The Case of the Medication Mishap

Case by Dr. John Eiken

Case
Dr. John Eiken

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Curated Community Commentary
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As Tim exited a patient's room he heard the tone of the EMS radio activation. With high-pitched sirens audible in the background, Tim listened carefully to the paramedic's report – "we are five minutes out with a 38 year old male having a severe allergic reaction after eating a pastry. His lips are swollen and we have administered intramuscular epinephrine…".

Tim was enjoying his new role as a senior emergency medicine resident and he gathered the team in the resuscitation bay to assign roles and prepare for a patient he suspected was suffering from anaphylaxis. Minutes later EMS briskly entered the emergency department with a patient sitting bolt upright on the stretcher, breathing rapidly, with his eyes wide open in a panic. Tim immediately realized this patient was very sick and he noticed an uneasy sensation developing in his gut in response to his own epinephrine release. As the patient was transferred to the emergency bed Tim noticed the patient's face was red, his tongue was swollen, and he was diaphoretic. EMS reported that the patient had a known peanut allergy and had inadvertently eaten a pastry that contained peanuts approximately 20 minutes ago. This was by far the most severe allergic reaction Tim had ever encountered.

Instinctively, Tim placed himself at the foot of the bed and began to direct the resuscitation effort, "let's get him on the monitor, we need 2 IV's followed by IV fluid boluses wide open, please place him on a non-rebreather mask, and we need more epinephrine in the room immediately." He asked his junior resident to prepare for a difficult airway including opening the cricothyroidotomy kit. Within seconds, the number of providers in the room had nearly doubled and nervous voices emerged as the team worked together. Tim looked at the monitor, the heart rate was 140, BP 90/60, and the oxygen saturation was 95%. The nurse turned to Tim and said, "I have the epinephrine, how should I give it?". The patient had already received 2 doses of intramuscular epinephrine and IV access had been established. Tim knew the standard initial treatment was 0.3 mg IM, but this patient looked as if he might soon code so he told the nurse to give 0.3 mg of epinephrine as an IV push instead. Within seconds the patient stated that he didn't feel well but then he began to improve. The swelling then began to decrease and his hemodynamic status improved – the epinephrine seemed to have worked. Tim exited the room thinking to himself, "Wow- that was close and very scary."

About 20 minutes later the patient's nurse asked Tim to return to the patient's bedside. The patient told Tim he felt his anaphylaxis symptoms were returning. With just Tim and the nurse in the room Tim asked the nurse to administer another dose of 0.3 mg epinephrine IV push. Following this dose the patient again reported that he didn't feel well and Tim looked up as the monitor and saw the narrow complex sinus rhythm change into ventricular tachycardia. Immediately he helped the nurse place defibrillator pads but fortunately the ventricular tachycardia spontaneously resolved. An epinephrine IV infusion was started, IV fluids were continued, and the patient again clinically improved.

With the patient now stable, the nurse and Tim debriefed outside the room. The nurse said, "I think I made a mistake – the doses of bolus IV epinephrine I gave were 0.3 mg of 1:1000 concentration, not 1:10,000". Tim realized the episode of ventricular tachycardia was in response to the incorrect dosing he had ordered for the IV epinephrine.

Tim had never encountered an error like this. He felt stupid because he knew how to treat anaphylaxis and thought that the stress of the situation had caused him to order the incorrect medication dose not once, but twice! He felt like he had "choked" while leading the resuscitation. Additionally, patient's nurse was one of the best in the department and he didn't want her to get in trouble. There didn't seem to be any harm to the patient, in fact, the patient was doing much better now. Tim then began to contemplate what he should do next.

Questions for Discussion

1. How should Tim respond to the realization that a medication error occurred? Should he disclose the error and if so to whom?

2. What factors contributed to the error and who is at fault? Did Tim "choke" while leading the resuscitation?

3. High stress and high stakes situations are inevitable in emergency medicine. What should Tim do to be better prepared for future similar stressful, high-stakes situations and prevent the occurrence of errors?

