- 13 *Notcutt W.* Overdose of opioid from patient controlled analgesia pumps (Letter). *Br J Anaesth* 1992; 68: 450.

To the Editor:

I read with interest this case report of the tragic death of a young woman while receiving patient-controlled analgesia (PCA) post-Cesarean delivery.¹ The authors conclude their report with several recommendations. These are all very sensible. The most important recommendation, not mentioned however, concerns the initial nursing assessment of a loudly snoring and unarousable patient while receiving PCA on the ward. This obviously can be an urgent and life-threatening situation which must be dealt with expeditiously. Typically a nursing protocol exists which provides for an immediate and effective response. Did this not exist, or, if so, was it not followed? A different and more favourable outcome might have resulted.

An astute and appropriately trained nurse is the last line of defense for a wide range of untoward and potentially critical situations, such as could arise from a PCA programming error. This, in my opinion, is the paramount message in this tragic case, and not the programming error itself.

Jonathan D. Lamb MD FRCPC
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Reference

- 1 *Vicente KJ, Kada-Bekhaled K, Hillel G, Cassano A, Orser BA.* Programming errors contribute to death from patient-controlled analgesia: case report and estimate of probability. *Can J Anesth* 2003; 50: 328–32.

To the Editor:

Patient-controlled analgesia (PCA) programming error is an important patient safety issue as highlighted by Vicente *et al.*¹ Drug overdose and death resulted when morphine 1 mg·mL⁻¹ was set instead of the actual 5 mg·mL⁻¹. I appreciate Dr. Vicente's reminder and sound recommendations but find the viewpoints somewhat misleading. The article seems to suggest that the Abbott Lifecare 4100 Plus II Infusion Pump is uniquely dangerous because there might be "relatively numerous mortalities ... from user programming errors with this device".¹ The authors have singled out the Abbott PCA pump as dangerous without providing objective adverse outcome data for other PCA pumps as comparison. While I acknowledge that the Abbott PCA pump is not foolproof, we must realize that incorrectly entering a lower drug

concentration than one actually used can happen with most PCA pumps currently on the market. For example, the factory preset PCA default drug concentration for the Baxter I pumpTM and Sims Deltec CADD[®] pump is 0 mg·mL⁻¹ and 0.1 mg·mL⁻¹ for the Abbott pump. To my knowledge, only the Alaris PCAM[®] pump can be programmed to a customized drug delivery profile at this time.

It is important that we read this article in the proper context recognizing that heightened vigilance to prevent human error and drug overdose is needed for all brands of PCA pumps. In the meantime, we wait in anticipation for the next generation of PCA pumps with the promised safety features of bar code reading capability and automatic drug identification.

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Reference

- 1 *Vicente KJ, Kada-Bekhaled K, Hillel G, Cassano A, Orser BA.* Programming errors contribute to death from patient-controlled analgesia: case report and estimate of probability. *Can J Anesth* 2003; 50: 328–32.

REPLY:

We are pleased that our article generated interest in the anesthesia community.¹ Dr. Lederer identifies several well-known performance shaping factors that induce error. However, most of these are uncontrollable and cannot be eliminated; all health care providers will sometimes be stressed, tired, or emotionally upset. It is irresponsible to design medical systems that do not accommodate these harsh realities. Rather than wishing these factors will simply go away, we should design devices and systems so that providers can function more robustly - even under less than ideal conditions.

Dr. Doyle outlines an excellent taxonomy of patient-controlled analgesia (PCA) hazards to assist manufacturers and investigators improve patient safety. Dr. Lamb correctly reports that well trained, astute nurses play a key role in preventing tragic outcomes from drug errors. Dr. Chan raises questions about the context for our research that we are pleased to address.

Our primary goal is to use human factors engineering design principles to improve the safety of medical devices, not to denigrate any particular manufacturer or model.² The circumstances surrounding the patient death, not our personal preferences, dictated the particular model we investigated.

