Pediatric Body Surface Area and Medication Dosages

Unit: Medical Math

Problem Area: Basic Calculations, Conversions, and Measures

Lesson: Pediatric Body Surface Area and Medication Dosages

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Estimate percent of body surface area using an industry-accepted mathematical representation for the assessment of burns in children and infants.**
2. **Use the West Nomogram to determine body surface area.**
3. **Calculate pediatric medication dosages using body surface area measurements obtained from the West Nomogram.**

Resources.

The following resources may be useful in teaching this lesson:

"Adult Rule of Nines" and "Total Body Surface Area: By Age Group (In Percent)" (pg. 12) of *Guidelines for Early Care and Transfer of Burn Patient*, Arizona Burn Center, Maricopa Integrated Health System, Arizona. Accessed October 8, 2008. <http://www.saems.net/Downloads/50152_Burn%20Center2col_f.pdf>

"Body Surface Area Calculator for Medication Doses," *Halls e-MD.* Accessed October 3, 2008. <http://www.halls.md/body-surface-area/bsa.htm>

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Estimate and Calculate Body Surface Area. Lesson V1–1. Health Science Technology, Lesson Library. Curriculum Revitalization: Career and Technical Education. Illinois Career and Technical Education.

"Formulas for Body Surface Area," *Halls e-MD.* Accessed October 3, 2008. <http://www.halls.md/body-surface-area/refs.htm>

Lesmeister, Michele. *Math Basics for the Health Care Professional,* 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2009.

Lesmeister, Michele. *Instructor's Manual for Math Basics for the Health Care Professional,* 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2009.

Lesmeister, Michele. *TestGen Computerized Test Bank for Math Basics for the Health Care Professional,* 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2009.

Nichols, Eugene D., and Sharon L. Schwartz. *Mathematics Dictionary and Handbook.* Honesdale, PA: Nichols Schwartz Publishing, 1999.

Simmers, Louise. *Practical Problems in Math for Health Occupations*, 2nd ed. Clifton Park, NY: CENGAGE Delmar Learning, 2005.

Tiger, Steven, Julienne Kirk, and Robert Solomon. *Mathematical Concepts in Clinical Science*. Upper Saddle River, NJ: Prentice Hall, 2000.

Timmons, Daniel L., and Catherine W. Johnson. *Math Skills for Allied Health Careers.* Upper Saddle River, NJ: Prentice Hall, Prentice Hall, 2008.

Timmons, Daniel L., and Catherine W. Johnson. *Instructors Solutions Manual for Math Skills for Allied Health Careers*. Upper Saddle River, NJ: Prentice Hall, Prentice Hall, 2008.

Timmons, Daniel L., and Catherine W. Johnson. *TestGen Computerized Test Bank for Math Skills for Allied Health Careers*. Upper Saddle River, NJ: Prentice Hall, Prentice Hall, 2008.

"Wallace's 'Rules of Nines' Burn Diagram," *Biotel EMS System.* Accessed October 3, 2008. <http://www.biotel.ws/protocolsHTML/Protocols2004/BurnDiagramBurnFormula.asp>

West Nomogram-Body Surface Area. From Nursing Tools, Pearson Education, Inc. Accessed October 8, 2008. <http://wps.prenhall.com/wps/media/objects/2943/3014230/Nomogram.pdf>

Equipment, Tools, Supplies, and Facilities.

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials
- ✓ Scientific calculators

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Key Terms. The following terms are presented in this lesson (shown in bold italics):

- body surface area
- BSA
- nomogram
- West Nomogram

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situation. A possible approach is included here.

> *(Consider presenting lesson: Estimate and Calculate Body Surface Area from the HST Lesson Library prior to this lesson, as it will provide introductory material on body surface area and its importance in health care.) Wrap the arms and abdomen of a child-size manikin in red plastic wrap (available from grocery stores). Inform students that the red plastic wrap represents significant burns on the arms and abdomen of the child due to a scalding accident. Instruct the students to try to estimate the percent of body surface area on the child that is affected by burns. Inform the students that this assessment must be done rapidly so that medication and treatment of the child can begin quickly. Assess students' responses and reactions. Discuss approaches to estimating percentage of body surface area affected. Then inform students that, in this lesson, they will learn how to quickly assess percent of body surface area in children and infants for the purpose of burn assessment using health care industry approved methods. Also explain that they will learn more accurate methods of body surface area calculations for the purpose of calculating medication dosages.*

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Estimate percent of body surface area using an industry-accepted mathematical representation for the assessment of burns in children and infants.