Competencies

ACGME	CanMEDS
Professional Values (PROF1) Team Management (ICS2)	Professional Communicator Collaborator

Intended Objectives of Case

1. Discuss the ethics of error disclosure.

2. Describe an approach to the following processes that should occur in cases of medical error: 1) error identification; 2) error disclosure; and 3) safety occurrence reporting and quality improvement.

3. List specific strategies that may prevent events such as the one featured in the case.

Expert Response

Medication Errors and Patient Risk

by Fareen Zaver MD, FRCPC, MSc (Candidate)

The *Case of The Medical Mishap* highlights multiple common issues we deal with in any acute care setting, especially Emergency Medicine (EM).

Medications are the most frequent cause of adverse events in patients in medicine.[1] A medication error occurs when a medication is given inappropriately regardless of whether an adverse clinical outcome occurs. Medication errors are especially prevalent in the Emergency Department (ED) due to simultaneous management of acutely ill patients, a limited knowledge of the patients' preexisting medical conditions, high degree of diagnostic uncertainty, frequent disturbances and interruptions, staff fatigue and high decision density. [2] This places a high cognitive load on the emergency physician and places patient safety at risk, particularly during the management of a critical patient.

There are many factors that can result in a medication error. In the case presented there were multiple areas in which an error occurred – both times Tim ordered intravenous (IV) epinephrine instead of the standard intramuscular (IM) epinephrine, each time resulting in symptomatic ventricular ectopy. When ordering the medication, he also simply states 0.3mg and did not clarify which vial the nurse should draw the medication from. Until the department starts stalking appropriately labeled epinephrine, this distinction must be clear as our nursing colleagues can easily make a dosing error in an acute situation when the order is not explicit. Medicine is a team sport, however, and the nurse shares the responsibility in this situation when she did not clarify the dose, drew up the medication and administered the drug without any closed loop communication. In this situation, there was also no second nurse/pharmacist verifying the correct dose/concentration prior to administration - a more common occurrence in modern tertiary care centres. Epinephrine is unfortunately a common culprit of medication errors as it is generally administered in critical, high stress situations and has a variety of doses and dilutions based on the type of administration (IV, IM).[3]

Prevention of medication errors:

Many medication errors occur due to knowledge-based mistakes – this is when a nurse or physician orders or administers a medication they rarely or infrequently use.[4] Using a checklist, mobile devices, or handbooks can decrease reliance on remote memory to mitigate this type of error.[2]

Rule-based mistakes occur when there is a misapplication of standard rules regarding dosage adjustments. Infusion pumps, previous experience, high workload and local working practices are all contributory factors for this type of error.[4] Rule-based mistakes can also occur when a member of the healthcare team does not question deviation from normal protocols.

Other methods to decrease mistakes in medication administration include minimizing distractions during drawing up the medication, especially with those medications that require multiple dilutions or potentially having pre-diluted medications. Using standardized medications and doses and having set protocols for common medication errors can mitigate these errors. Most importantly, having a second nurse or a pharmacist participate and verify the medication dosage and concentration – pharmacist participation has shown a decrease of up to 66% of adverse drug events.[5]

Physicians in training:

Every physician, whether in training or not, will at some point in their career commit an error in medication ordering. When an error occurs, physicians will undoubtedly develop emotions related to shame, perceived incompetence and concern for litigation.

The resident-attending relationship is an extremely important relationship and starts with an underlying level of trust and as it builds, the resident receives more autonomy. When a resident commits an error, they are then faced with the stress of disclosing the error to their attending physician. They must disclose their error to the very person in charge of their performance evaluation and they may fear the loss of autonomy, trust and respect of their attending physician as well as potential remediation. These emotions can fester for days or even years after the error has occurred, and leads to physician burnout. 6

With this in mind, residency is the best time to formulate positive error management strategies. Attending physicians must be actively involved in creating a positive, supportive educational culture around resident error. The most effective way to establish a culture of safety is for the attending to model disclosure of errors to their own patients in front of trainees. In the case of Tim, his attending physician should actively help him identify and dissect the error, and assist him in disclosing the error to the patient.

