Let’s Stop this “Epi”demic!—Preventing Errors with Epinephrine

The Pennsylvania Patient Safety Reporting System (PA-PSRS) has received numerous reports of accidental administration of concentrated epinephrine: a high alert drug. While not more prone to error than other drugs, epinephrine does pose a greater risk of serious patient harm and death when used in error. Based on the reports submitted to PA-PSRS and elsewhere, the majority of the errors involving epinephrine can be traced to two problems: 1) expressing the concentration as a ratio strength rather than a metric per volume concentration, and 2) confusion between epinephrine and ephedrine.

Problem 1—Ratio Strength

Many epinephrine-related reports submitted to PA-PSRS describe situations in which clinicians administered undiluted epinephrine (i.e., 1:1,000 [1 mg/mL]) intravenously instead of a less concentrated solution (i.e., 1:10,000 [0.1 mg/mL]). Unfortunately, when this occurs, the result to the patient is dramatic and life-threatening, as can be seen in this example from PA-PSRS:

During a diagnostic bronchoscopy, the patient developed bleeding. Epinephrine was instilled to control bleeding, and the patient developed ventricular tachycardia and possible ischemic changes on EKG monitoring. Patient was stabilized and transferred to Critical Care. Initial cardiac enzymes negative for myocardial infarction. On investigation, it was determined that the patient received the incorrect concentration of epinephrine. Measures are being undertaken to remove the incorrect concentration of epinephrine from the bronchoscopy set up to avoid a recurrence.

Often in situations like this, the more diluted epinephrine (1:10,000) is available for use, but staff inadvertently prescribe or select the 1:1,000 concentration. One such situation occurred in an outpatient radiology unit where the nurse rarely administered medications. The patient developed hives and respiratory distress after administration of contrast media. The physician prescribed 3 mL of the 1:10,000 concentration IV, but 3 mL of the 1:1,000 concentration was administered in error. The patient developed a rapid heart rate and increased blood pressure, requiring hospital admission.

More tragically, a 16-year-old boy was brought into the emergency department with priapism and died due to an epinephrine overdose. A urologist ordered epinephrine, but he thought that the 1:1,000 ratio on the epinephrine 1 mg/mL label meant that the epinephrine had already been "prediluted" with 1,000 mL of fluid. The patient received 4 mL of 1:1,000 undiluted epinephrine injected into his penis. The patient arrested and died when the epinephrine reached his systemic circulation.

These errors highlight the problem of drug concentration presentation. The contents of most injectable medications are given as their mass concentration (mg or mcg per mL). Only a few drugs have concentrations expressed as a ratio or percentage. These expressions are error-prone because: 1) practitioners, even physicians and emergency medicine residents, may not recognize or understand the difference between dose concentrations, such as 1:1,000 or 1 mg/mL and 1:10,000 or 0.1 mg/mL, and 2) it is easy to confuse numbers in the thousands because there are so many zeros (i.e., 1,000 looks like 10,000).

Most alarming, these poorly understood expressions are particularly prevalent with drugs used for resuscitation (e.g., epinephrine, lidocaine, sodium bicarbonate). An inappropriate dose or life-threatening delay in treatment is quite possible, especially if these drugs are prescribed in mg (which requires prior knowledge of ratio or percent concentrations and calculations) or mL (which is a problem if multiple concentrations exist).

Problem 2—Look-Alike Names: Epinephrine and Ephedrine

Another cause of errors involving epinephrine is confusion between epinephrine and ephedrine.
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do these drug names look similar, but their use as vasopressors or vasoconstrictors makes storage near each other likely. Both products also may be packaged alike in 1 mL ampuls or vials.

In one case reported to PA-PSRS, a patient in the post anesthesia care unit (PACU) was prescribed ephedrine. However, the nurse inadvertently chose and administered epinephrine IV push. An ECG was performed, and the patient required a longer stay and further monitoring in PACU.

Another case involved a healthy young woman in a labor and delivery unit who became hypotensive after epidural anesthesia. A nurse called the obstetrics resident to inform him of the patient’s condition. The resident became irritated and ordered ephedrine 10 mg to be given slow IV push. The nurse, who was anxious because of the physician’s behavior, mistakenly processed the order as epinephrine. Because there was not enough epinephrine on the unit, she borrowed some from the nursery. She found a 30 mL vial of epinephrine 1:1,000, withdrew 10 mL (10 mg), and administered that amount to the patient. The patient developed tachycardia, severe hypertension, and pulmonary edema. Fortunately, an anesthesia staff member was present and recognized the problem immediately. The patient was treated successfully and the baby was delivered safely.

Safe Practice Strategies

Because many of the emergency medications with concentrations expressed in ratios or percentages, including epinephrine, date back to before the 1938 Food Drug and Cosmetic Act, they do not fall under current FDA labeling standards. Epinephrine is a United States Pharmacopeia (USP) drug, subject to USP labeling requirements. Until USP eliminates the use of ratio expressions on epinephrine labels and changes the nomenclature to prevent confusion between epinephrine and ephedrine, consider these strategies as you strive to improve the safe use of epinephrine.

- Do not expect all healthcare practitioners to be familiar with percent or ratio expressions of concentrations, or to be adept at calculating doses for drugs with concentrations expressed in this manner.

- To the extent possible, use prefilled syringes, and limit storage of concentrated epinephrine to crash carts (except in the ED and OR) to reduce the risk of dilution errors or administration of the wrong product.

- Store a single concentration wherever possible, and affix warning labels as appropriate to minimize confusion between the two concentrations of epinephrine.

- In units where multiple concentrations are needed (such as the ED), apply auxiliary warning labels to 1:1,000 ampuls to alert staff to the concentration in mg and to dilute it before IV use.

- Epinephrine 1:1,000 in 30 mL vials for systemic use presents a hazard and, at least in nurseries, should not be available on units. If this concentration is necessary, stock just the 1 mL ampuls so that the need for multiple ampuls can serve as an alert to the healthcare provider. If a 30 mL vial must be stored outside the pharmacy, alert staff about potential problems. Use auxiliary warning labels or circle “30 mL” to make the total volume more prominent.

- Post a dose conversion chart reflecting available concentrations on emergency carts and in other areas where these medications may be prepared.

- During annual CPR certification for clinical staff, review the dose chart and mention potential confusion with emergency drugs dosed in ratio or percent concentrations alone.

- Use “tall man” lettering to help differentiate EPInephrine from ePHEDrine. Consider using this on computer screens, pharmacy and nursing unit shelf labels and bins (including automated dispensing cabinets), pharmacy product labels, and medication administration records.

- Avoid storing epinephrine and ephedrine side-by-side.

- To ensure an independent double-check system, it would be best to have pharmacy prepare all infusions and bolus doses for these drugs, when possible.

Notes


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The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error (“Mcare”) Act. Consistent with Act 13, ECRI, as contractor for the PA-PSRS program, is issuing this newsletter to advise medical facilities of immediate changes that can be instituted to reduce serious events and incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority’s website at www.psa.state.pa.us.

ECRI is an independent, nonprofit health services research agency dedicated to improving the safety, efficacy and cost-effectiveness of healthcare. ECRI’s focus is healthcare technology, healthcare risk and quality management and healthcare environmental management. ECRI provides information services and technical assistance to more than 5,000 hospitals, healthcare organizations, ministries of health, government and planning agencies, and other organizations worldwide.

The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP's efforts are built on a non-punitive approach and systems-based solutions.