Fahrenheit temperature scales.
- Conversions are among the simplest of the calculations that nurses perform. You may be tempted

to skip the conversions and jump to the more complex calculations. Resist this temptation. This course uses conversions to demonstrate and explain some of the techniques that you will need to solve more complex problems later in the course.

Use your critical thinking skills as you study this course.

- Does this number make sense?
- Which should be larger?
- Why is the “amount” of the dose so small?

All these are important questions to ask yourself in order to be certain you have made a correct calculation.

Test Yourself:

The most common conversions needed for drug calculations involve:

A. The metric system
B. Conversions between Fahrenheit and Celsius
C. Cooking measures and metric measures
D. All of the above

The correct answer is D. all of the above.

The Metric System

The metric system has been used globally for years. In the United States, adoption of the metric system has been slowly increasing. This system of measurement units is decimal-based, and the units used for quantity are provided in factors of 10. The calculations used within the system involve a simple process of moving the decimal point to the left or right. The metric system is also known as the International System of Units, or SI (National Institute of Standards and Technology, n.d.).

Although the metric system itself is easy to use, once understood, the conversion of units of measurement between systems may still seem complicated.

Metric Scale

Look at the unshaded levels in the table.

- Note that within the unshaded levels in the scale, value of each level is ten times the value of level below it and also 1/10 the value of the level above it.
- Therefore, converting between two measures that are contiguous (next to one another) in the unshaded levels of the scale requires moving the decimal point one place for each step:
    - One place to the right for each step up the scale
    - One place to the left for each step down the scale
- The shaded levels of the scale at each the high end (mega) and low end (micro) of this scale are separated from the next level by a multiple of 1,000.

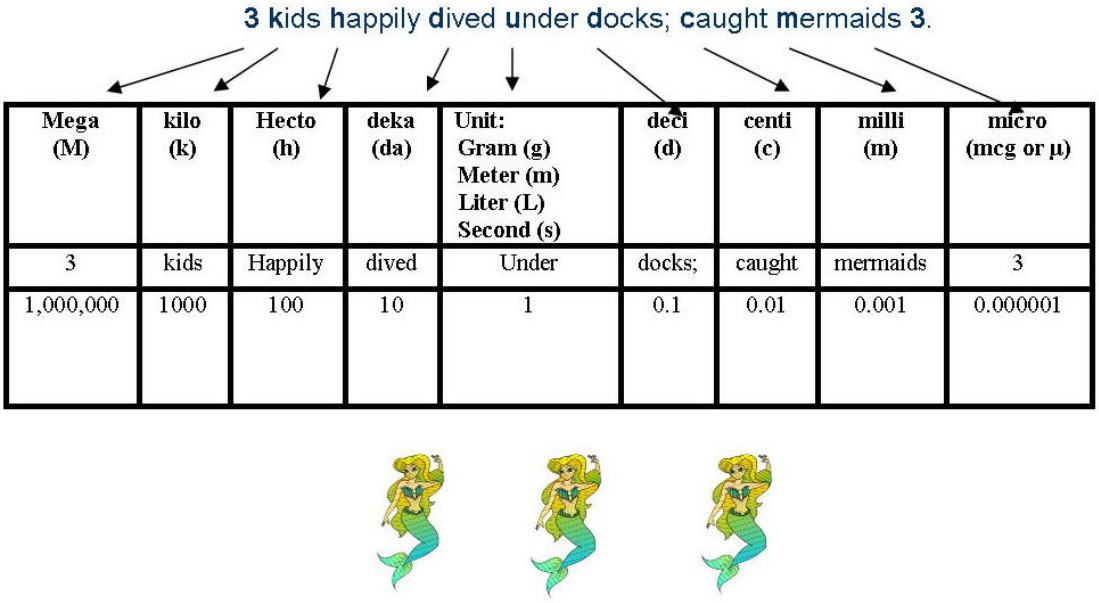
The Metric Scale

Prefix	Symbol	Multiply By
Mega	**M**	**1,000,000**
Kilo	k	1,000

Hecto	h	100
Deka	da	10
Unit: · Gram · Meter · Liter · Second	Unit: · g · m · L · s	1
Deci	d	0.1
Centi	c	0.01
Milli	m	0.001
Micro	**mc or μ**	**0.000001**

Mnemonic Memory Helper

Some people find a mnemonic (a memory helper) useful. The order of the levels in the metric scale and the 3-place separation at each end is represented in the mnemonic:



The Metric System

For the purposes of medication administration, conversions within the metric system most frequently involve conversions among micrograms, milligrams and grams.

1 milligram (mg) = 1,000 micrograms (mcg or µg)
1 gram (g) = 1,000 milligrams (mg)
1 kilogram (kg) = 1,000 grams (g)

The simplest way to perform conversions involving these quantities is to memorize the equivalents and move the decimal point to multiply or divide. For example:

A 50 mg tablet contains how many micrograms?

If 1 mg = 1,000 mcg, then you multiply 50 X 1,000, by moving the decimal point three places to the right (one place for each zero).

