

PCA Overdose

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<https://psnet.ahrq.gov/web-mm/pca-overdose>

The Case

A 49-year-old woman underwent an uneventful total abdominal hysterectomy bilateral salpingo-oophorectomy. Postoperatively, the patient complained of severe pain and received intravenous morphine sulfate in small increments. She remained alert and oriented and, while in the post-anesthesia care unit (PACU), she began receiving a continuous infusion of morphine via a patient-controlled analgesia (PCA) pump.

A few hours after leaving the PACU and arriving on the floor, she was found pale with shallow breathing, a faint pulse, and pinpoint pupils. The nursing staff called a “code” and the patient was resuscitated and transferred to the intensive care unit on a respirator. A search for reversible causes was unrevealing and, despite aggressive supportive care, the patient had no improvement in her mental status. Several days later, an electroencephalogram result revealed no brain activity. Based on family wishes, life support was withdrawn and the patient died. Review of the case by providers implicated a PCA overdose, though no autopsy was performed to exclude other etiologies. The precise mechanism of the overdose was never elucidated.

The Commentary

The lack of details available in the reader-submitted case synopsis limits the already challenging task of identifying an exact mechanism of death. Even if we presume an overdose was the cause, it is my experience from past investigations of similar cases that the exact mechanism of overdose is often not apparent.

Patient-controlled analgesia (PCA) is a computer-based medical technology used extensively to treat postoperative pain via self-administration of analgesic agents.⁽¹⁾ Potential benefits include superior pain control, automatic electronic documentation, and improved utilization of nursing resources. Unfortunately, however, analgesics also represent a frequent cause of adverse drug events (ADEs).^(2,3)

It is not known exactly how often ADEs are associated with PCA use, especially because problems with medical devices tend to be severely under-reported.(4) Nor is it known exactly which patients are at special risk of ADEs in relation to PCA use, although common sense suggests that special caution may be warranted in frail or elderly patients, in patients with obstructive sleep apnea, and in patients with impaired respiratory function.

A typical PCA machine (Figure) contains an embedded computer programmed to give a specified amount of opiate intravenously every time the patient pushes a button. To help prevent excessive drug administration, the onboard computer ignores further patient demands until a *lockout period* (usually set for 5–10 minutes) has passed. In addition, cumulative limits of opiates that can be administered during specified time intervals also exist in some models.

Despite such safety features, numerous reports of respiratory depression and death associated with PCA pumps have surfaced.(5-10) A number of adverse outcomes with PCA use have involved particular models that require manual entering of specific parameters. Easily misprogrammed by caregivers, such models need a more sensible and forgiving user interface.(11) A number of patients have received opiate overdoses because of PCA errors, such as when the operator has inserted a 5 mg/mL morphine cartridge when the machine is expecting a concentration of 1 mg/mL or has accepted the default (initial) drug concentration instead of scrolling to select the correct value.(12-14)

In 1997, ECRI, a nonprofit health research organization, documented three deaths that occurred during PCA use.(12) In at least two of the cases, the errors that led to the deaths appeared to be related to the same critical design flaw: the machine displays the minimal drug concentration as the initial choice. If nurses mistakenly accept the initially displayed minimal value (eg, 0.1 mg/mL) instead of changing it to the correct (and higher) value (eg, 2.0 mg/mL), the machine will “think” that the drug is less concentrated than it really is. As a result, it will pump more liquid, and thus more opiate, into the patient than is desired.

It should be emphasized, however, that other mechanisms of PCA overdoses may occur. A possible classification for such overdoses has been proposed.(15) Problems include misprogramming; using the wrong drug or cartridge; IV flow, triggering, or pump malfunctions; hardware or software failures; and others.

Under ideal circumstances, the continuous use of a pulse oximeter and/or other forms of respiratory monitoring would prevent many of these tragic deaths. In the real world, such technologies are often too expensive and/or plagued with false alarm problems for use on ordinary nursing floors. Fortunately, new signal processing technologies are making pulse oximeter technology much more reliable. These new oximeters may provide an important mechanism to better monitor respiratory status and improve safety when using PCA pumps.

In addition to improved respiratory monitoring technology, attention to improving the PCA user interface is desperately required, such as has been carried out at the University of Toronto.(11,16) Redesigning PCA pumps to make them more intuitive and easier to program (using human factors engineering techniques) will add another important safety layer.(14) In the meantime, hospitals should avoid purchasing PCA pumps known to have design flaws.

Beyond drastically improving the user interface, a recent article suggested several approaches to improve safety when using PCA pumps.⁽¹⁴⁾ One potential safeguard would be to stock only a single concentration of morphine cartridge (eg, 1 mg/mL). Where this is not practical in every circumstance (such as in oncology wards), the hospital should establish special safety measures when higher-concentration morphine cartridges (eg, 5 mg/mL) are also available. Another precaution would be to require an independent check by a second caregiver when a PCA pump is programmed. Caregivers should report any problems or complications associated with PCA pumps (as well as all other medical devices) to hospital authorities and the U.S. Food and Drug Administration (FDA). [To file an online FDA report, visit <https://www.accessdata.fda.gov/scripts/medwatch/>]. In addition, there is a critical ongoing need for experts to formally and informally review medical products in a “Consumer Reports” fashion. Finally, in the event of an adverse clinical event possibly related to PCA usage, nothing should be discarded, and an investigation should begin immediately.

Take-Home Points

- PCA pumps provide an important mechanism for delivering analgesia but can result in respiratory depression; routine monitoring of respiratory status may prevent future adverse events.
- Achieving greater safety with the use of PCA pumps will require emphasis on improved design, better user interfaces, and continued vigilance in reporting existing flaws in current systems.

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Figure

Figure. Patient-Controlled Analgesia (PCA) Machine.



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