Expert Response

Reporting an error to the patient:

There are many barriers to prevent a physician from disclosing an error to their patient with the greatest being fear of litigation. This however has been debunked as studies have demonstrated the disclosure of errors to a patient actually reduces litigation.6 It is imperative that physicians disclose medical errors to their patients to respect the patient's autonomy and allow the patient to provide informed consent for additional medical treatment that may be required to correct the mistake. This disclosure does not solely rest on the treating physician as hospital risk management staff and the organization in charge of protecting physicians professional integrity (the Canadian Medical Protective Association in Canada) have protocols in place and should also assist in the process.

Conclusion:

The Emergency Department is a fast-paced, high stress environment in which all providers will make medication mistakes – some of which will have dire outcomes on our patients. It is our duty to limit medical error by recognizing common areas of risk, and attempt to decrease the risks as much as possible. Residents should be supported by attending physicians and learn tools to manage disclosure of errors. Physicians should disclose medication errors, but should use local and national support systems to assist with this challenging task.

References

1. Gkhman R, Seybert AL, Phrampus P, Darby J, Kane-Gill SL. Medication errors during medical emergencies in a large, tertiary care, academic medical center. Resuscitation 2012; 83(4):482-7.

2. Fu D, Sibley A, Woods R. Prevent Medical Errors in the Field with Cognitive Strategies. Journal of EMS 2014; 39(12).

3. Paparella S. Epinephrine: A Potpourri of Potential Medication Safety Risks. Journal of Emergency Nursing 2013; 39(2): 151-153.

4. Keers RN, Williams SD, Cooke J, Ashcroft DM. Understanding the causes of intravenous medication administration errors in hospitals: a qualitative critical study. BMJ Open 2015;5.

5. Chris Nickson. Medication Error. Life in The Fast Lane 2013. Link: https://lifeinthefastlane.com/ccc/medication-error/

6. Hevia A, Hobgood C. Medical Error During Residency: To tell or not to tell. Ann Emerg Med 2003; 42:565-570.

About the Expert

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Expert Response

To Err is Human

by Shashank Ravi MD & Arjun Venkatesh MD, MBA, MHS

To Err Is Human. This was the title of a landmark report published by the Institute of Medicine in 1999 identified several factors that made US healthcare more dangerous than automobile driving, breast cancer, and AIDS.[1] The report focused not solely on the actions of individual care providers, but rather on the holes in processes of care in a complex medical system. These 'holes' are often analogized to Swiss cheese; usually, the holes don't line up, but when they do, gaps in care are the result.

In *The Case of the Medication Mishap*, both the resident Tim and the nurse involved feel personally responsibility for a medication error. It is natural to feel guilt and self-doubt after an error of any kind; it is essential, however, that the focus be not on "who" is responsible, but rather "what" is responsible. Where are the holes in the "Swiss cheese" of a patient's care, and how did they line up to cause a gap in care or harm to the patient?

Just Culture

A *Just Culture* is an environment where individuals are not held responsible for system failures.[2] Just culture ensures that employees feel safe in reporting errors and near misses. This allows the organization to learn from mistakes and take steps to avoid future error.

In this month's case, the nurse felt safe reporting the medication error to Tim, the resident. Full transparency doesn't stop with the healthcare team, however, as timely error disclosure to the patient often both appropriate and recommended. Most hospitals also utilize a safety event reporting system to allow a multidisciplinary team to identify areas of focus. Hospital safety reporting systems should not be used vindictively, or to lay blame. The true purpose of these systems is to capture and classify errors in a manner that supports continuous quality improvement and advances the healthcare system.