50.000 X 1,000 = 50,000

When performing ANY conversion or calculation, first ask yourself “Which unit is larger?” In this example conversion you know that milligrams are larger than micrograms and so the correct answer will be a number larger than the number of milligrams. Similarly when computing more complicated problems involving dosages, ask yourself first if the correct amount will be greater or less than 1 tablet, 1 milliliter, 1 milligram or whatever unit of measure is appropriate to the problem.

Abbreviation Alert!

The symbol µg is sometimes used to represent micrograms. Experts recommend that the symbol **not** be used since it may easily be mistaken for “u” meaning units, “mg” which is ten times the measurement, or “cc” (Agency for Healthcare Research and Quality [AHRQ], 2013)

The Metric System

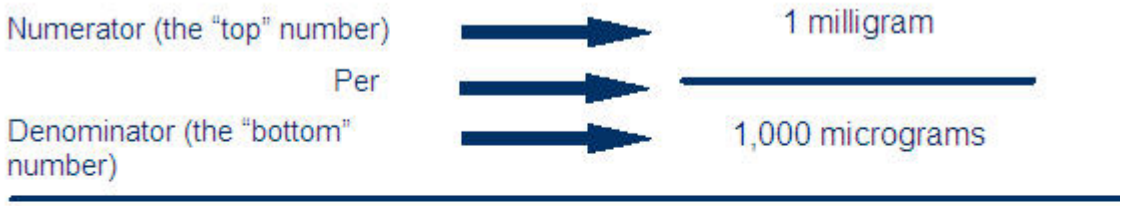
Another approach to this problem is to apply the metric scale, either using a written version, or using the mnemonic to recall the number of steps (or decimal places) between the two quantities.

Applying the scale, the number of steps (decimal places) between milligrams and micrograms is three. Since you are moving to the right in the scale, move the decimal point three places to the right. And the result is that 50 milligrams = 50,000 micrograms (50 mg= 50,000 mcg).

Fractions or Proportions

Another method to convert mg to mcg is to create a proportion. When you create a proportion, you are creating two fractions which are equal to each other. In this case, use the equivalent 1 mg = 1,000 mcg.

For the purposes of creating proportions and fractions, think of the equal sign as equivalent to “per.” In other words, 1 milligram per 1,000 micrograms (1 mg per 1,000 mcg). When you change equivalents into fractions, the “per” separates the numerator from the denominator.



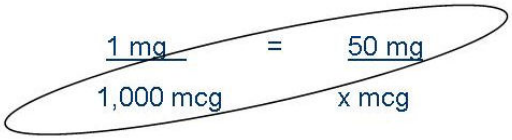
Set up the problem using this equivalent:

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} = \frac{50\text{ mg}}{x\text{ mcg}}$

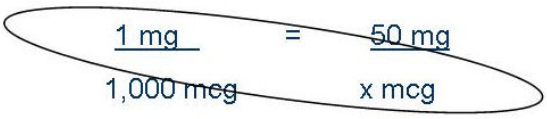
Use “x” to represent the number of micrograms because that is the unknown quantity that you are computing.

Fractions or Proportions

In the language of mathematics, these two numbers (the denominator of the first fraction and the numerator of the second fraction) are called “means.”



In the language of mathematics, these two numbers (the numerator of the first fraction and the denominator of the second fraction) are called “extremes.”



Critical Thinking Tip:

Always begin your calculation by using “x” to represent the quantity which will be your answer. In this case “How many micrograms?” translates into “x” micrograms (mcg).

Means = Extremes

When two fractions are equal to each other, the product of the means equals the product of the extremes. The product is the result of multiplying two numbers together. For example, the product of 2 X 3 is 6.

To prove to yourself that the product of the means = the product of the extremes when two fractions are equal, choose two fractions that you know to be equivalent. For example, 4/8 = ½. If you multiply the means (8 X 1) and multiply the extremes (4 X 2), you can see that each of the two products equals 8.

Means = Extremes

Critical Thinking Tip:

When setting up an equation (or two equivalent fractions), place like units in the same position in the two fractions. In the example, both “mg” are in the numerator and both “mcg” are in the denominator.

$$\frac{1\text{ mg}}{1{,}000\text{ mcg}} = \frac{50\text{ mg}}{x\text{ mcg}}$$

To solve the equation and find the value of x, cross-multiply the means and the extremes.

Dimensional Analysis

Another method that will answer the question, “A 50 mg tablet contains how many micrograms (mcg)?” is called dimensional analysis. If you have studied drug calculations recently, this technique may be familiar.

1. Determine the GIVEN QUANTITY.
   In the example, the GIVEN QUANTITY is 50 mg.
2. Determine the unit of measure for the WANTED QUANTITY.

In the example, the WANTED QUANTITY is in mcg.

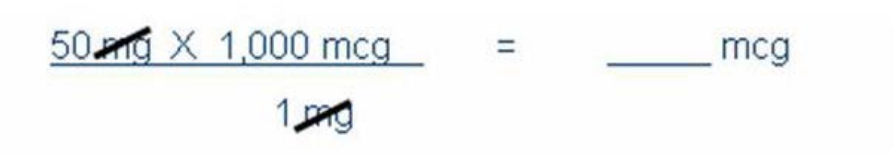
3. Determine what CONVERSION FACTORS you will need to use.
   In the example, the CONVERSION FACTOR is 1 mg equals 1,000 mcg, or 1 mg per 1,000 mcg or 1mg/1,000 mcg.
4. Now you are ready to SET UP the problem. Dimensional Analysis problems are set up like fractions, with a numerator (top number) and a denominator (bottom number).

