Systems of Measurement

Course
Principles of Health Science

Unit X
Vital Signs

Essential Question
What's math got to do with it?

TEKS
130.202 (c)1A, 1B, 1D

Prior Student Learning
Basic understanding of the metric system and conversions.

Estimated time
3 hours

Rationale
To pursue a career in the health care industry, the student should be proficient in academic subject content. The Health Science student will have the knowledge and skills necessary to perform the mathematical processes used in careers in health care.

Objectives
Upon completion of this lesson, the student will be able to
- Convert units between systems of measurements
- Use measurement functions for client assessment
- Interpret technical material related to health care

Engage
Show students the sample Hematology report. Have students read the report. Ask students what does it mean? How is math used in this report?

Key Points
I. Knowledge and skills related to mathematical conversions are important in the health care industry. See conversion charts
II. Systems of Measurement
  A. Metric System
  B. Apothecary System
  C. Household System
III. Terms used in measurement
  A. Metric System
  B. Scientific System
IV. Vital Signs, I&O, and Charting
  A. Proper technique for determining blood pressure, temperature, pulse, respirations, and I&O will be demonstrated by the teacher in another lesson.
  B. Proper charting of client data will be demonstrated by the teacher.

Activity
I. Analyze and interpret a sample hematology report for use of scientific notation and the metric system.
II. Hand out conversion chart and discuss when the conversions or formulas might be used.
III. Solve the Conversion Problems.

Assessment
Successful completion of Conversion Problems

Materials
Sample Hematology Report

Access to one or more of the following resources is recommended:
Simmers, Louise, *Diversified Health Occupations*, 7th edition, Delmar, 2009, ISBN 9781418030216

Kennamer, Michael, Mathematics for Health Care Professionals, Delmar, 2005, ISBN 9781401858032

Pickar, Gloria D., *Dosage Calculations*, Delmar, 2008, ISBN 9781418080471

Any Medical Mathematics book is helpful.

www.hosa.org/natorg/sectb/cat-i/mm.pdf (HOSA Medical Math Contest with Conversion charts)

Accommodations for Learning Differences
For reinforcement, the student will identify the difference between scientific notation and the metric system data.

For enrichment, the student will research rationale for using the metric system in health care and why it was not adopted as the universal system in the United States.

National and State Education Standards
National Health Science Cluster Standards
HLC1O.01 Technical Skills
Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

TEKS
130.202 (c)(1)(A) convert units between systems of measurement;
130.202 (c)(1)(B) apply data from tables, charts, and graphs to provide solutions to health-related problems; and
130.202 (c)(1)(D) organize, compile, and write ideas into reports and summaries.

Texas College and Career Readiness Standards
Mathematics
IV. A. 1. Select and use the appropriate type of unit for the attribute being measured.
IV. B. 1. Convert from 1 measuring system to another
IV. B. 2. Convert within a single measurement system.

Mathematics Conversion Chart

Length
1 meter = 100 centimeters
1 meter = 1000 millimeters
10 millimeters = 1 centimeter
1 inch = 2.5 centimeters

Volume for Fluids
1 liter = 1000 milliliters
1 milliliter = 1 cubic centimeter
10 centiliters = 1 deciliter
10 deciliters = 1 liter
1 teaspoon = 5 milliliters
1 tablespoon = 15 milliliters
1 ounce = 30 milliliters
1 pint = 500 milliliters
1 quart = 1000 milliliters

Weight Conversions
1 gram = 1000 milligrams
1 kilogram = 1000 grams
1 kilogram = 2.2 pounds
1 pound = 16 ounces

Temperature Conversions
Celsius to Fahrenheit $(^0C \times 1.8) + 32 = {^0F}$
Fahrenheit to Celsius $(^0F - 32) \div 1.8 = {^0C}$

Terms and abbreviations
Gram (g) measures mass or weight
Liter (l) measures volume or liquid
Meter (m) measures length or distance

Kilo (k) = thousands
Deci (d) = tenths
Centi (c) = hundredths
Milli (m) = thousandths

DOSE AND DOSAGES

YOUNG'S RULE:
Child's Dose = (Child's Age (in years)/Child's Age in Years + 12) x Adult Dose

FRIED'S RULE:
Infant's Dose = (Age (in months) /150 pounds) x Adult Dose

CLARK'S RULE:
Child's Dose = (Weight of Child (in pounds) / 150 pounds) x Adult Dose

Child's Dose = (Weight of Child (in kilograms) / 68 kilograms) x Adult Dose

SOLUTIONS

Ratio Strength of Solutions = amount of drug / amount of solution
Percent of Strength by Volume = (volume of solute/volume of solution)x100
Percent Strength by Weight (Mass) = (mass of solute/volume of solution)x100
Amount of Solute /Amount of First Solution = Amount of Solute / Amount of Second Solution

BODY SURFACE AREA

Used to determine drug dosage in infants and children and also used to determine the loss of body fluid in ml/hour in burn patients.
Formula: BSA (m2)=0.20247 x height (m) 0.725 x weight (kg)0.425
Web site to automatically calculate BSA:
http://www-users.med.cornell.edu/~spon/picu/calc/bsacalc.htm
http://www.halls.md/body-surface-area/bsa.htm

IV DROP RATE CALCULATION

CC'S/hour x Drop Factor of the tubing divided by 60 (minutes) = drops/minute

Calculating the Amount of Skin Burned

Overall, burn severity is a measurement of the depth of burning and the size of the burn. Measuring the size of a burn is difficult because every person is different in size, shape and weight. It's impossible to simply choose what universal size of burn is significant. A square foot of burned surface area is much worse to a person who weighs 130 pounds than it is to someone who weighs 200 pounds.

