Dana Center
Mathematics
PATHWAYS

Teaching Dosage Calculations: Strategies for Narrowing the Theory-Practice Gap

High-Quality Mathematics Education for Nurses Task Force

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About Today's Discussion

Objectives

- Discuss the unique challenges of teaching dosage calculations.
- Identify specific strategies for adapting classic dosage calculation problems to actively engage learners.
- Describe the role of simulation and lab activities in narrowing the theory-practice gap and supporting diverse learners.
- Connect with other educators dedicated to improving mathematics education for nurses.

Please use the chat to share your thoughts and reflections

What Is A "Dosage Calculation"?

Order: 500 mg Ibuprofen
Available: 250 mg / 1 tablet
Calculate the amount to administer.

Order: 1 L NS over 4 hours
The available tubing has a drop factor of 25 gtt/mL.
Calculate the appropriate gtt/min flow rate.

An infant who weighs 7 pounds and 4 ounces has an order for digoxin solution, 49.5 mcg, oral, every 12 hours.
The drug reference states that a safe dosage range is 6-10 mcg/kg/ dose oral daily in 2 divided doses. Digoxin solution contains 0.05 mg/ 1 mL.
What is the minimum recommended dosage range for this child per dose? Round to the nearest tenth.

Why Is This Discussion So Important?

Over 7,000 deaths annually are attributed specifically to medication errors

(IOM, 2000)

Only 19% of incoming nursing students passed a competency test that assessed basic math abilities, including arithmetic, decimals, SI units, and fractions

(Harvey et al., 2010)

Only 55% of practicing nurses passed a basic numeracy test

(McMullan, Jones, & Lea, 2010)

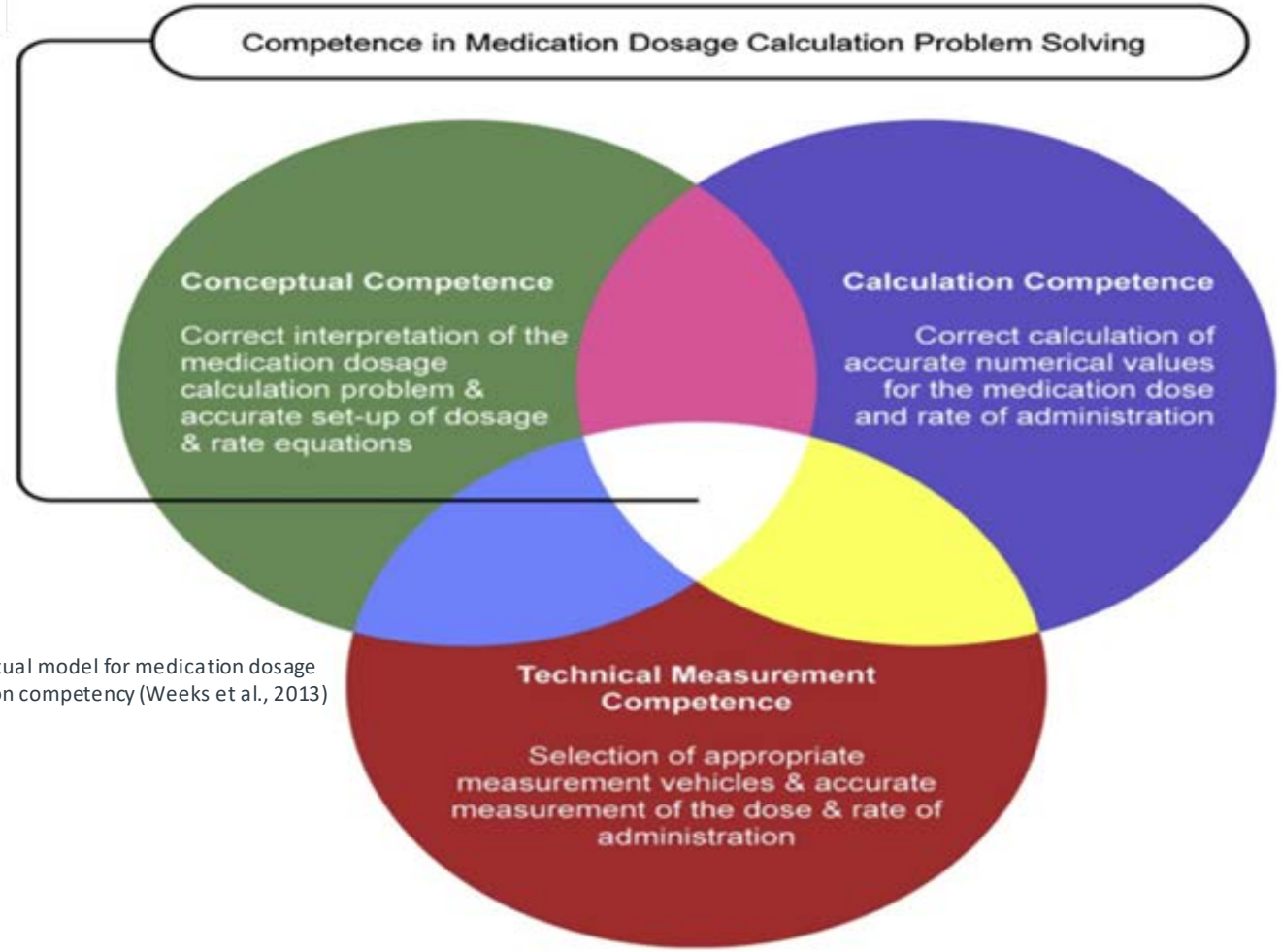
Have You Heard This Before?