   In dimensional analysis, you set up the problem so that the unwanted units are canceled out. Cancel out units by having one in the numerator and a matching one in the denominator.

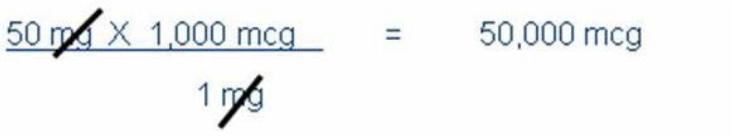
   So, if you have mg on top, and you want the answer in mcg, set up the problem using the mg to mcg conversion. Place mg on the bottom, so the mg cancel out. Separate the numbers with a multiplication sign.

$$\frac{50 \text{ mg} \times 1{,}000 \text{ mcg}}{1 \text{ mg}} = \_\_\_\_\_ \text{ mcg}$$

4. CROSS OUT the units which cancel out, leaving nothing but the WANTED QUANTITY.



5. DO THE BASIC MATH. Solve the problem by using basic math (no algebra required). Multiply the numbers across. Divide the top number by the bottom number.



Dimensional analysis is an extremely long and complex way to solve this simple conversion problem. However, dimensional analysis will be more useful later in the course for more complicated calculations. If you master the procedure on this simple conversion, you will find it easier to apply the technique to more complicated problems.

We have presented dimensional analysis as an option, but will not demonstrate it further in the course. As you can see, it is lengthy to present in written format. If you are familiar with dimensional analysis, go ahead and continue to use it. Remember that whatever method you choose, be consistent. Consistency increases your chances of performing the calculation correctly. If you wish further information on dimensional analysis, see the Resources section at the back of the course.

Practice

Apply these techniques to another conversion within the metric system.

How many grams does 35 mg equal?

Using the simplest method, recall the equivalents you have memorized:

1 milligram (mg) = 1,000 micrograms (mcg)
1 gram (g) = 1,000 milligrams (mg)
1 kilogram (kg) = 1,000 grams (g)

If 1 gram = 1,000 milligrams (1 g= 1,000 mg), then you divide 35 by 1,000 by moving the decimal point three places to the left (one place for each zero).

$$\frac{35}{1{,}000} =$$

Answer: 0.035g

Did you pause to ask yourself whether your answer will be a larger or smaller number than the 35 you were given? If you did so, you realized that since a gram is larger than a milligram, your answer will be a smaller number than the number of milligrams.

Test Yourself

In dimensional analysis, the formula is set up so that which of the following is removed?

A. Wanted units
B. Unwanted units
C. Units of measurement

Practice a Different Approach

Now use another approach to this problem. Apply the metric scale, either using a written version, or using the mnemonic to recall the number of steps (or decimal places) between the two quantities.

Applying the scale, the number of steps (decimal places) between milligrams (mg) and grams (g) is three. Since you are moving to the left in the scale, move the decimal point three places to the left. And our result is that 35 milligrams = 0.035 grams (35 mg = 0.035 g).

If you use the mnemonic “3 kids happily dived under the docks; caught mermaids 3,” you focus on the “u” word (under) representing “unit” (in this case gram) and the last “m” word (mermaids) representing milligrams. In the mnemonic sentence, mermaids is the 3rd word after under and so you move the decimal point three places in the direction of the unit: gram. Gram (g) is to the left of milligram (mg) in the sentence and so you move the decimal to the left.

Milligrams to grams

Mega (M)	kilo (k)	Hecto (h)	deka (da)	Unit: Gram (g) Meter (m) Liter (L) Second (s)	deci (d)	centi (c)	Milli (m)	micro (mc or µ)
3	kids	Happily	dived	Under	docks	caught	Mermaids	3
1,000,000	1000	100	10	1	0.1	0.01	0.001	0.000001

Total of 3 steps, or decimal

Practice a Different Approach

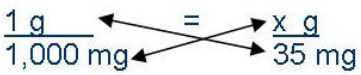
A third way to convert 35 mg to grams is to create a proportion. When you create a proportion, you are creating two fractions which are equal to each other. In this case, use the equivalent 1 gram = 1,000 milligrams (1 g = 1,000 mg).

Set up the problem using this equivalent:

$$\frac{1\text{ g}}{1{,}000\text{ mg}} = \frac{x\text{ g}}{35\text{ mg}}$$

Use "x" to represent the number of grams because that is the unknown quantity that you are computing.

To solve the equation and find the value of x, cross-multiply the means and the extremes.



Now, divide each side of the equation by 1,000 so that you will have a result that is equal to one "x."