Another aspect of a Just culture that is often forgotten is care for the caregiver. In the Emergency Department, we are often forced to immediately move on to the next patient after a difficult case. Taking the time to provide emotional support for patients, family members, and fellow providers, and taking the time to reflect on our own emotions and seek support is essential.

Swiss-Cheese

When discussing errors, healthcare providers often casually refer to the *Swiss Cheese Model*, which was originally developed by James Reason in the 1990s.[3] As described above, this model explains the way in which errors may line up in a healthcare system to result in gaps of care or harm to a patient.

This model classifies failures into two types: active failures and latent failures. Latent failures are often due to poor system design, training shortfalls, and undetected defects. They may go unnoticed for extended periods of time. Active failures are often identified more quickly because they usually have a direct effect on a patient and involve frontline caregivers. The administration of an incorrect medication dosing in this case was an active error.

So how do we try to plug the holes of the *Swiss cheese*?

It is not enough to simply say what people should have done. Instead, we must find out how what people did at the time made sense at the time. Then we can understand how a series of decisions, systems issues, and events resulted in an error. Once we have accomplished this, we can finally devise methods to mitigate these areas of contributing risk.[4] We can work toward systems that are fault-tolerant and keep the holes in the Swiss cheese of our healthcare system from lining up.

Karl Weick and Kathleen Stucliffe have identified five orientations that are implemented by organizations that are successful in minimizing error and creating high reliability systems.[5] These include:

1. Preoccupation with Failure

2. Resisting Simplifying Observations

3. Sensitivity to Operations

4. Commitment to Resilience

5. Deference to Expertise

In this case, we see both the resident, Tim, and the nurse upset about the events that occurred, which show that they do not take the error lightly. In other words, they are 'preoccupied with failure'. Importantly, however, the players in this month's case must adopt a 'commitment to resilience'. Tim doubts his own leadership and decision-making capacity. He must resist viewing this case as a *single occurrence* where the patient ended up doing well, but rather think about how to improve the system of verbally ordering medications in high stress code situations.

Tim already demonstrated examples of being attuned to the *complex operations* of the emergency department by gathering

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the team members before the patient arrived and assigning roles and tasks, as well as placing himself at the foot of the bed where he could effectively direct the resuscitation. Tim should work with the physician and nursing leadership at his institution, as well as *engage peer institutions* in healthcare to enact new protocols for verbal medication orders in code situations. The changes that Tim can help implement will not only benefit himself and his colleagues, but more importantly future patients.

References

1. Kohn, L, et al. To Err Is Human. 2000. National Academy Press.
2. Boysen, PJ. Just Culture: A Foundation for Balanced Accountability and Patient Safety. 2013. Ochsner J. 13(3): 400–406.
3. Reason, J. Human Error: Models and Management. 2000. BMJ. 320(7237): 768–770.
4. Woods, David D., et al. Behind Human Error. 2010. London: CRC Press.
5. Weick, Karl E., and Kathleen Sutcliffe. Managing the Unexpected: Resilient Performance in an Age of Uncertainty. 2007. Jossey-Bass.

About the Expert

Dr. Shashank Ravi is a Clinical Instructor and Senior Fellow in Administration in the Department of Emergency Medicine at Yale University. He has contributed to numerous national quality improvement initiatives including acting as an officer for the ACEP Quality Improvement and Patient Safety Section and contributing member to the E-QUAL and CEDR registries. He is currently also obtaining his MBA from the Yale School of Management.

About the Expert

Dr. Arjun Venkatesh (@arjunvenkatesh) is an Assistant Professor and Director of Performance Improvement in the Department of Emergency Medicine at Yale University. He is also Scientist at the Yale Center for Outcomes Research and Evaluation. He is funded by the NIH and AHRQ to study health system outcomes and efficiency, and he is supported by CMS as co-Principal Investigator of the Emergency Quality Network (E-QUAL) and for the development of the Overall Hospital Quality Star Ratings. He has published over 70 peer-reviewed papers and is senior editor of *The Evidence* book series. He is a national leader within SAEM and ACEP and he serves on expert panels for the NQF, AHRQ and CMS.