"I calculated that the patient needs to receive 110 mL of morphine"

"The appropriate rate to set is 45.8 gtt/mL"

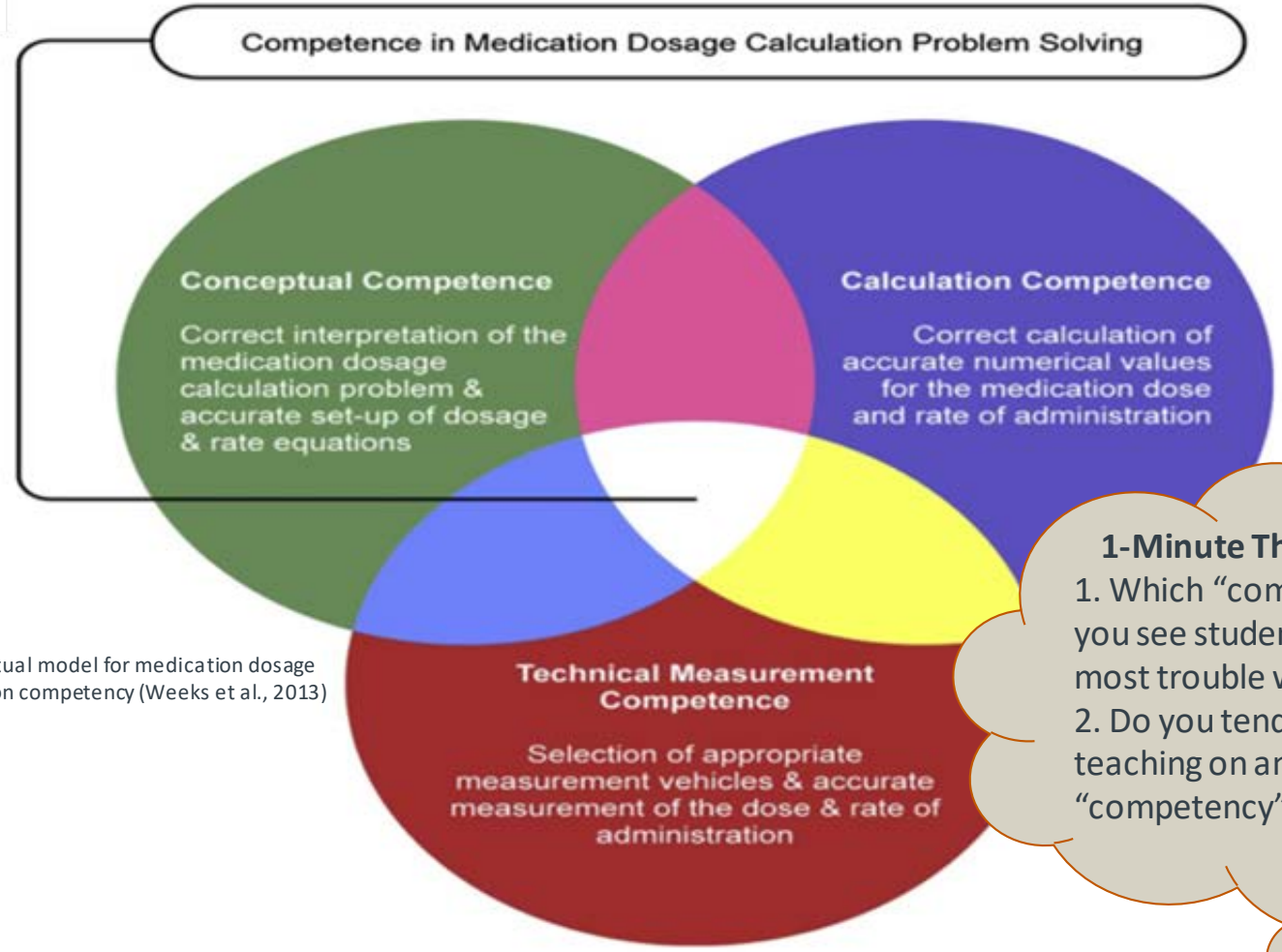
"I will set the IV pump to 0.00578 mL/hr"