1,000 x/1,000 = 35/1000

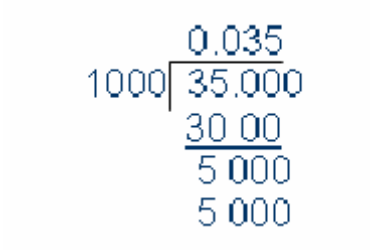
x = 0.035 g

To prove to yourself that moving decimal places to divide gives the same result as traditional long division:

$$1000\overline{)\,35}$$

$$1000\overline{)\,35.000}$$

Place a decimal point after 35 and add zeros.



More Practice

Solve each of the following for x:

1. 20 + x = 50

Answer

20 + x = 50

20 + x – 20 = 50 – 20

x = 30

Critical Thinking Tip:

To check your algebra, go back to your original equation containing x and substitute your answer for the x. If your answer "works" – (that is, if the two sides of the equation are equal using your answer) – then your answer is correct.

2. 3 x = 60

Answer:

3 x = 60

3 x/3 = 60/3

x = 20

3. x – 20 = 30

Answer:

x – 20 = 30

x – 20 + 20 = 30 + 20

x = 50

4. $\frac{x + 10}{2} = 45$

Answer:

$$\frac{x + 10}{2} = 45$$

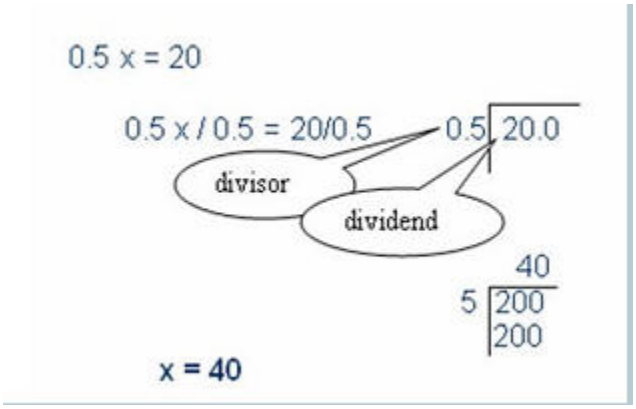
$$\left(\frac{x + 10}{2}\right) X\ 2 = 45\ X\ 2$$

$$x + 10 - 10 = 90 - 10$$

x = 80

5. 0.5 x = 20

Answer:



6. ⅜ x = 15

Answer:

$$\frac{3}{8}x = 15$$

$$\frac{3}{8}x \div \frac{3}{8} = 15 \div \frac{3}{8}$$

$$x = 15 \times 8/3 \text{ or } \frac{15 \times 8}{3}$$

$$x = \frac{120}{3} = 40$$

Critical Thinking Tip:

When you set fractions equal to one another and use x to represent the quantity you need to find, you will do what in algebra is known as "solving for 'x'." When you solve for x, remember that your final goal is to have 1 and only "1 x" remaining. In the problem you just reviewed, you needed to divide 1,000 x by 1,000 in order to have only 1 x remaining. Since you must maintain equal values on each side of the equal sign, you must divide the other side (35 in the example) by the same quantity (1,000).

Test Yourself

When you create a proportion, you set up two fractions that

A. Equal each other

B. Have the first one greater than the other

C. Have the second one greater than the other

Practice These Metric Conversions

- Use your preferred method.
- Then, try each of the additional techniques described in the previous section to make one of the conversions.

1. 500 mcg = _____ mg
   The correct answer is 0.5 mg

2. 300 g = _____ kg
   The correct answer is 0.3 kg

3. 65 mg = _____ g
   The correct answer is 0.065 g

4. 3 kg = _____ g
   The correct answer is 3,000 g

5. 45 mg = _____ mcg

The correct answer is 45,000 mcg

Practice These Metric Conversions

Critical Thinking Tips:

Make a habit of always using “leading zeros” – that is, placing a zero before a decimal point when the quantity is less than a whole number – e.g., instead of .5 write 0.5. Without the zero, you or someone else might overlook the decimal point and make a dosage error as a result.

For the same reason, do not use “trailing zeros.” Trailing zeros follow the decimal point – e.g., 5.0 rather than simply 5. Again, the decimal point may be overlooked, resulting in a dose or quantity 10 X greater than was intended.

Absence of zeros before the decimal and presence of trailing zeros have been implicated in many medication errors (AHRQ, 2013).

6. 0.65 kg = _____ g
   The correct answer is 650 g

7. 200 g = _____ mg
   The correct answer is 200,000 mg

8. 375 mcg = _____ g
   The correct answer is 0.000375 g

9. 2500 mcg = _____ mg
   The correct answer is 2.5 mg

10. 125 mg = _____ mcg
    The correct answer is 125,000 mcg

Conversions between Selected Units of the U.S. Customary System and Metric Units

For the purposes of medication administration, conversions between selected units of the U.S. Customary System the metric system most frequently involve conversions between:

- pounds (lb.) and kilograms (kg)
- inches (in.) and centimeters (cm)
- fluid ounces (oz.) and milliliters (mL)

1 kilogram (kg) = 2.2 pounds (lb.)
1 inch (in) = 2.54 centimeters (cm)
1 centimeter (cm) = 0.394 inch (in)
1 ounce (oz.) = 30 milliliters (mL)

Many medications are dosed in mg or mcg per kg of body weight. Since body weight in the United States is customarily measured in pounds, nurses frequently need to convert pounds to kilograms. Special note: When medications are ordered based on weight, the patient should be weighed before initial orders! Errors have occurred when weights are used based on patient statements, which are

frequently inaccurate. Estimated weights should not be used to calculate medications, except in emergency situations.

