# A Case of Medication Error: Conversion Factors in Clinical Calculations

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## ME Rules Death Of Brooklyn 6-Month-Old 'Accident' Resulting From Antibiotic Overdose

*Brookdale Hospital Investigating How 17-Pound Baby Got An Adult Dosage*

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NEW YORK (CBSNewYork) — A Brooklyn family is dealing with absolute devastation after their only child died following a fatal mistake. Their baby boy was taken to the hospital with just a fever and was given what turned out to be a deadly dose of medication.

Earlier Wednesday afternoon, the New York City Medical Examiner ruled the death of 6-month-old Amaan Ahmmad an accident. The ME said the death was the result of complications following administration of an adult dose of the antibiotic azithromycin, which is commercially known as Zithromax.

Instead of looking forward to a lifetime of birthdays, the family is now making funeral arrangements for their child. Ummay Sultana and Amain Ahmmad said their son became ill last Friday, so they took him to Brookdale, where he was born.

"He catch cold and we took him to the emergency," Sultana said.

Hospital records showed baby Amaan was brought to the ER "alert and responsive" and with the exception of a fever, which was reportedly around 100, the nursing staff did not list any other visible symptoms.

But an examination led to a diagnosis of clinical pneumonia. Amaan was transferred to the pediatric unit and given a dose of the azithromycin through an IV drip in his right arm.

According to the nursing notes, at least 36 minutes passed before the hospital staff realized something was wrong.

CBS 2's Jay Dow spoke with the parents Wednesday and asked the boy's father who he blames for his son's death.

"Hospital management, doctor, nurse—of emergency," he replied.

"I'm like 'look, look my baby's dying! My baby's dying!' and then nurse came over and said 'no, you're baby's pretty good. He's sleeping,'" Sultana told CBS 2's Sean Hennessey.

A copy of the hospital's discharge summary states the child was given "Azithromycin (500mg), in error" — which led to "cardiac shock."

Family pediatrician Dr. Suzanne Loiselle said that dosage is more typical for an adult and not a 17-pound baby like Amaan.

"Nobody can feel worse for the family than the doctors and nurses that were involved in this child's care," Loiselle said. "About 80 milligrams would be appropriate for a child roughly in his weight class."

Less than 24 hours after the overdose, Ummay and Amain were told their son was brain dead. Amaan was taken off a respirator on Monday.

"They told us there is no hope because his head is totally collapsed," his father told Hennessey.

Brookdale Hospital would not answer questions from 1010 WINS or CBS 2, saying only: "We are investigating the circumstances of this tragic incident and express our condolences to the Ahmmad family."

"I never think like that he pass away forever," Sultana said. "I thought he's gonna come back."

The two first-time parents said they are both devastated and outraged over a fatal medical mistake that cut short their baby's life just as it was getting started.

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## *Pre-Case Questions (40 points)*

1. Sultana indicated that the baby "catch cold and we took him to the emergency." She was referring to what is known as the "common cold." What causes the "common cold"? What are its symptoms? How is it usually treated? Is the underlying cause of the illness treated or are only its symptoms treated? (3 points)
   *Reference:* http://www.mayoclinic.org/diseases-conditions/common-cold/home/ovc-20199807
2. The "common cold" and influenza (flu) are different. What causes influenza? What are its symptoms and how is it generally treated? (3 points)
   *Reference:* https://www.cdc.gov/flu/keyfacts.htm
3. What is pneumonia? What causes it? What is its relationship to influenza and the common cold? (3 points)
   *Reference:* http://www.webmd.com/lung/tc/pneumonia-topic-overview
4. Pneumonia is usually treated with antibiotics. What is an antibiotic? (3 points)
   *Reference:* http://www.nlm.nih.gov/medlineplus/antibiotics.html
5. Explain how azithromycin works to treat pneumonia without harming us. In other words, explain the mode of action of azithromycin and the reason for its selective toxicity. (3 points)
   *Reference:* http://chemistry.elmhurst.edu/vchembook/654antibiotic.html
6. Explain what is meant by the therapeutic index (TI) of a medication. (3 points)
   *Reference:* http://www.britannica.com/EBchecked/topic/591179/therapeutic-index
7. (5 points)

   (a) Define a "conversion factor" and provide an example of it.

   (b) Using a suitable example, explain how the conversion factor you provided can be used in a calculation.
8. Some conversions require the use of more than one conversion factor. Using a suitable example, explain how two conversion factors can be used in a calculation. (4 points)
9. The unit for the baby's temperature is not given in the article. Which unit do you think it is? Explain the reason for your answer. (3 points)
10. Using suitable examples, explain how temperatures can be interconverted between °F and °C. (6 points)
11. Using suitable examples, explain how weights can be interconverted between lb (pounds) and kg (kilograms). (4 points)