The Uniqueness of Dosage Calculations



A conceptual model for medication dosage calculation competency (Weeks et al., 2013)

The Uniqueness of Dosage Calculations



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1-Minute Think and Share

1. Which "competency" do you see students having the most trouble with?
2. Do you tend to focus your teaching on any "competency" in particular?

What Do We Know From the Literature?

Conceptual errors are most common

(Blais & Bath, 1992; Fleming, Brady, & Malone, 2011)

The mathematics skills and concepts learned in a classroom setting tend to be very different then those actually applied in practice (i.e. Theory-Practice Gap)

(Dyjur, Rankin, & Lane, 2011; Marks et al., 2015; Wright, 2012)

"For learning with understanding to occur, [mathematics] instruction needs to provide students the opportunity to develop productive relationships, extend and apply their knowledge, reflect about their experiences, articulate what they know, and make knowledge their own"

(Carpenter & Lehrer, 1999)

What Does This Mean for Educators?

Select tasks that are engaging, incorporate discipline-based content, and provide opportunities to build connections.

(Abell et al., 2019; Wright, 2012)

Support development of mathematical proficiency through active learning, reasoning, and application of real-world skills.

(AMATYC, 2018; Murphy & Murphy, 2019)

A Classic Dosage Calculation Problem

A 4-week-old infant weighing 8 pounds, 12 ounces is admitted for fever.

The provider orders acetaminophen 15mg/kg PO q4h prn fever.

Acetaminophen is available as 160mg/5mL.

How many mL will the nurse administer?

How could this task be modified to be more "authentic"?

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Simulation Hospital

Physician Orders

Name: Ana Hernandez **DOB:** 05/03/20XX **Age:** 4 weeks	**Diagnosis:** Fever
Allergies & Sensitivities: NKDA **Weight:** 8 lb., 12 oz.	

Date	**Provider Orders**
Today	Admit for fever work-up
	CBC, BMP, UA
	Straight cath for urine cx
	Blood cx
	CSF for chem, culture
	Meds: • PO acetaminophen 15mg/kg q4h prn fever • IV cefotaxime 50mg/kg q6h • IV ampicillin 50mg/kg q6h