Converting Pounds (lb.) to Kilograms (kg)

How many kilograms does a 150-pound person weigh?

One method for converting pounds to kilograms is to create ratio and proportion. Use the equivalent 1 kilogram = 2.2 pounds. Another way of saying this is, 1 kilogram per 2.2 pounds.

Remembering that "per" implies a fraction, create the fraction representing 1 kilogram per 2.2 pounds.

Abbreviation Alert!

Milliliters (mL) and cubic centimeters (cc) are equivalent and are often used interchangeably. However, because cc may be misread as u (representing units), or µg (representing mcg), the use of mL is recommended. The use of upper case L is recommended rather than "l" because the lower case can easily be confused with the number 1 (AHRQ, 2013).

Now set this fraction equal to the weight in pounds for which you need to find the kilogram equivalent.

$$\frac{1 \text{ kg}}{2.2 \text{ lb.}}$$

Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ kg}}{2.2 \text{ lb.}} = \frac{x \text{ kg}}{150 \text{ lb.}}$$

$$\frac{1 \text{ kg}}{2.2 \text{ lb.}} = \frac{x \text{ kg}}{150 \text{ lb.}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ kg}}{2.2 \text{ lb.}} = \frac{x \text{ kg}}{150 \text{ lb.}}$$

$$2.2\,x = 150$$

Now, divide each side of the equation by 2.2, so that you will have a result that is equal to one "x."

$$2.2\,x/2.2 = 150/2.2 \qquad \mathbf{x =}$$

Answer: 68.18 kg

The actual value of x in this case is 68.1818181818 . . .∞. The symbol "∞" represents infinity – in

other words, the 0.18 fraction repeats endlessly when you perform the division of 150 ÷ 2.2. For practical purposes, most medication calculations can be safely rounded to one or two decimal places.

Practice Calculations: Weight

Try the follow practice calculations for converting weights:

1. 125 lbs.= ____ kg

Answer= 56.82 kg

2. 200 lbs.= _____ kg

Answer= 90.91 kg

3. 75.5 kg = _____ lbs.

Answer= 166.1 lbs.

4. 60.3 kg = _____ lbs.

Answer= 132.66 or 132.7 lbs.

Rounding

Look at the number that is one decimal place to the right of the decimal place to which you are rounding. In this case, that number is 1.

68.1818181818 . . ∞.

If the number that is one decimal place to the right of the number to which you are rounding is 5 or greater (also expressed as ≥ 5), round the number you are rounding to one number higher. For example, if you were rounding 68.1818181818 . . ∞ . to the first decimal place, the result would be 68.2. Since 8 is greater than 5, the 1 which follows the decimal point is increased by 1 to a value of 2.

When the number that is one decimal place to the right of the number to which you are rounding is 4 or less (also expressed as < 5), retain the value of the preceding number.

After determining the value of the decimal place to which you are rounding, simply delete the numbers beyond that decimal place.

Greater Than and Less Than

Here's how to remember the meaning of the greater than and less than symbols. Four symbols are used to represent this concept:

≤ equal to or less than
≥ equal to or greater than
< less than
> greater than

The symbols are always used with a number, for example ≥ 100 means equal to or greater than 100. You might receive an order to take an action, such as administer an antipyretic drug for a temperature ≥ 100 degrees F.

To remember the meaning of these symbols, just remember that the open end of the symbol points to the larger number; the point of the symbol points to the smaller number. For example, < 6, means less than six. The open end of the symbol points toward the 6, so 6 is the largest number to be considered.

Critical Thinking Tip:

Don't let decimal fractions of pounds or hours trick you into making an error. In the United States, nurses are accustomed to working with pounds and ounces; with hours and minutes. When you are making calculations and your answer comes out to a decimal fraction of a pound or an hour, don't mistake that fraction for a number of ounces or minutes. For example, 1 kilogram = 2.2 pounds. NOT 2 pounds, 2 ounces. How many ounces does 0.2 pound equal? To answer this question, you must know that a pound is equal to 16 ounces. Then, multiply to find the number of ounces in 0.2 pound:

16 X 0.2 = 3.2 ounces. So, 2.2 pounds = 2 pounds, 3 ounces (rounded).

< >

Abbreviation Alert!

Because these symbols are frequently misinterpreted, the recommendation is to write out the words "greater than" and "less than." (AHRQ, 2013)

Test Yourself

When rounding, you will round up if the number to the right of the number you are rounding is at least

B. 4

C. 5

D. 6

Conversions between Inches (in.) and Centimeters (cm)

1 inch (in) = 2.54 centimeters (cm)
1 centimeter (cm) = 0.394 inch (in.)

How many cm does 5 inches equal?

The simplest way to convert inches to centimeters is to multiply the number of inches by 2.54.