To account for inequities in size and shape, burned surface area is calculated as a percentage of total body area. Of course, we don't actually know how many square inches of skin covers any single person, but we do know about how much of our skin it takes to cover our arms and legs, for example.

The Rule of Nines

To approximate the percentage of burned surface area, the body has been divided into eleven sections:

- Head
- Right arm
- Left arm
- Chest
- Abdomen
- Upper back
- Lower back
- Right thigh
- Left thigh
- Right leg (below the knee)
- Left leg (below the knee)

Each of these sections takes about nine percent of the body's skin to cover it.
Added all together, these sections account for 99 percent. The genitals make up the last one percent.

To apply the rule of nines, add up all the areas of the body that are burned deep enough to cause blisters or worse (2^{nd} or 3^{rd} degree burns). For example, the entire left arm and the chest covered in blisters would be 18 percent. Partial areas are approximated. For example, the face is only the front half of the head and would be considered 4.5 percent.

Since kids are shaped so much different than adults, there are adjustments made to the rule of nines, which of course ruins the point of making this tool the rule of nines. So many variations exist that it would be fruitless to go into them here.

The most important thing to remember about the rule of nines is that it is intended to be used in the field to quickly determine if victims need to go to a specialty burn center. Once the victim is in a burn center, more advanced techniques will be used to determine the exact burned surface area. (taken from firstaid.about.com)

Conversion Problems

1. Lidocaine is available in an ampule with 100 mg in 5 ml of solution. How many ml do you give to administer 65 mg?

2. The temperature in the classroom is 86 oF. What is this in celsius?

3. You fill a storage cabinet with 12 bottles of dextrose. Each bottle contains 15 ½ ounces. How many ounces of this solution are in the storage cabinet?

4. The physician will need a needle 7.5 cm long to take a bone marrow sample. This is equal to how many inches?

5. The stomach produces about 8 cups of gastric acid each day. How many liters is this?

6. The temperature today is –10 °F. What is the temperature in Celsius?

7. The doctor gives you a prescription for a cough medication. He tells you to take 6 mg. The label on the prescription says there are 2 mg per 4 ml. How many teaspoons do you need to take?

8. A patient drank 6 ounces of juice, 3 cups of water, and a half pint of milk. What was the total intake in ml?

9. You measure a friend who is 5 ft. 3 inches tall. What is her height in centimeters?

10. Your friend weighs 110 pounds. What is her weight in kg.

11. A laboratory technician measures 45 ml of urine sample in a 4 ounce beaker. How many more ml of urine are necessary to fill the beaker?

12. You need to find the BSA for a 10 y/o boy who is 55 inches tall and weighs 70 pounds.

13. A patient is admitted to the Emergency room with 1^{st} degree burns over his right and left thighs, 2^{nd} degree burns on his lower back and abdomen and 3^{rd} degree burn over his chest. Using the rule of 9's, calculate the % of total body area burned.

14. The Doctor ordered an IV for your patient: 1000 cc of D5W over 8 hours. How many cc's will the patient receive per hour?

15. The nurse is regulating the IV according to the order. If the hospital tubing has a drop factor of 10 drops per cc, how many drops must be given per minute to deliver the number of cc's per hour in problem #14?

Answers to Conversion Problems

1. 3.25 ml
2. 30o C
3. 186 ounces
4. 3 inches
5. 1.92 liters
6. -23.3o C
7. 2.4-3 teaspoons
8. 1140 ml
9. 157.5 cm
10. 50 kg
11. 75 ml
12. 1.12 m2
13. 27%
14. 125 cc/hour
15. 20.8=21 drops per minute

Sample Hematology Report

Anytown Lab

Patient Information
Mary Smith

Ordering Physician
Anderson, Susan

DOB: 8/26/1992
Gender: F Fasting: Y

Collected: 8/12/2006 10:15
Received: 8/12/2006 11:00

Test Name: Hematology

	In Range	Out of Range	Reference Range
White Blood Cell Count	6.1		3.8-10.8 Thous/MCL
Red Blood Cell Count	5.05		3.80-5.10 Mill/MCL
Hemoglobin		10.4 L	11.7-15.5 G/DL
Hematocrit		32 L	35.0-45.0 %
MCV	93.3		80.0-100.0 FL
MCH	32.0		27.0-33.0 PG
MCHC	34.3		32.0-36.0 G/dl
RDW	13.8		11.0-15.0 %
Platelet Count	156		140-400/Thous/MCL
Absolute Neutrophils	3245		1500-7800cells/MCL
Absolute Lymphocytes	2306		850-3900 cells/MCL
Absolute Monocytes	378		200-950 cells/MCL
Absolute Eosinophils	140		15-500 cells/MCL
Absolute Basophils	31		0-200 cells/MCL