Signed: D. Siberski MD

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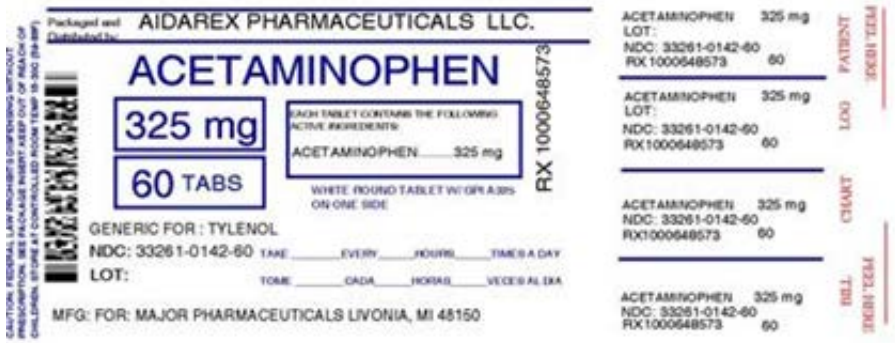

A Classic Problem – Reconceptualized

Simulation Hospital
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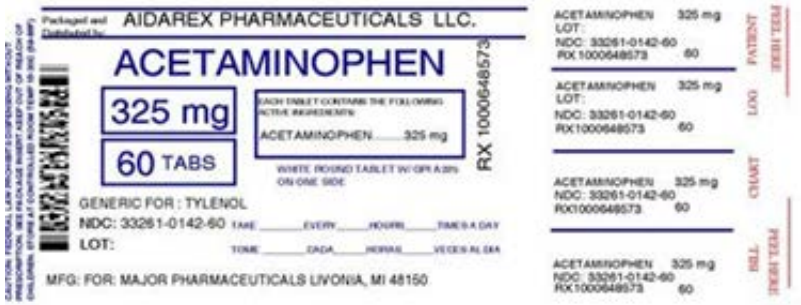
Signed: D. Sbenki MD

Calculate the appropriate amount of acetaminophen to administer to Ana

Available Medications



A Classic IV Rate Calculation

Ceftriaxone 2 g q12h is ordered.

The infusion time is 30 minutes.

Ceftriaxone is available at a strength of 2000 mg per 50 mL.

What mL/hr rate is needed to set an IV pump?

A Classic IV Rate Calculation

Ceftriaxone 2 g q12h is ordered.

The infusion time is 30 minutes.

Medications
azithromycin
1000 mg po
Ceftriaxone
2 g IV q12h
Start 12/14/2019 0915
End 12/14/2019 0945

Ceftriaxone is available at a strength of 2000 mg per 50 mL.

A Classic IV Rate Calculation

Ceftriaxone 2 g q12h is ordered.

The infusion time is 30 minutes.

Ceftriaxone is available at a strength of 2000 mg per 50 mL.

A Classic IV Rate Calculation

Given the order and available medication, determine how you would set the pump.

Medication Orders
Azithromycin 1000 mg po
Ceftriaxone 2 g IV q12h Start 12/14/2019 0915 End 12/14/2019 0945

A Classic gtt/min IV Calculation

A patient is ordered to receive 500 mL of NS over 90 minutes. The drop factor is 10 gtt/mL. Calculate the gtt/min drip rate.

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A patient is ordered to receive 500 mL of NS over 90 minutes. The drop factor is 10 gtt/mL. Calculate the gtt/min drip rate.

1-Minute Think and Share

1. What artifacts and processes could be included in this problem to make it more engaging?
2. How might this problem be modified to prompt reflection on the underlying concepts?

A Classic gtt/min IV Calculation -- Prompt Reflection

ORDER: Infuse 500 mL NS over 90 minutes.
The available CLEARLINK primary tubing is provided.

A Classic gtt/min IV Calculation -- Prompt Reflection

ORDER: Infuse 500 mL NS over 90 minutes.
The available CLEARLINK primary tubing is provided.

Given the IV set ups (Bag A, Bag B and accompanying chambers) on the right, which flow rate more-closely aligns with the rate needed to complete the order above. Explain.