Performing this calculation: 5 X 2.54 = 12.7 cm
Using ratio and proportion will give you the same result.

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ in}}{2.54 \text{ cm}} = \frac{5 \text{ in}}{x \text{ cm}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ in}}{2.54 \text{ cm}} = \frac{5 \text{ in}}{x \text{ cm}}$$

12.7 cm = x

Height Considerations

With the exception of pediatric patients, most people report his or her height in feet (ft.) and inches (in.). It is important to convert this to total inches before making the next conversion to centimeters. For example, a person who is 5 ft. 5 in. is the same as 65 in. This is the number that will be used for the conversion.

$$\frac{1 \text{ in}}{2.54 \text{ cm}} = \frac{65 \text{ in}}{x \text{ cm}}$$

165.1 cm = x

Conversions between Inches (in) and Centimeters (cm)

How many inches does 20 cm equal?

The simplest way to convert centimeters (cm) to inches (in.) is to multiply the number of centimeters by 0.394.

Performing this calculation: 20 X 0.394 = 7.9 inches

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ cm}}{0.394 \text{ in.}} = \frac{20 \text{ cm}}{x \text{ in}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ cm}}{0.394 \text{ in.}} = \frac{20 \text{ cm}}{x \text{ in}}$$

x = 7.9 inches

Critical Thinking Tip:
Remember, as with decimal fractions of pounds or of hours, you must convert 0.88 inch into a unit of measure which appears on a ruler that is calibrated in inches and fractions of inches – i.e., fourths, eighths or sixteenths of an inch.

$$\frac{88}{100} = \frac{x}{16}$$

$$100x = 1408$$
$$x = 14.08$$
(rounded to 14)

Therefore,
7.88 inches = 7 14/16 inch

Practice Calculations: Height

Try the follow practice calculations for converting heights:

1. 23 in.= ____ cm

Answer= 58.42 cm

2. 6 ft. 2 in.= _____ cm

Answer= 187.96 cm

3. 152 cm = _____ in.

Answer= 59.89 in. or 60 in.

4. 60 cm = _____ in.

Answer= 23.64 or 23 10/16 in.

Converting between Ounces (oz.) and Milliliters (mL)

1 ounce (oz.) = 30 milliliters (mL)
Milliliters (mL) and cubic centimeters (cc) are equivalent and are often used interchangeably. However, mL is recommended, as "cc" can be mistaken for "u" or units (AHRQ, 2013).

The simplest way to convert ounces to milliliters is to multiply the number of ounces by 30.

Performing this calculation: 8 X 30 = 240 mL

Using ratio and proportion:

Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ oz.}}{30 \text{ mL}} = \frac{8 \text{ oz.}}{x \text{ mL}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ oz.}}{30 \text{ mL}} = \frac{8 \text{ oz.}}{x \text{ mL}}$$ **x = 240 mL**

Converting between Ounces (oz.) and Milliliters (mL)

How many oz. does 150 mL equal?

The simplest way to convert milliliters to ounces is to divide the number of milliliters by 30.

Performing this calculation: $\frac{150}{30}$ = 5 ounces (oz.)

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ oz.}}{30 \text{ mL}} = \frac{x \text{ oz.}}{150 \text{ mL}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ oz.}}{30 \text{ mL}} = \frac{x \text{ oz.}}{150 \text{ mL}}$$

$30x = 150$ **$x = 5$oz.**

Conversions between Selected Units of Cooking Measures and Metric Units

For the purposes of medication administration, conversions between selected units of the U.S. Customary System the metric system most frequently involve conversions of teaspoons (tsp.) or tablespoons (Tbsp.) to milliliters.

1 tablespoon (Tbsp.) = 15 milliliters (mL)
1 teaspoon (tsp.) = 5 milliliters (mL)

How many mL does 6 tsp. equal?

The simplest way to convert teaspoons (tsp.) to milliliters (mL) is to multiply the number of teaspoons by 5.

Performing this calculation: 6 X 5 = 30 mL
Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ tsp.}}{5 \text{ mL}} = \frac{6 \text{ tsp.}}{x \text{ mL}}$$

x = 30 mL

How many tsp. does 15 mL equal?

The simplest way to convert milliliters (mL) to teaspoons (tsp.) is to divide the number of milliliters by 5.

Performing this calculation: 15/5 = 3 tsp.

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$\frac{1 \text{ tsp.}}{5 \text{ mL}} = \frac{x \text{ tsp.}}{15 \text{ mL}}$

Cross multiply means and extremes to solve for x.

$\frac{1 \text{ tsp.}}{5 \text{ mL}} = \frac{x \text{ tsp}}{15 \text{ mL}}$.

$5x = 15$

x = 3 tsp.

Abbreviation Alert!

An upper case T is often used to abbreviate tablespoons in order to minimize possible confusion with teaspoons, represented by lower case t. The safest abbreviations are Tbsp. for tablespoon and tsp for teaspoon.

How many Tbsp. does 30 mL equal?

The simplest way to convert milliliters (mL) to Tablespoons (Tbsp.) is to divide the number of milliliters by 15.

Performing this calculation: $\frac{30}{15} = 2$ Tbsp.