Curated Community Commentary

By John Eicken MD, Ed.M.

This month's case highlighted a medication error by Tim, a senior emergency medicine resident, during an encounter with a critically ill patient requiring emergent bedside management for a life-threatening case of anaphylaxis. Despite having already been treated with two doses of 0.3 milligrams of intramuscular epinephrine prior to arrival to the ED the patient's condition continued to deteriorate and Tim ordered 0.3 milligrams (300 micrograms) of intravenous epinephrine via an intravenous push, which resulted in the patient experiencing symptomatic non-sustained ventricular tachycardia. Prior to discussing the community response to this case it is crucial to discuss the important teaching points this case highlighted regarding epinephrine and the treatment of anaphylaxis. Medication errors, one by Tim and one by the nurse, were precipitated by this high-stress patient encounter.

Error #1: Tim ordered a 0.3 milligram intravenous push of epinephrine which equated to a 300 microgram bolus of IV epinephrine. This occurred twice during the case and was a medication error each time.

Teaching Point - This exceptionally high, and incorrect, dose for intravenous administration of epinephrine in a patient not in cardiac arrest led to symptomatic ventricular tachycardia which could have progressed to an episode of ventricular fibrillation had it not spontaneously resolved. It was reasonable for Tim to order intravenous epinephrine for a patient experiencing life-threatening anaphylaxis who had already received two doses of intramuscular epinephrine 0.3 milligrams (this is the correct dose for *intramuscular* epinephrine). However, the correct dose for intravenous epinephrine for treatment of anaphylaxis is a continuous drip of 0.01 milligrams per minute (i.e. 10 micrograms per minute). If a pre-mixed continuous infusion of epinephrine is not immediately available, a provider can easily mix their own life saving epinephrine intravenous drip.

Contributors

Thanks to the participants (in alphabetical order) for all of their input:

Clare O'Connor
Dr. Mel
Will Barany

Error #2: The nurse administered epinephrine 1:1,000 concentration intravenously.

Teaching Point – 1:1,000 concentration epinephrine should *only* be administered intramuscularly. The higher concentration (compared to 1:10,000 concentration) equates to a lower volume for the intramuscular injection. It is important to note that labels for epinephrine are being changed from ratios (i.e. 1:1,000) to milligrams/millilitre (mg/mL)
-The 1:1,000 concentration is equivalent to 1 mg/mL
-The 1:10,000 concentration is equivalent to 0.1 mg/mL
The response from the community to this case was limited, however some excellent thoughts and teaching points were shared.

Clare O'Connor provided excellent insight regarding multiple different aspects of this particular case. In regards to disclosure of the medication error to the patient she highlighted that many institutions have established disclosure policies to help guide physicians after a medical error. She also expressed the importance of creating an "incident report", regardless of whether harm was experienced by the patient, to help track and prevent future similar errors.

Teaching Point – Following a medical error your institution may be able to help 1) determine if harm occurred and 2) may be able to help you during the error disclosure process with the patient and/or patient family. Clare also highlighted that medical errors are usually multifactorial and not the result of misjudgment of a

single person. She highlighted that environmental factors (such as the number of people in the room), physical factors (such as the organization of the resuscitation cart and appearance of the vials of epinephrine), and human factors (poor communication between providers in this case the absence of a clear verbal order regarding dose, concentration, and route of the medication as well as an absence of closed loop communication) all play pivotal roles in whether an error occurs or is pre-emptively avoided.

Teaching Point – Medical errors rarely are the result of a single individual and often are the result of a Swiss cheese model of errors at multiple levels.
If a provider is fortunate enough to have pre-notification of a critically ill patient en route to the emergency department a team huddle should take place. Clare suggested that Tim should have gathered his team in the room and discussed with them the anticipated clinical scenario and anticipated potential interventions the patient may require. A team "pre-briefing" as described by Clare may have prevented the errors that ultimately occurred.