One Last Example: Injection Calculation

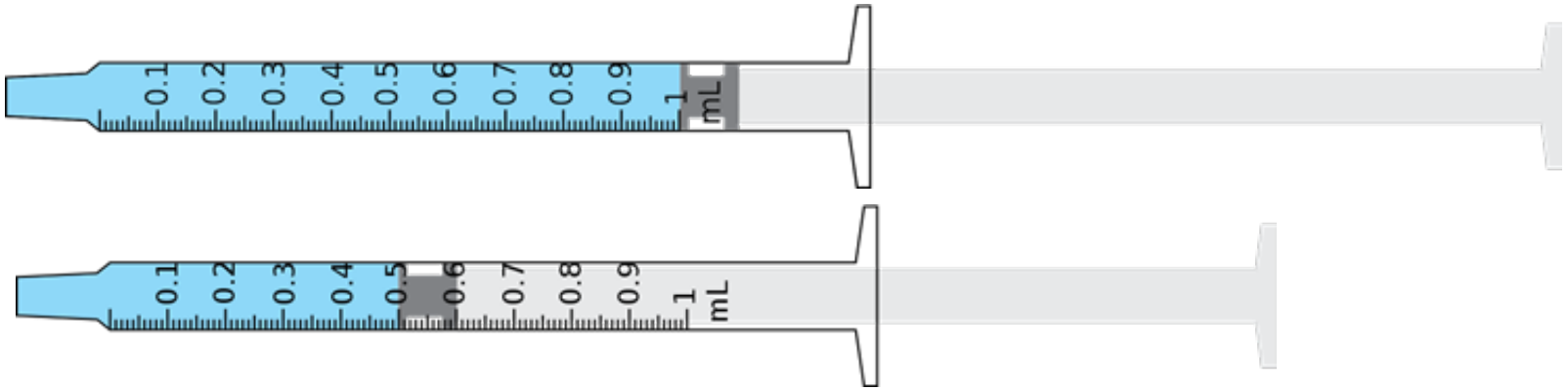
Your patient, Brendan Garcia, weighs 14.9 kg.
Order: 0.5 mg/kg ketorolac (Toradol) injection Q6H prn
Available: ketorolac (Toradol) 30 mg/mL

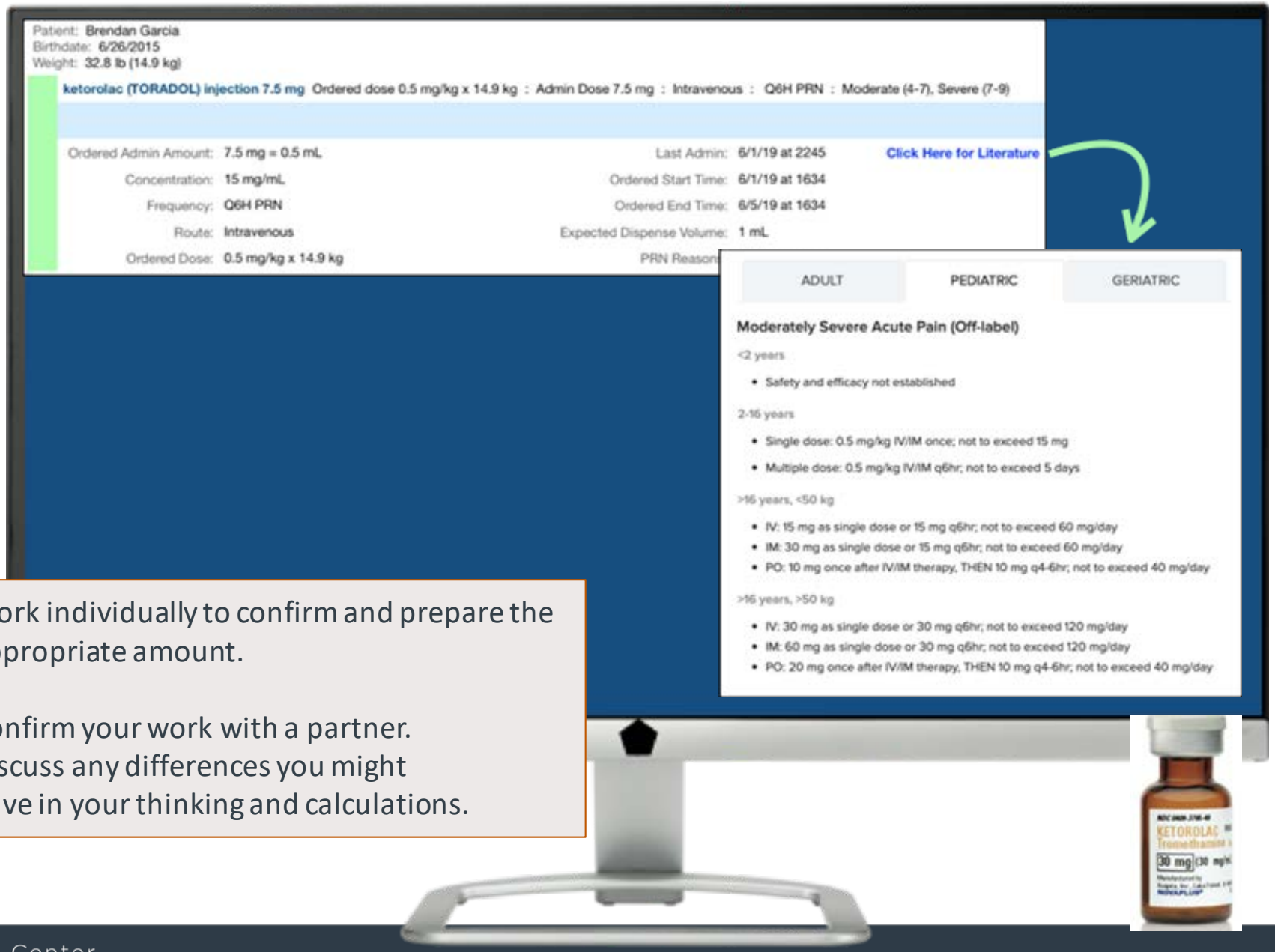
Calculate the mL dose to administer.