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$\frac{1 \text{ Tbsp.}}{15 \text{ mL}} = \frac{x \text{ Tbsp.}}{30 \text{ mL}}$

Cross multiply means and extremes to solve for x.

$\frac{1 \text{ Tbsp.}}{15 \text{ mL}} = \frac{x \text{ Tbsp.}}{30 \text{ mL}}$

$15x = 30$

$15x / 15 = 30/15$

x = 2 Tbsp.

Critical Thinking Tip

How many Tbsp. does 40 mL equal?

Answer:
40/15 = 2 10/15 or 2 2/3 or 2.67

BUT – are fractions meaningful in terms of tablespoons? Not really.

However, you might consider that the answer is really 2 tablespoons (Tbsp.) with 10 milliliters (mL) left over.

The ten milliliters (mL) is equal to 2 teaspoons (tsp.).

It is not practical to deal with fractions or decimal fractions of a Tablespoon.

Instead, it is more practical to round off to the nearest teaspoon.

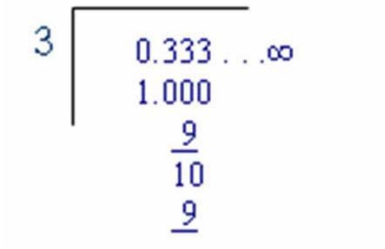
So, the most practical answer in this case is 2 Tablespoons (Tbsp.) and 2 teaspoons (tsp.).

Reducing Fractions

To reduce a fraction, divide BOTH the numerator and the denominator by the largest number which divides evenly into both numbers.

e.g. $\frac{12}{36} = \frac{1}{3}$ $\frac{30}{45} = \frac{6}{9} = \frac{2}{3}$

To express a fraction as a decimal fraction, perform long division, dividing the numerator by the denominator. For example, 1/3 =



When the answer is a metric unit always express fractions as decimals.

How many mL does 7 Tablespoons (Tbsp.) equal?

The simplest way to convert Tablespoons (Tbsp.) to milliliters (mL) is to multiply the number of Tablespoons by 15.

Performing this calculation: 7 X 15 = 105 mL

Using ratio and proportion:
Remember that like units must have the same position (numerator or denominator).

$$\frac{1 \text{ Tbsp.}}{15 \text{ mL}} = \frac{7 \text{ Tbsp.}}{x \text{ mL}}$$

Cross multiply means and extremes to solve for x.

$$\frac{1 \text{ Tbsp.}}{15 \text{ mL}} = \frac{7 \text{ Tbsp.}}{x \text{ mL}}$$

Do the math: $\frac{\mathbf{7 \text{ X } 15 \text{ mL}}}{\mathbf{1}} = \mathbf{105 \text{ mL}}$

105 mL = x

Test Yourself

How many mL are in a tsp?

A. 2.2
B. 5
C. 15

Practice Calculations: Cooking Measures and Metric Conversions

Try the follow practice calculations for converting cooking measures and metric conversions:

1. 5 tsp.= ____ mL
   Answer= 25 mL
2. 2 Tbsp. = _____ mL
   Answer= 30 mL
3. 10 mL = _____ tsp.
   Answer= 2 tsp.
4. 25 mL = _____ Tbsp.
   Answer= 1 Tbsp. and 2 tsp.

Conversions between the Celsius & Fahrenheit Temperature Scales

Fahrenheit Temperature (^{o}F) = (9/5 x Centigrade Temperature or ^{o}C) + 32
Centigrade Temperature (^{o}C) = (Fahrenheit Temperature or ^{o}F – 32) x 5/9

The Fahrenheit (F) temperature scale is more commonly used in the United States, but you may be required to convert temperatures to the centigrade scale, also known as the Celsius scale. Celsius and centigrade are synonymous. For simplicity, the course uses the term “Celsius” or abbreviation "C".

When converting between Fahrenheit and Celsius temperature scales, it is simplest to follow the above highlighted formula.

Facts to Remember:

- The freezing point of water (0^{O}C) on the Fahrenheit scale is 32^{o} F.
- To convert **C**elsius to Fahrenheit, **s**ubtract 32 and use the **s**maller fraction 5/9.
- To convert Fahrenheit to Celsius, add 32 and use the larger fraction 9/5.

Conversions between the Celsius and Fahrenheit Temperature Scales

What is the Celsius equivalent of 99 ºF?

ºC = 5/9 (99 – 32)

$$ºC = \frac{5 \times 67}{9}$$

$$ºC = \frac{335}{9}$$

ºC = 37.22 . . . ∞, rounded to 37.2

What is the Fahrenheit equivalent of 38º C?

ºF = 9/5 (38) + 32

$$ºF = \frac{9 \times 38}{5} + 32$$

$$ºF = \frac{342}{5} + 32 = 68.4+32$$

ºF = 100.4

Conversions between the Celsius and Fahrenheit Temperature Scales

An alternative way to convert between Celsius and Fahrenheit scales is to use the factor of 1.8. Formulas using this factor are as follows:

Fahrenheit Temperature (ºF) = (Celsius Temperature or ºC x 1.8) + 32
Celsius Temperature (ºC) = (Fahrenheit Temperature or ºF – 32) /1.8

Using the same examples used above, this is how this conversion can be applied:

What is the Celsius equivalent of 99 ºF?

