Lack of Standard Dosing Units And Measurements Creates Mishaps In Intravenous Drug Administration

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PROBLEM: As the use of parenteral medications increases, improvements in drug-infusion technology have enhanced the ability to administer these agents precisely. However, a variety of dosing units and measurements, such as mcg/kg, mcg/kg/minute, mcg/kg/hour, and many others exist, and few drug-specific dosing norms have been established. It is common to find that multiple dosing measurements are being used for a single drug. Unfortunately, the lack of standardization makes it difficult to select the proper dosing approach, and errors are common.

Some mixups have involved using the wrong dosing method when medications were being prescribed. For example, Lesar found that the method was wrong in 29.5% of 200 consecutive prescribing errors, resulting in potentially adverse outcomes, particularly in pediatric patients. Other errors have involved the misprogramming of pumps when the incorrect dose or infusion rate was selected.

Following is an example of an error that was submitted to the Institute for Safe Medication Practices (ISMP).

An 80-year-old comatose man, weighing 80 kg, was taken from a long-term care facility to an urgent-care center to be treated for urosepsis and septic shock. Among other intravenous (IV) fluids and medications, dopamine (400 mg/500 mL) was ordered in a dose of mcg/kg/minute to treat persistent hypotension, with increasing titration prescribed to maintain his blood pressure. Over the next hour, the infusion was titrated upward two more times in increments of 5 mcg/kg with no response. The patient was then taken to a nearby hospital for admission to a critical-care unit.

When the transport team arrived, one of the paramedics reviewed the patient’s IV infusions and, per protocol, independently calculated the rate of infusion for each. While reviewing the pump settings, the paramedic noticed that the dopamine dose had been programmed in mcg/kg/hour, not in mcg/kg/minute. Although a Baxter Colleague smart pump had been used to program the initial infusion, the nurse had elected to bypass the pump library and instead used the pump in the dose-calculator mode. Looking at the screen to choose dosing options, the nurse accidentally selected mcg/kg per hour, which appeared on an alphabetical list before mcg/kg per minute. This sequence represents a pump feature with the potential to result in an error because mcg/kg per minute is used more frequently than mcg/kg per hour.

After the pump was reprogrammed to deliver the correct dose, the patient’s blood pressure increased and he became conscious. The patient was then transported to the nearby hospital and was discharged five days later.

When reporting this error to the receiving hospital where the patient had been transported, the paramedic learned that the same type of error had been reported earlier, during the previous six months. In fact, the ISMP has received many reports about selection of the wrong dosing method when pumps were being programmed.

In one of these reports, for example, an order for propofol (Diprivan) 80 mcg/kg/hour was administered at 80 mcg/kg/minute for an elderly man because of a pump programming error, resulting in oversedation but no additional harm.

A similar type of error involves mixups between doses stated in mcg and mcg/kg of body weight. The following scenario illustrates how the wide variability of dosing units, seen in practice settings, contributes to the risk of pump-programming errors.

An infant weighing 3 kg received a 36-mcg bolus dose (12 mcg/kg) of fentanyl instead of a 12-mcg dose (4 mcg/kg). Using a Medfusion 3500 Syringe Pump (Smiths Medical) with smart pump technology, the nurse did not notice that the pump had prompted for a dose in mcg/kg, not a total dose. She subsequently entered “12” into the pump, which calculated a dose of 36 mcg (12 mcg/kg) for the 3-kg infant.

In this case, a “soft” dose-limit alert had displayed on the pump. Another nurse had double-checked the pump settings, but the alert was overridden and the drug was administered. Later that day, the infant received a 1.8-mg bolus dose of midazolam (Versed) instead of the intended dose of 0.6 mg after the same programming error was made.

SAFE PRACTICE RECOMMENDATIONS: To reduce the risk of IV dosing errors, health care organizations should consider the following suggestions:

1. Dosing methods should be standardized. After looking for variable dosing approaches for the same medication in the hospital, staff members should select a standard way to administer that drug for adults and a standard way to give it to pediatric patients. Differences in dosing procedures for all drugs used in the organization should be examined. If possible, dosing methods should be standardized to promote familiarity. Because patients and nurses may transfer between facilities, health systems comprising multiple hospitals can also benefit from standardization at the systems level. The standard technique should be listed on preprinted or electronic order sets in which the applicable drugs appear. 

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2. **Smart pumps should be fully functional.** The use of smart pumps that provide software to reduce dosage errors helps to prevent harmful mixups among various dosing methods for the drugs in the pump’s library. Other safety features include unchangeable dosing units after a drug is selected, weight limits, and clinical advisories. Smart pump alerts, which warn practitioners of impending medication errors, should not be overridden. If an alert is activated, it is crucial for the practitioner to investigate the warning and act accordingly. Organizations should conduct regular compliance rounds to ensure that dose-checking capabilities are in working order. The facility should also review available data from error-reduction software to ensure that the staff is interacting appropriately with the technology.

3. **Dosing methods should be listed on the medication administration record (MAR) and label.** When possible, the drug dose should be displayed on the MAR and on the drug container label in the same way as the information is needed to program the pump.

4. **Dosing methods should be listed on orders.** Prescribers should list the dosing method or unit used, as well as the calculated dose, of drugs that are more prone to be involved in an error, such as pediatric and chemotherapeutic agents.

5. **The dosing method should be verified.** When applicable, pharmacists and nurses should confirm both the dosing technique used and the calculated dose before they dispense or administer a medication.

6. **Pump settings should be verified during hand-offs.** Upon transfer of patients to another setting and at the beginning of each shift, all pump settings should be confirmed. The dosing method and the total dose must be appropriate for all patients, given their weight, age, and condition.

7. **The possibility of an error should be considered.** If a patient is not exhibiting the physiological changes that would be expected after an infusion, the staff should consider that an error might have occurred and should verify the pump settings.

8. **Simulation training should be implemented.** To heighten staff awareness about mix-ups with dosing practices, organizations might offer simulation training and exercises in which participants investigate a hypothetical case with a dosing error, uncover the error, and take corrective action.

**REFERENCES**


The reports described in this column were received through the ISMP Medication Errors Reporting Program (MERP). Errors, close calls, or hazardous conditions may be reported on the ISMP Web site (www.ismp.org) or communicated directly to ISMP by calling 1-800-FAILSAFE or via e-mail at ismpinfo@ismp.org.