One Last Example: Injection Calculation

Your patient, Brendan Garcia, weighs 14.9 kg.
Order: 0.5 mg/kg ketorolac (Toradol) injection Q6H prn
Available: ketorolac (Toradol) 30 mg/mL

Which syringe is needed to complete this order? How do you know?





Work individually to confirm and prepare the appropriate amount.

Confirm your work with a partner.
Discuss any differences you might have in your thinking and calculations.

What is missing in all of these tasks…?

"[Incorporating multimedia and artifacts] lack the access to resources (pharmacists, nursing colleagues and reference tools) that are often available in the real-life setting. Despite attempts to contextualize them, [assessments and tasks] are isolated from embodied reality and the sights, sounds, smells, and other cues that place the nurse in the everyday world of practice"

(Dyjur, Rankin, & Lane, 2011; p. 206)

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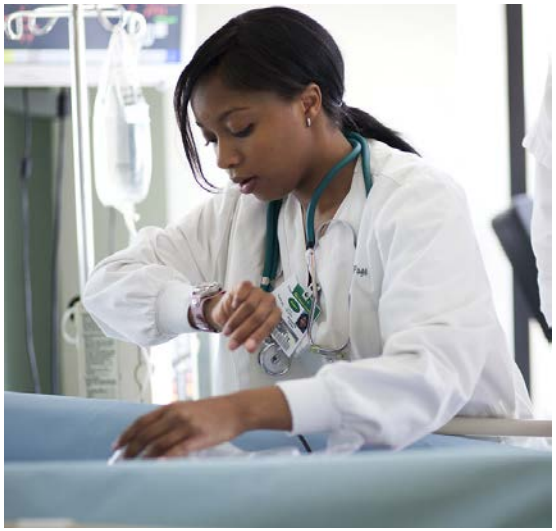
Simulation and Lab Activities!