ºC = (99 – 32)/1.8

ºC = 67/1.8

ºC = 37.22 . . . ∞, rounded to 37.2

What is the Fahrenheit equivalent of 38º C?

ºF = (38 x 1.8) + 32

ºF = 68.4 + 32

ºF = 100.4

Practice Calculations: Temperature

Try the follow practice calculations for converting weights:

1. 98 ºF = ____ ºC

Answer= 36.7 ºC

2. 101.2 ºF = _____ ºC

Answer= 38.4 ºC

3. 37.5 ºC = _____ ºF

Answer= 99.5 ºF

4. 39 ºC = _____ ºF

Answer= 102.2 ºF

Practice Conversions

Practice These Conversions

76 kg = _____ lb.
The correct answer is 167.2 lb.

200 lb. = _____ kg
The correct answer is 90.9 kg

10 in. = _____ cm
The correct answer is 25.4 cm

5 cm = _____ in.
The correct answer is 1.97 inches or 15.52/16 inches rounded to 2 inches

500 mL= _____ oz.
The correct answer is 16.90 oz. or 17 oz.

Practice Conversions

Practice These Conversions

3 tsp. = _____ mL
The correct answer is 14.8 mL or 15 mL.

20 mL = _____ tsp.
The correct answer is 4.

8 Tbsp. = _____ mL
The correct answer is 118 mL

50 mL = _____ Tbsp.
The correct answer is 3.3 Tbsp. OR 3 Tbsp. rounded to nearest Tablespoon OR 3 Tbsp., 1 tsp rounded to the nearest teaspoon (since the 3 mL remainder = more than ½ teaspoon)

103 ºF= _____ ºC
The correct answer is 39.4 degrees.

39 ºC = _____ ºF
The correct answer is 102.2 degrees.

Calculation Safety Tips

When using calculations, the following tips can help assure calculation safety:

- Always use the same method to approach the same type of problem.
- Always have your answer verified by an RN colleague. Assure that your colleague actually performs the calculation.
- Assert your need to concentrate by eliminating distractions while performing calculations.
- Before beginning the calculation procedure, identify some of the parameters of a sensible answer – for example, should the correct answer be more or less than one mL? Then compare the answer you obtain with your common sense parameter.
- Validate your calculated answer with an appropriate up-to-date drug reference. That is, does your calculated answer fall within recommended guidelines?

- Use tools, calculators, references, the Internet, etc. to verify your calculations.

Case Scenario: Calculating IM Dosages

You are preparing a 65-year-old female patient for hip surgery. The pre-operative medication order sheet lists the following medications to be given one hour prior to surgery:

- Demerol 40 mg IM.

The pharmacy supplies Demerol 50mg/mL in pre-filled syringes.

How many mL of Demerol will you administer?
You will administer 0.8 mL

- Phenergan 25 mg IM.

The pharmacy supplies Phenergan 50 mg/mL ampule.

How many mL of Phenergan will you administer?
You will administer 0.5 mL

- Heparin 3000 units SQ. The pharmacy supplies heparin 10,000 units/2mL.

How many mL of heparin will you give?
You will administer 0.6 mL

Case Scenario: Calculating mL

Your patient is a 70-year-old diabetic, who is one day post-operative following a bowel resection. The patient is nil by mouth (NPO), has an NG tube set to low intermittent suction, and is receiving IV fluids. The patient is complaining of nausea. The 7am blood sugar analysis showed a blood sugar of 322. The medication order sheet lists the following medication orders:

- Compazine 7.5 mg IM every 4 hours prn for nausea

The pharmacy supplies Compazine 20mg/2mL

How many mL of Compazine will you administer?
You will administer 0.75 mL

- Heparin 7500 units sub q every 12 hours

The pharmacy supplies heparin 5000 units/mL

How many mL of heparin will you administer?

You will administer 1.5 mL

Case Scenario: Calculating mL

Your patient is a 70-year-old diabetic, who is one day post-operative following a bowel resection. The patient is nil by mouth (NPO), has an NG tube set to low intermittent suction, and is receiving IV

fluids. The patient is complaining of nausea. The 7am blood sugar analysis showed a blood sugar of 322. The medication order sheet lists the following medication orders:

- Humalog insulin on sliding scale per bedside glucose testing:

2 units for blood glucose 200-250 mg/dL

4 units for blood glucose 251-300 mg/dL

6 units for blood glucose 300-325 mg/dL

Call doctor for blood glucose above 325 mg/dL

How many units of Humalog insulin will you give?
You will administer 6 units

Conclusion

This course offers evidence to support the need for nurses to maintain competency in performing selected calculations. The course has presented basic principles of math and algebra. A variety of examples of calculation problems common in nursing practice have been presented and solved. The course has provided the opportunity for practice with several methods for solving particular problems.

Resources

For abbreviations toolkit:

http://www.ismp.org/Tools/abbreviations/default.asp

For calculation practice:

http://www.manuelsweb.com/nrs_calculators.htm

http://www.dosagehelp.com/

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