That being said, the Abbott Lifecare® 4100 PCA Plus II Infusion Pump is unique in several important respects. First, according to Abbott, by 2000, this device was the market leader, was used around the world, and accounted for about 75% of all PCA use in the U.S., being used in nearly 4,000 hospitals there.^{3,4} Furthermore, in 2001, ECRI (formerly the Emergency Care Research Institute, www.ecri.org) stated "this pump has a significant safety problem".⁵ In late 2002, ECRI continued to receive reports of deaths from programming errors with this pump.⁶ These deaths were not included in our epidemiological analysis.

Second, "the Abbott PCA pumps are the only pumps that ECRI is aware of that can default to a low concentration setting".⁶ As we explained in our article, this design feature has important safety implications. For example, accepting an initially displayed concentration value of 0.1 mg·mL⁻¹ could lead to an over-infusion of analgesic when a more concentrated drug preparation is used (e.g., 1 mg·mL⁻¹ or 5 mg·mL⁻¹). In contrast, accepting the initially displayed concentration value of 0.0 mg·mL⁻¹, as provided by other PCA pumps described by Dr. Chan, presumably does not lead to any infusion — a fail-safe design feature. In retrospect, given that no study of this type had ever been conducted, analyzing the market leader that has unique design features linked with patient safety seems worthwhile.

We agree with Dr. Chan that human factors analyses of other PCA pumps should be conducted and we encourage him and others to do so. If objective scientific evidence eventually confirms Dr. Chan's opinion that all PCA pumps are equally error-prone, then the threat to patient safety of PCA use is even greater than anticipated; the total number of deaths from concentration programming errors alone could be greater than our initial upper estimate of 667.¹ This would make the application of human factors engineering design principles to protect public health even more urgent.

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- 1 Vicente KJ, Kada-Bekhaled K, Hillel G, Cassano A, Orser BA. Programming errors contribute to death from patient-controlled analgesia: case report and estimate of probability. *Can J Anesth* 2003; 50: 328–32.
- 2 Lin L, Isla R, Doniz D, Harkness H, Vicente KJ, Doyle DJ. Applying human factors to the design of medical

equipment: patient-controlled analgesia. *J Clin Monit Comput* 1998; 14: 253–63.

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(www.gasnet.org//societies/apsf/newsletter/2000/fall/07OpinionResponse.htm, May 2, 2003).
- 4 Abbott Laboratories. LifeCare® PCA Plus II Infuser. (www.abbotthosp.com/PROD/pain/pcaplus.html, August 23, 2001).
- 5 ECRI. Patient-controlled analgesic infusion pumps. *Health Devices* 2001; 30: 157–85.
- 6 ECRI. Medication safety: PCA pump programming errors continue to cause fatal overinfusions. *Health Devices* 2002; 31: 342–7.

Another use for the forced air warmer

To the Editor:

A 14-yr-old, developmentally delayed girl presented for emergency debulking of a cerebral tumour. As a result of hemorrhage into the tumour she had become comatose and had been placed on mechanical ventilation. Vital signs revealed a heart rate of 140·min⁻¹, blood pressure of 125/80 mmHg and a nasopharyngeal temperature of 39°C. The peripheries were noted to be cool, despite the patient's febrile condition, with delayed capillary refill, but a satisfactory oxygen saturation of 98% was obtained by pulse oximetry. Anesthesia and surgery proceeded uneventfully until two hours into the case, when the pulse oximeter waveform became smaller and the value for oxygen saturation began to fall. Manual ventilation with 100% did not improve the displayed oxygen saturation. Hemodynamic status and end-tidal CO₂ remained unchanged. The surgeon felt that air embolus was very unlikely at that time in the procedure. The extremities were again noted to be poorly perfused and the recorded oxygen saturation was found to be equally low (approximately 60%) or unrecordable in both hands and feet. An arterial blood gas revealed a PO₂ of 492 mmHg, suggesting that the problem was with poor peripheral perfusion, not hypoxemia. Volume loading failed to improve the peripheral perfusion and the waveform and value remained unreliable for 30 min. An attempt was then made to improve peripheral perfusion by the local use of a forced air warmer to a foot. Within five minutes, a satisfactory waveform was re-established and oxygen saturations of 100% were obtained. The waveform and values remained satisfactory for the rest of the case. This event demonstrated that a forced air warmer can