Teaching Point – Take the few moments leading up to the arrival of a critically ill patient to huddle with your team, assign roles, and discuss the expected clinical scenario and potential therapeutic interventions that the patient may require.

Clare astutely pointed out the dangers of assuming a provider will not make an error because of their stellar reputation, in this case the nurse carrying the reputation of being "one of the best" in the department. Providers at all levels of patient care are human, and therefore capable of making mistakes. This concept highlights the importance of having in place and utilizing standardized protocols and closed loop communication during high stress situations.

Teaching Point – Everyone in the room of a critically ill patient should feel empowered to speak up if they are concerned about a potential error about to occur and no one should be assumed not capable of making a mistake. Finally, "Dr Mel" contributed, "It doesn't matter what concentration was given, just the dose – which was 0.3mg (it would be a problem if they gave the wrong volume of the wrong concentration)". He is accurate that concentration does not matter if the dose is the same (i.e. 0.3 mg of epinephrine is 0.3 mg regardless of whether it is 1:1,000 or 1:10,000 concentration – the *volume* will simply be different between the doses). However, the higher concentration (1:1,000) allows for a smaller volume (which is why it is used for intramuscular administration) and therefore much more difficult to accurately draw up in small doses, such as the small doses that are required for intravenous administration. This is why 1:1,000 (i.e. 1 mg/1mL) should never be used for doses of IV epinephrine *unless it is being used to create an epinephrine drip by being added to a bag of crystalloid that is then infused into the patient (see link above).*

Upon final reflection, anaphylaxis is a clinical condition that easily elicits high stress for all providers caring for the patient and is a scenario that emergency medicine providers need to be comfortable managing. We are the experts in regards to treatment of this acute life-threatening, yet treatable, condition. Unfortunately the various concentrations, dosing, and routes of administration of epinephrine has resulted in significant errors and seemingly never-ending confusion, particularly in high stress situations. However, despite these unique challenges we owe it to our patients to take the time to ingrain the treatment of anaphylaxis in our minds to ensure that we rise to the occasion and provide excellent care and team leadership for the next patient who presents in extremis with severe anaphylaxis leading to our own endogenous epinephrine release.

Final Teaching Points

1) **Epinephrine is the life-saving drug for anaphylaxis** (patients should also receive IV fluids, steroids, H1 blockade, and H2 blockade BUT these should NOT delay administration of epinephrine)

2) If administering epinephrine **intramuscularly** (the majority of patients) the dose is 0.3 milligrams for adults (0.15 milligrams for pediatric patients) of the 1 mg/mL solution (i.e. 1:1,000) concentration

3) If administering epinephrine **intravenously** (the minority of patients – those who are peri-coding and/or

have not responded to intramuscular injection of epinephrine) the dose is 10 **micro**grams per minute of the 0.1 mg/mL solution (i.e. 1:10,000) concentration. In other words a pre-mixed epinephrine drip to be infused as a continuous (NOT a bolus) infusion. However, if a premixed epinephrine drip is not immediately available you need to make your own. If you are making your own epinephrine drip combine 1 mg of epinephrine (concentration DOES NOT matter) with 1,000mL of crystalloid which results in a concentration of epinephrine 1 mcg/mL.

4) Medical errors are an unfortunate reality of patient care. It is important that providers are honest with themselves, their patients, and their institution when it is determined that a medical error may have occurred. Not only does this strengthen our relationship with our patients and our colleagues but also promotes a culture of safety and continuous improvement to avoid future similar errors.

References:

1. Reason, J. Human error: models and management. 2000. *BMJ. 320*(7237), 768-770
2. Kanwar, M., Irvin, C. B., Frank, J. J., Weber, K., & Rosman, H. Confusion about epinephrine dosing leading to iatrogenic overdose: a life-threatening problem with a potential solution. 2010. *Annals of Emergency Medicine. 55*(4), 341-344.

About

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