



ISMP Medication Safety Alert!®

Nurse Advise-ERR™

Special Follow Up to “Safety issues with patient-controlled analgesia”

We’ve received several phone calls regarding the January 2005 article on patient-controlled analgesia (PCA). Many of you are using the article for educational purposes and were asking for supplemental information. Most of the requests surrounded two sections and we wanted to provide additional explanations that might facilitate understanding.

It is important to remember that PCA infusion pumps are programmed differently than regular rate/volume-based infusion pumps for intravenous fluids. The concentration must also be programmed into a PCA device and is used by the pump to calculate a volume to be delivered.

Although at first counterintuitive, concentration and volume have an inverse relationship. The higher the concentration setting, the less volume is required to achieve the desired dose. Therefore if the concentration programmed does not match the actual concentration inside the device, an incorrect volume and thus incorrect dose will be delivered to the patient. Below are examples from January’s issue.

Page 2, under Practice-related problems: A hydromorphone concentration was accidentally set at “2.0” mg/mL, not 0.2 mg/mL (undertreatment).

In the above example, if the bolus dose to be given upon activation of the PCA was 0.2 mg, but the concentration was programmed at 2 mg/mL, the volume delivered would be 0.1 mL. If the actual concentration was 0.2 mg/mL, a 0.1 mL volume would only deliver 0.02 mg, resulting in undertreatment.

Bolus dose prescribed = 0.2 mg
Actual concentration = 0.2 mg/mL
Programmed concentration = 2 mg/mL

For example, using the above concentrations, solve for x , where x equals the actual volume delivered:

$$\frac{2 \text{ mg}}{\text{mL}} = \frac{0.2 \text{ mg}}{x}$$

Cross multiply...

$$(2 \text{ mg})(x) = (0.2 \text{ mg})(\text{mL})$$

Units (mg) cancel out...

$$(2 \cancel{\text{mg}})(x) = (0.2 \cancel{\text{mg}})(\text{mL})$$
$$(2)(x) = (0.2)(\text{mL})$$

Divide both sides by 2...

$$x = 0.1 \text{ mL}$$

$x = 0.1 \text{ mL}$, Actual volume delivered

Actual concentration X Actual volume delivered = Actual dose received
(0.2 mg/mL) X (0.1 mL) = 0.02 mg received instead of 0.2 mg (prescribed dose) =
undertreatment

Page 3, Device design flaws: Unknown to the nurse, the pump default for morphine was set at 0.1 mg/mL, not the standard 1 mg/mL, which resulted in a 10-fold overdose.

Similar to the above example, suppose the demand dose to be delivered upon activation of the PCA was 1 mg and the concentration of morphine in the pump was 1 mg/mL. If, for some reason, the pump defaults to a concentration of 0.1 mg/mL (equal to 1 mg/10 mL), it will deliver 10 mL of volume to reach the 1 mg dose, whereas if the default concentration was set at 1 mg/mL, only 1 mL of volume would be delivered. Again, an inverse relationship.

As a general guide, ISMP recommends that default settings on PCA pumps be set at zero, so that no volume is delivered in the event of a default, or at the highest concentration so that very little volume will be delivered.