Anticipated Problem: How do we estimate the percent of body surface area in children and infants for the purpose of burn assessment?

I. Estimate percent of body surface area for burn assessment

A. ***Body surface area*** is a measurement of the skin that covers the body. It is a measurement or calculation of the total surface area of the human body. (***BSA*** is an accepted abbreviation for "body surface area".)

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B. Proportions of children and infants are very different from adults. The "Rule of Nines" (as described in the Lesson: Estimate and Calculate Body Surface Area) used for burn assessment in adults is not accurate enough for use in children and infants.

C. Demonstrate and explain the diagram for estimating percent body surface area for children and infants. (Distribute VM–A.)

D. Determine body surface area in children and infants for the purpose of burn assessment using the given diagram. (Use VM–A with LS–A.)

Many techniques can be used to help students master this objective. Instructors can project VM–A on overhead projector. Use VM–A with LS–A. Instructors can also use red plastic wrap (available in grocery stores) around the torso and limbs of infant and child manikins to simulate burns. Students can assess body surface area involved in these simulated burn victims using accepted diagram for estimating BSA in children and infants.

Objective 2: Use the West Nomogram to determine body surface area.

Anticipated Problem: What is the West Nomogram? How and why is it used to determine body surface area in children and infants?

II. West Nomogram

A. Explain that while estimating BSA using the previously discussed method is acceptable for rapid assessment of burns, a more accurate method of determining BSA is needed in order to calculate medication dosages for children and infants.

B. (Optional: Briefly review the Mosteller method for BSA that was discussed in Lesson: Estimate and Calculate Body Surface Area.)

C. West Nomogram

1. ***Nomogram***—a 2-dimensional mathematical device that shows the relationship between variables; a graph or chart, typically with three scales, that allows calculation of one variable when two other variable are known.
2. ***West Nomogram***—a mathematical chart used to determine body surface area when the height and weight of a patient are known.

Many techniques can be used to help students master this objective. Instructors can refer to the resource texts for descriptions and diagrams of the West Nomogram. The websites listed in the list of resources can also be accessed for copies of the West Nomogram.

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Objective 3: Calculate pediatric medication dosages using body surface area measurements obtained from the West Nomogram.

Anticipated Problem: How do we calculate pediatric medication dosages using body surface area measurements obtained from the West Nomogram?

III. Calculate pediatric medication dosages using BSA measurements from West Nomogram.

A. The formula for calculating pediatric medication dosage is:

$$\frac{\text{BSA of child}}{1.73} \times \text{adult dose} = \text{child dose}$$

(Recall that 1.73 is the approximate BSA for the average adult.)

B. To calculate pediatric medication dosage:

1. Use the West Nomogram to determine child's BSA.
2. Insert the child's BSA measurement and the known adult dosage into the given formula, and perform calculation.
3. Example: "A doctor orders a chemotherapy agent for a child with leukemia. The child has a height of 120 cm, and a weight of 40 kg. The normal adult dose of this medication is 20 mg. what is the child dosage?"
4. Answer: Using the West Nomogram, the child's BSA is determined to be 1.2 m^2.

Therefore, $\frac{1.2}{1.73} \times 20 = \text{child dose}$

$.69 \times 20 = \text{child dose}$

$13.8 \text{ mg} = \text{child dose}$

Therefore, the child's dose would be 13.8 mg (or 14 mg if rounded up.)

Many techniques can be used to help students master this objective. Instructors can give students several examples in class and have students complete them on the whiteboard or on an overhead projector. Instructors can also use LS–B.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may also be used in the review/summary.

Application. Use the included visual master and lab sheets to apply the information presented in the lesson.

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Evaluation.

Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Matching

1. c
2. d
3. b
4. a

Part Two: True/False

1. True
2. True
3. True
4. False

Part Three: Short Answer

$\frac{1.5}{1.73} \times 50 =$ child dose,

therefore $0.88 \times 50 =$ child dose , therefore child dose $= 44$mg.

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Sample Test

Name _____

Pediatric Body Surface Area and Medication Dosages

Part One: Matching

Instructions: **Match the term with the correct definition.**

a. BSA
b. body surface area
c. nomogram
d. West Nomogram

_____1. A 2-dimensional mathematical device that shows the relationship between variables; a graph or chart, typically with three scales, that allows calculation of one variable when two other variable are known.

_____2. A mathematical chart used to determine body surface area when the height and weight of a patient are known; commonly used for calculation of pediatric medication dosages.

_____3. A measurement of the skin that covers the body; a measurement or calculation of the total surface area of the human body.

_____4. An accepted abbreviation for body surface area.

Part Two: True/False

Instructions: **Write *T* for true or *F* for false.**

_____1. The West Nomogram is commonly used to determine body surface area in order to calculate pediatric medication dosages.

_____2. The proportions of children and infants are very different from adults.

_____3. Health care workers estimate of percent of body surface area for the purpose of burn assessment.

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_____4. The West Nomogram uses known variables of body surface area and height to determine the third variable of weight.

Part Three: Short Answer

Instructions: **Answer the following. Show your work.**

A physician orders a chemotherapy agent for an adolescent whose BSA m^2 is 1.5. The normal adult dose for this chemotherapy agent is 50 mg. What is the appropriate pediatric dose?

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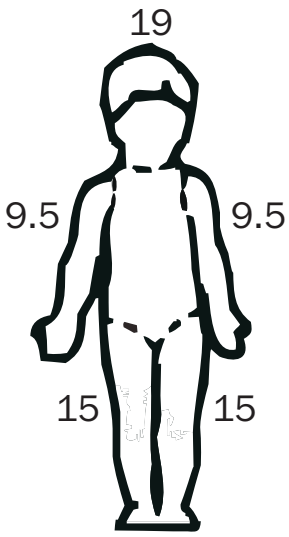
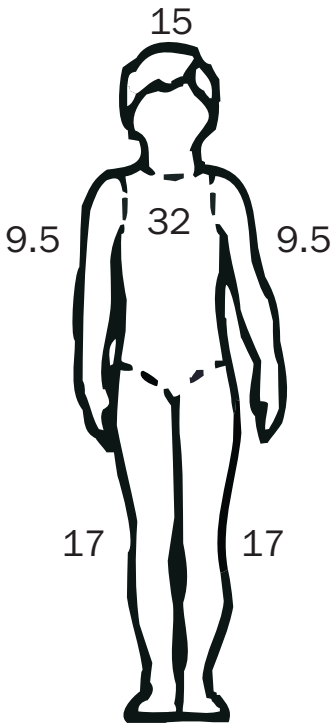
VM–A

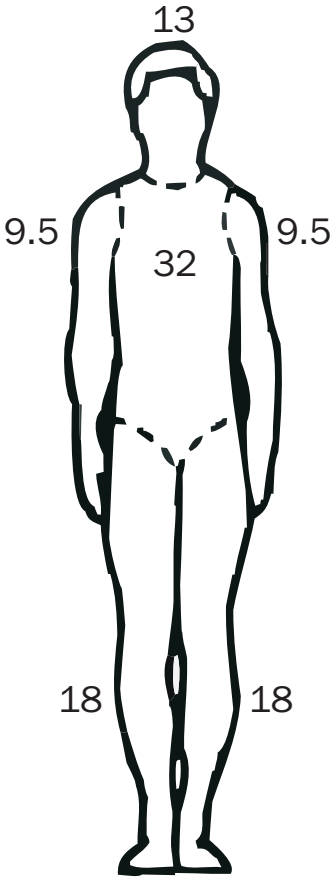
ESTIMATING PERCENT BODY SURFACE AREA (BSA) FOR CHILDREN AND INFANTS



Age
1 to 4



Age
5 to 9



Age
10 to 14

Note: Values above indicate percent BSA for whole body part (anterior & posterior sides). To determine percent BSA for one side of body part, reduce each value by 50%. (i.e. Percent BSA involved in a burn of the anterior portion of the leg of a 1-yr old infant would be 7.5%; Percent BSA involved in a burn of the back of the torso only of an infant, child, or adult would be 16%)

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LS–A

Name _____

Estimating Percent BSA for Children & Infants

Purpose

The purpose of this lab sheet is to facilitate practice in estimating percent body surface area for children and infants.