## *Case Questions (40 points)*

1. Pneumonia is characterized by fever (a body temperature above 37.2 °C). Does the patient have a body temperature that indicates that he has pneumonia? Justify your answer with suitable calculations. (4 points)
2. What was the baby's weight in kg? (3 points)
3. Some medications are formulated such that there is a slow release of the active ingredients. Such formulations are known as "extended release." Azithromycin ER is a single-dose, extended release formulation. The recommended dosage for a child 6 months and older who is brought to the Emergency Room with community acquired pneumonia is 60 mg/kg administered orally. Azithromycin (immediate release) has much faster onset of action and acts almost immediately when administered intravenously (by IV). Clinicians exercise clinical judgment when deciding whether or not to treat a pediatric patient with azithromycin intravenously. If therapy is deemed necessary, a dose of 10 mg/kg for those age 6 months to 16 years is considered reasonable.
   (a) Based on the information above, what would be an appropriate dose of azithromycin ER for a baby weighing 17 lbs such as Amaan? (3 points) *Note:* The dosage used in this problem was obtained from the reference: http://www.drugs.com/dosage/azithromycin.html#Usual_Pediatric_Dose_for_Pneumonia
   (b) How does the appropriate dose of azithromycin ER for a baby weighing 17 lbs such as Amaan compare with the dose of azithromycin that was given intravenously to Amaan. (3 points)
   (c) What would be an appropriate dose of azithromycin (immediate release) administered by IV for a baby weighing 17 lbs such as Amaan? How does your calculated dose compare with that indicated by Dr. Loiselle? (3 points)
4. Dr. Loiselle indicated that the 500 mg dosage administered for Amaan is more typical for an adult and not a 17-pound baby. If a 500 mg of the medication is administered to an adult male of 190 lbs, what would be the dosage (in mg/kg)? If the same amount of medication is administered to an adult female weighing 140 lbs, what would be the dosage (in mg/kg)? (6 points)
5. Based on your answers to Question 3 above, why do you think that, as a general practice, when antibiotics (including azithromycin) are prescribed to adults, the same dose is usually given, regardless of weight of the patient? (5 points)
6. An intravenous dose of azithromycin is usually prepared by injecting a measured small amount of sterile water into a sealed vial containing a specific known amount of solid formulation containing the medication and shaking the vial until all of it is dissolved. The dosage to be administered to a patient is then removed (with a syringe) and added to a specific volume of diluent solution, which is then administered as an IV drip. A diluent solution that is commonly used is 1/2 normal saline (0.45% sodium chloride solution). If an azithromycin formulation contains 500 mg of azithromycin and sterile water is added to make 5 mL of the formulation, how much must be removed with the syringe to add to the diluent solution for a dosage of 80 mg? (3points)
7. (10 points) According to the nursing notes, at least 36 minutes passed before the hospital staff realized something was wrong. Azithromycin is usually administered intravenously over a concentration range of 1.0 – 2.0 mg/mL over a period of one hour. Consider a hypothetical situation whereby a dose of 500 mg of azithromycin is administered at 2.0 mg/mL of azithromycin in ½ normal saline.
   (a) How many mg of medication would have been administered every 15 minutes?
   (b) Plot a graph of dose administered vs. time.
   (c) Using the graph only, determine how much medication would be administered in 36 minutes.
   (d) What % of medication (relative to the total dose of 500 mg) would be administered by 36 minutes?
   (e) How much saline solution would have been administered for a dosage of 500 mg in 36 minutes?

## *Post-Case Questions (20 points)*

1. (6 points) The amount of medication that is in the blood (and available to reach cells and treat the underlying condition) is often different than the dose that was given. The fraction of a dose of medication that is in the blood stream and has not been chemically modified (metabolized) by the body is referred to as its bioavailability. When a medication is administered intravenously, its bioavailability is considered to be 100 % at the time of administration and this decreases with time as it is metabolized and/or excreted. However, when a medication is administered orally, its bioavailability is much less due to incomplete absorption and being metabolized on passing through the liver.

   The paper referenced below compares (in Figure 2) the concentration of azithromycin in the blood in subjects who were administered 500 mg of the medication orally and in other groups who were given the same dose intravenously. From the graphs, determine for the healthy patients:

   (a) When were the peak concentrations achieved for intravenous and for oral administration of the medication?

   (b) What were the peak concentrations for intravenous and for oral administration of the medication?

   (c) What were the concentrations after 12 hours for intravenous and for oral administration of the medication?

   Note that the graphs in Figure 2 of the article use a logarithmic scale for the azithromycin concentration.

   *Reference:* Beringer, P., et al. 2005. *Antimicrob Agents Chemother.* 49(12): 5013–5017. The paper can be accessed at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1315964/

2. Reflecting on the case, in what way is an IV dose of azithromycin different than an oral dose in terms of its dose, onset of activity, effect on the infection and on the body. Your response should be no more than a short paragraph. (5 points)

3. The medication administration process starts with a health care provider (medical doctor, physician's assistant, or nurse practitioner) who examines a patient, makes a diagnosis, and then writes the order for a medication. A pharmacist then dispenses the medication and it is a nurse who usually administers the medication. As such, most medication errors occur as a result of a breakdown in the system. What role can a nurse play in ensuring that a correct dose of medication is administered to a patient? (4 points)

4. Why do you think it is important for pre-nursing students to learn to do dosage calculations? Explain the reasoning behind your answer. (5 points)