Common Calculations

Medication administration is a core competency for all nurses in every clinical setting. A key skill required to safely dispense drugs is the ability to perform accurate dosage calculations. New technologies such as bar coding medication and smart infusion pumps have helped to reduce medication errors (Cookson, 2013). However, nurses cannot rely completely on these advances. Two dosage calculation techniques are presented below: traditional formulas and dimensional analysis. Nurses should select one formula and practice to become proficient in that method.

Universal Formula (Wilson, 2013)

All dosage calculations have these 2 components:

- Medication dosage prescribed by the healthcare provider
- Medication concentration supplied by the pharmacy

In the universal formula, the desired amount (D) is the dose prescribed by the provider. The amount on hand (H) is the dose on the container label. The volume (V) is the form and amount in which the drug is supplied (i.e. tablet, capsule, liquid). To use this formula, divide the desired amount by the amount on hand and multiply by the volume.

**Example 1:**

Administer digoxin 0.5 mg IV daily. The drug concentration available from the pharmacy is digoxin 0.25 mg/mL. How many mL will you need to administer a 0.5 mg dose?

\[
\frac{D}{H} \times V = \text{Dose}
\]

\[
\frac{0.5}{0.25} \times 1 = 2 \text{ mL}
\]

Intravenous (IV) Medications (Wilson, 2013)

Continuous IV drip calculations are more complex. Use the universal formula, but some conversions are usually necessary. First, determine the drug concentration. Then consider the unit in which your drug is measured (units/hour, mg/hour, mg/min, mcg/min, or mcg/kg/minute). Then, depending on how the drug is ordered, use one of the formulas below.
**To find mcg/min:**

If your amount on hand is in milligrams (mg), convert mg to micrograms (mcg) by multiplying by 1,000. Also, convert hours to minutes.

**Example 2:**

A patient is on a nitroglycerin drip. The pump is running at 8 mL/hour. The label on the bottle reads 50 mg in 500 mL 0.9% sodium chloride solution. What dose of nitroglycerin (mcg/min) is the patient receiving?

\[
\frac{50 \text{ mg}}{500 \text{ mL}} \times \frac{1000 \text{ mcg}}{1 \text{ mg}} \times \frac{8 \text{ mL}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = \frac{13.3 \text{ mcg}}{\text{min}}
\]

**Answer:** 13.3 mcg/min

**To find mcg/kg/min:**

Use the formula for mcg/min and divide by patient’s weight (kg).

**Example 3:**

Administer dopamine at 10 mcg/kg/min. The pharmacy provides dopamine 800 mg in 250 mL of D₅W. What is the hourly IV pump rate? The patient weighs 85.3 kg.

In this example, solve for mL/hr.

\[
\frac{800 \text{ mg}}{250 \text{ mL}} \times \frac{1000 \text{ mcg}}{1 \text{ mg}} \times \frac{\text{mL/hr}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = \frac{85.3 \text{ kg}}{10 \text{ mcg/kg/min}}
\]

\[
800,000 \text{ mcg/250 mL x mL/hr x 1 hr/60 min} = 85.3 \text{ kg} = 10 \text{ mcg/kg/min}
\]

\[
3,200 \text{ mcg/mL x mL/hr} \times \frac{1 \text{ hr}}{60 \text{ min}} = 85.3 \text{ kg} = 10 \text{ mcg/kg/min}
\]

\[
3,200 \text{ mcg/mL} \times \frac{\text{mL/hr}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 853 \text{ mcg/min}
\]

\[
\text{mL/hr} = \frac{853 \text{ mcg/min} \times 1 \text{ mL}}{3,200 \text{ mcg} \times 60 \text{ min/hr}}
\]

\[
\text{mL/hr} = 16 \text{ mL/hr}
\]

**To find units/hour:**

First, determine the concentration of the amount on hand. Then, use the universal formula to calculate the rate.

**Example 4:**

Administer heparin 500 units per hour I.V. Th pharmacy supplies the heparin infusion as 20,000 units in 500 mL D₅W.
Find the concentration:
20,000 units/500 mL = 40 units/mL

Use the universal formula:
D/H x V = Dose
500 units/hr ÷ 40 units/mL = 12.5 mL/hour

Dimensional Analysis (Cookson, 2013)
Dimensional Analysis (DA) or factor-label method: uses a series of conversion factors of equivalency from one system of measurement to another but doesn’t require memorizing specific formulas (Koharchik & Hardy, 2013). This method reduces errors and can be used for all dosage calculations.

1. Start with the labels needed in the answer to determine what unit of measure is needed to begin setting up the calculation.
2. Build the calculation by placing information with the same label as the preceding denominator into the equation in the numerator to cancel out the unwanted labels. Repeat until all units of measure not needed in the answer are cancelled out.
3. Calculate to determine the correctly labeled numeric answer. Don’t round any numbers in the equation until you have the final answer.

Using the same examples above, let’s use the dimensional analysis method.

Example 1:
Administer digoxin 0.5 mg IV daily. The drug concentration available from the pharmacy is digoxin 0.25 mg/mL. How many mL will you need to administer a 0.5 mg dose?