Objective

Use an accepted method to estimate percent body surface area for children and infants for the purpose of burn assessment.

Materials

- lab sheet
- writing utensil
- VM–A

Procedure

1. Using this lab sheet with the visual master provided, estimate percent body surface area (BSA) involved in each of the following scenarios. (Round your answer to the nearest whole number.)
2. When you have completed the worksheet, turn it in to your instructor.

Scenarios

1. A 1-year old infant is rescued from a burning building. The infant has burns to the face and head, the entire left arm, and the entire left leg. What is the percent of BSA affected?

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2. When fireworks exploded, a 13-year old boy received 2nd degree burns to the anterior portion of the right arm, and the anterior torso. What is the percent of BSA affected?

3. A 6-year old girl playing with matches accidentally set her clothes on fire. When she was brought to the emergency room, she had 2nd degree burns on her anterior torso, and the front and back of both arms. What is the percent of BSA affected?

4. A 3-year old girl received burns to the anterior left arm, the anterior torso, and the anterior aspect of her left leg when she pulled a pan of boiling water off the stove. What is the percent of BSA affected?

5. An 11-year old boy had an accident while playing with his chemistry set. He received 2nd degree chemical burns to front side of both legs. What is the percent of BSA affected?

6. An 8-year old girl was pulled from a burning vehicle after an accident. The girl had burns on her face/head, anterior torso, and the front and back of both arms. What is the percent of BSA affected?

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Estimating Percent BSA for Children & Infants

Scenarios

1. 44%
2. 21%
3. 35%
4. 28%
5. 18%
6. 50%

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LS–B

Name _____

Calculate Pediatric Medication Dosage

Purpose

The purpose of this lab sheet is to provide an opportunity to practice calculation of pediatric medication dosages.

Objectives

1. Given the height and weight of a child, students will determine child's body surface area (BSA) using the West Nomogram.
2. Using body surface area measurements in an accepted formula, students will determine pediatric medication dosages.

Materials

- lab sheet
- writing utensil
- West Nomogram websites from List of Resources
- calculator

Procedure

1. Use the West Nomogram and the formula for pediatric medication calculations to complete the problems below.
2. Use a calculator (if needed) to perform your calculations, but show your work.
3. Round calculations to the nearest hundredth.
4. Round final answers to the nearest whole number.
5. Turn your completed lab sheet in to your instructor.

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Formula for Pediatric Medication Calculations

$$\frac{\text{BSA of child}}{1.73} \times \text{adult dose} = \text{child dose}$$

Problems

1. A physician orders a chemotherapy agent for a child whose height is 40 inches, and whose weight is 40 lbs. The normal adult dose for this chemotherapy agent is 75 mg.

   Step 1: Determine the BSA using the West Nomogram.

   Answer: _____ m^2.

   Step 2: Calculate the pediatric dose using the given formula.

   Answer: _____ mg.

2. A physician orders a strong antibiotic for a child whose height is 44 inches and whose weight is 45 lbs. The normal adult dose for this antibiotic is 150 mg.

   Step 1: Determine the BSA using the West Nomogram.

   Answer: _____ m^2.

   Step 2: Calculate the pediatric dose using the given formula.

   Answer: _____ mg.

3. A physician orders a chemotherapy agent for a child who height is 58 inches, and whose weight is 12 kg. The normal adult dose of medication is 200 mg.

   Step 1: Determine the BSA using the West Nomogram.

   Answer: _____ m^2.

   Step 2: Calculate the pediatric dose using the given formula.

   Answer: _____ mg.

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Calculate Pediatric Medication Dosage

1. Step 1: .72 m^2
   Step 2: 32 mg
2. Step 1: 0.8 m^2
   Step 2: 69 mg
3. Step 1: 0.66 m^2
   Step 2: 76 mg

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