Additional Skills for Safe Medication Administration

Nurses need to:

- Understand when calculations are needed
- Know what needs to be discovered
- Complete the calculation using correct methods
- Evaluate to make sense of answer
- Administer using correct equipment with correct technique



Authentic Lab and Simulation Activities

Design

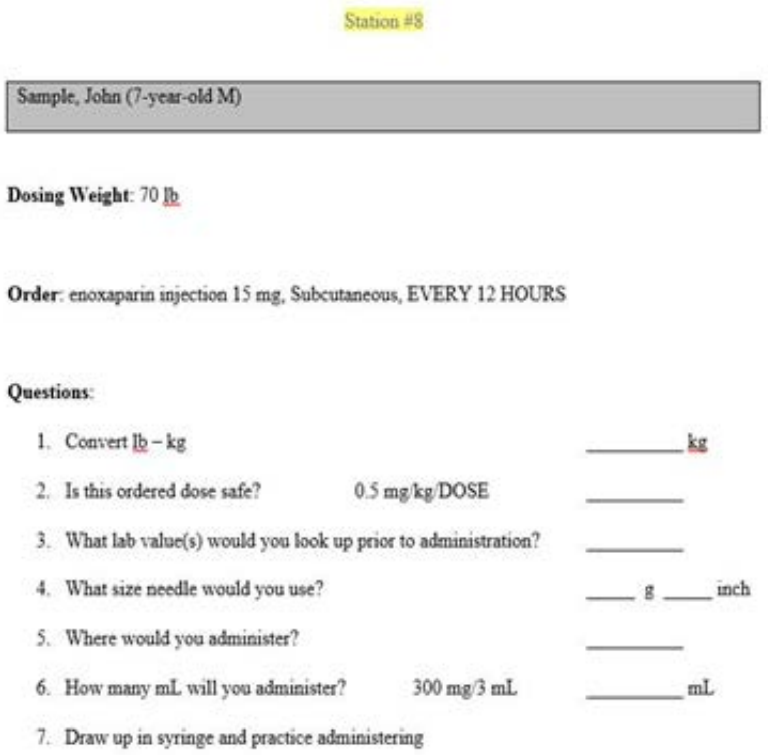
- Simulation lab
- Skills stations
- Groups of 8

Practical mathematics

- Calculations
- Medication orders
- EHR of primary clinical site
- Weight-based calculations

Administration

- Hospital equipment/ policies



Station #8

Sample, John (7-year-old M)

Dosing Weight: 70 lb

Order: enoxaparin injection 15 mg, Subcutaneous, EVERY 12 HOURS

Questions:

1. Convert lb – kg _____ kg
2. Is this ordered dose safe? 0.5 mg/kg/DOSE _____
3. What lab value(s) would you look up prior to administration? _____
4. What size needle would you use? ____ g ____ inch
5. Where would you administer? _____
6. How many mL will you administer? 300 mg/3 mL _____ mL
7. Draw up in syringe and practice administering

Authentic Lab and Simulation Activities

Key elements of pediatric math calculations

- Safe dosage ranges
- IV fluid volumes/ rates
- Medication volumes
- Weight conversions

Psychomotor skills for med administration

- Oral suspension preparation
- IV infusion pump programming
- Injections
- Nasogastric tube

Authentic Lab and Simulation Activities

Authentic Lab and Simulation Activities

Student Feedback

- "Helped me critically think, more applicable"
- "This is how medication administration is; distractions are present"
- "It makes you have to think; you have to think of the solution and if it makes sense- not just how to solve the problem."
- "This makes it make sense, you can see why you perform steps in math problems."
- "The environment is much less threatening; you feel like you can ask questions."

Suggestions for Implementing these Ideas

Collaborate with colleagues outside your department.

Work with your colleagues to create a database of artifacts.

Contact us for access to our materials.

Stay Connected and Participate!

Join the task force!

http://bit.ly/QSENMathTaskForce

Learn more about the Mathematics Education for Nurses National Initiative from our webpage

https://www.utdanacenter.org/our-work/higher-education/collaborations/math-for-nurses

Questions?

Contact Us

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About the Dana Center

The Charles A. Dana Center at The University of Texas at Austin works with our nation's education systems to ensure that every student leaves school prepared for success in postsecondary education and the contemporary workplace.

Our work, based on research and two decades of experience, focuses on K–16 mathematics and science education with an emphasis on strategies for improving student engagement, motivation, persistence, and achievement.

We develop innovative curricula, tools, protocols, and instructional supports and deliver powerful instructional and leadership development.

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