Step 1: What unit of measure (label) is needed? Place this on the left side of the equation.

mL? =

Step 2: On the right side, place the information given with the same label needed in the numerator.

mL? = mL
0.25 mg

Step 3: Place information with the same label as the preceding denominator into the equation in the numerator to cancel out the unwanted labels. Repeat this step sequentially until all unwanted labels are canceled out.

mL? = mL x 0.5 mg
0.25 mg
Step 4. Multiply numbers across the numerator, then multiply all the numbers across the denominator. Divide the numerator by the denominator for the final answer with the correct label.

\[
mL? = \frac{mL}{0.25 \text{ mg}} \times \frac{0.5 \text{ mg}}{0.25} = 2 \text{ mL}
\]

**Example 2:**
A patient is on a nitroglycerin drip. The pump is running at 8 mL/hour. The label on the bottle reads 50 mg in 500 mL 0.9% sodium chloride solution. What dose of nitroglycerin (mcg/min) is the patient receiving?

Step 1: \(\frac{? \text{ mcg}}{\text{min}}\)

Step 2: *Convert 50 mg to 50,000 mcg.*

\[
\frac{? \text{ mcg}}{\text{min}} = \frac{50,000 \text{ mcg}}{500 \text{ mL}} = \frac{100 \text{ mcg}}{\text{ml}}
\]

Step 3: \(\frac{? \text{ mcg}}{\text{min}} = \frac{100 \text{ mcg}}{\text{ml}} \times \frac{8 \text{ ml}}{1 \text{ hour}} \times \frac{1 \text{ hour}}{60 \text{ min}} = \frac{800 \text{ mcg}}{60 \text{ min}} = 13.3 \text{ mcg/min}\)

**Example 3:**
Administer dopamine at 10 mcg/kg/min. The pharmacy provides dopamine 800 mg in 250 mL of D5W. What is the hourly IV pump rate? The patient weighs 85.3 kg.

Step 1: \(\frac{? \text{ mL}}{\text{hr}}\)

Step 2: \(\frac{? \text{ mL}}{\text{hr}} = \frac{250 \text{ mL}}{800 \text{ mg}}\)

Step 3: \(\frac{? \text{ mL}}{\text{hr}} = \frac{250 \text{ mL}}{800 \text{ mg}} \times \frac{1 \text{ mg}}{1,000 \text{ mcg}} \times \frac{10 \text{ mcg}}{\text{kg/min}} \times \frac{85.3 \text{ kg}}{1 \text{ hr}} \times \frac{60 \text{ min}}{1 \text{ hr}} = 12,795,000 = 16 \text{ mL/hr}\)

\[
= \frac{16 \text{ mL/hr}}{800,000}
\]
Example 4:
Administer heparin 500 units per hour I.V. Th pharmacy supplies the heparin infusion as 20,000 units in 500 mL D₅W.

Step 1: \( \frac{? \text{ mL}}{\text{hr}} \)

Step 2: \( \frac{? \text{ mL}}{\text{hr}} = \frac{1 \text{ mL}}{40 \text{ units}} \)

Step 3: \( \frac{? \text{ mL}}{\text{hr}} = \frac{1 \text{ mL}}{40 \text{ units}} \times \frac{500 \text{ units}}{\text{hr}} \)

Step 4: \( \frac{? \text{ mL}}{\text{hr}} = \frac{500 \text{ mL}}{40} = 12.5 \text{ mL/hr} \)

Calculating Drops Per Minute (Koharchik & Hardy, 2013)
Continuous IV infusions are delivered via infusion pumps. However, if there is a power outage, nurses need to know how to deliver fluids without the use of an infusion pump. This requires calculating the number of drops per minute, as administered through basic IV tubing.

Example:
Administer lactated ringer’s solution IV at 75 mL/hour. The drip factor is 10 drops/mL. How many drops per minute will you run the infusion?

Using the DA method:
Step 1: \( \frac{? \text{ drops}}{\text{min}} \)

Step 2: \( \frac{? \text{ drops}}{\text{min}} = \frac{10 \text{ drops}}{\text{mL}} \)

Step 3: \( \frac{? \text{ drops}}{\text{min}} = \frac{10 \text{ drops}}{\text{mL}} \times \frac{75 \text{ mL}}{\text{hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \)

Step 4: \( \frac{? \text{ drops}}{\text{Mn}} = \frac{10 \text{ drops}}{\text{mL}} \times \frac{75 \text{ mL}}{\text{hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 12.5 \text{ or } 13 \text{ drops/min} \)

General Calculation Tips:
- Check that your answer makes sense clinically.
- Double-check your work.
- Have a colleague or pharmacist check your work.
- Know general therapeutic drug doses for common medications.
## Dosage Calculation Conversions

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<th>Conversion</th>
<th>Amount</th>
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<tbody>
<tr>
<td>1 kilogram</td>
<td>1,000 grams</td>
<td>2.2 pounds</td>
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<tr>
<td>1 pound</td>
<td>0.45 kg</td>
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<td>1,000 mcg</td>
<td></td>
</tr>
<tr>
<td>1 grain</td>
<td>60 mg</td>
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<td>4 cups</td>
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<td></td>
<td></td>
<td>3,785 mL</td>
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</table>

### Temperature Conversion:

\[ T^\circ C = (T^\circ F - 32) \times \frac{5}{9} \]

\[ T^\circ C = \frac{(T^\circ F - 32)}{1.8} \]

### References:

