Programming custom concentrations into smart pumps without hard "low concentration" alerts

While smart pumps are commonly used every day throughout health care institutions, serious programming errors continue to occur. One major mistake that practitioners make is forgetting to set hard stops for minimum concentration limits when programming custom concentrations. Inputting custom concentrations involves selecting a drug from the library and manually entering the concentration (i.e. # mg/# mL). According to a survey conducted by the Institute for Safe Medication Practices (ISMP), almost 50% of the 600 respondents were not sure if their pumps had a hard stop for minimum concentration limits or were completely confused by the question entirely.

There is an inverse relationship between the concentration of drug and volume administered. A more concentrated drug requires less volume to deliver a specific dose. Conversely, less concentrated drugs require more volume to deliver a specific dose. When setting up a smart pump using a custom concentration, the concentration must be programmed into the pump, so the volume needed to deliver the prescribed dose can be calculated by the device. If the programmed concentration is **lower** than the actual concentration in the infusion bag or syringe, the pump will deliver an **overdose** of medication. If the programmed concentration is **higher** than the actual concentration in the bag or syringe, the pump will deliver a **low dose**. Some pumps may have low concentration alerts; however, these can be overridden.

Errors occur when clinicians:

- Unnecessarily select a custom concentration option, and then enter the wrong concentration, even when a standard concentration option is available in the pump library.
- Confuse the dose per hour with the total infusion volume and enter it as the concentration.
- Leave custom concentration options in the drug library.
- Ignore soft low concentration alerts or mistaking them for "low dose" alerts.
- Do not build hard stops for low (minimum) concentration alerts into the smart pump library.
- Confuse pharmacy labels with drug preparation instructions for the drug concentration.

The following strategies may help reduce errors associated with smart pump custom concentrations:

- Use one standard concentration for each drug infusion. If more than one is needed, limit the number of concentrations to two, and avoid concentrations that differ by a factor of 10 (i.e. 0.1 mg/mL and 1 mg/mL, and 10 mg/mL).
- Ensure the pump library utilizes the standard concentration(s) used for each drug. Custom concentrations should only be used in select patient care areas. Remove custom concentration options when a standard concentration for that drug has been established and built into the library.
- Set hard minimum (low) concentration limits for each drug, particularly high-alert medications, that allows a custom concentration option in the library, to avoid overdose.
- Educate staff on the inverse relationship between the concentration and the volume, and the significance of low (minimum) concentration alerts.

References

1. Institute for Safe Medication Practices. (2018). *Nurse Advise-ERR.* Retrieved from Institute for Safe Medication Practices: http://www.ismp.org/newsletters/nursing/issues/NurseAdviseERR201808.pdf

- If a custom concentration is necessary, use an auxiliary label to distinguish it from bags or syringes containing a standard concentration.
- Utilize metric unit dosing (mg/hour, mcg/kg/hour, etc.) in protocols and order sets. Do not accept orders for infusions that include the infusion rate alone (i.e. mL/hour) even if only one standard concentration of the drug is used.
- Standardized order sets and electronic prescribing systems should allow the prescriber to select only the standard concentration(s) when applicable. Infusion orders should not prescribe the concentration, only the dose (mg/hour, mcg/kg/min) to avoid risk of varying concentrations. If fluid restrictions are required, a "double" or "triple" concentration can be prescribed without specifying the amount of drug per mL.
- Present the drug and concentration (and infusion rate, if provided) on the medication administration record (MAR) and the infusion label in the same units and sequence required when programming the pump. Include specific instructions for custom concentrations when necessary. Do not include pharmacy technician preparation instructions (i.e. calculations) on the final product label.
- When hanging a new bottle, bag, or syringe or when changing the infusion rate, require an independent double check using electronic health records (EHR), MAR and other technology (i.e. smart pumps, barcode scanning) to verify and document the following before starting the infusion:
    - Drug/solution
    - Drug concentration
    - Rate of infusion
    - Correct patient
    - Channel selection
    - Line attachment

  Note: In titrated medications (i.e. vasopressors), be sure the final infusion rate falls within an expected range.
- Evaluate the metrics available within smart pumps to identify the frequency of custom concentration use, hard stops for minimum concentrations, soft alert overrides, actions taken in response to these alerts, and other issues that may result in errors. Implement strategies to reduce these identified risks.

References

1. Institute for Safe Medication Practices. (2018). *Nurse Advise-ERR.* Retrieved from Institute for Safe Medication Practices: http://www.ismp.org/newsletters/nursing/issues/NurseAdviseERR201808.pdf