Anesthesiology
75:697–699, 1991

"Air in the Syringe": Patient-controlled Analgesia Machine Tampering

DONALD S. STEVENS, M.D.,* ROBERT I. COHEN, M.D.,† RAJENDRA V. KANZARIA, M.D.,‡
W. THOMAS DUNN, JR., M.D.§

Much effort has been made to make patient-controlled analgesia (PCA) machines tamper-proof. Prevention of access to the opioid in the machine is the major issue. Several methods in current use include locking the opioid-filled syringe inside the machine, requiring key or keypad code access for changing the prescription or delivering an opioid bolus, and using special swiveled luer lock fittings on the intravenous tubing to prevent disconnection and withdrawal of medication directly from the syringe.

Recently at our institution, we cared for a patient who we suspect tampered with a PCA machine to obtain opioid in a fashion not previously described.

CASE REPORT

A 20-yr-old man, 188 cm and 80 kg, was admitted for management of dehiscence of a parascapular free-flap donor site. He had sustained a gunshot wound to his right leg 10 months before admission and had had free-flap closure 2 months before admission. After that procedure, he had required a high dosage of opioid for analgesia (as much as 900 mg meperidine in 8 h by PCA).

PCA with meperidine was begun. A PCA machine with locked syringe compartment (C. R. Bard, North Reading, MA) was used. Tubing with a swiveling luer lock disk was used to prevent syringe disconnection (Bard Tamper Resistant Microbore Extension Set, C. R. Bard). Also, Y-tubing with an antireflux valve was used to prevent reflux into the maintenance intravenous tubing (Bard Microbore Anti-Reflux Y-set, C. R. Bard). Transition to oral methadone was to be implemented when opioid dosage was determined to be stable.

During the 4th hospital day, the patient's nurse contacted the Acute Pain Management Service with several questions. The nurse stated that she had found the PCA machine closed and locked as usual, but that the 60-ml syringe was half-full of air. She also stated that the patient had been observed to be examining his intravenous tubing closely on several separate occasions. Blood had been found backed up into the intravenous tubing. An intravenous therapist also noted on routine inspection that on one occasion the Y-tubing with the antireflux valve was incorrectly connected to the intravenous tubing. The nurse on duty also stated that she was concerned that the patient appeared too sedated.

The patient was examined. He was awake and alert, and his pupils were 2 mm in diameter.

The PCA machine was inspected. No obvious signs of tampering were found. The syringe and extension tubing were assembled correctly. Review of the "PCA MACHINE MEMORY" showed that the machine had been functioning properly for the preceding 24 h and had delivered only 90 mg meperidine over the last 8 h. Use during the prior day had been 400 mg every 8 h. Inspection of the 60-ml syringe showed 15 ml clear liquid remaining with a small amount of blood also present. The syringe was not cracked. There was no fluid in the PCA machine itself, as would have been expected if the fluid had leaked out of the syringe or luer lock fitting.

The patient vehemently denied that he had tampered with the PCA machine, the syringe, or the intravenous tubing.

Use of the PCA machine was discontinued and the patient was administered a dose of methadone equal to half of his prior daily opioid use.

Equipment Examination and Experimentation. Because blood was found in the PCA syringe, tampering with the intravenous tubing by the patient was suspected. To determine whether this were possible, PCA equipment was assembled in the laboratory as for routine use, except with saline in the 60-ml PCA syringe. A three-way stopcock was placed at the end of the extension tubing, and a 5-ml syringe was attached (fig. 1). Liquid could be aspirated from the PCA syringe by negative pressure applied to the 5-ml syringe. Four milliliters of liquid could be obtained by aspiration alone. Retrograde injection of air from the 5-ml syringe pressurized the PCA syringe, allowing easy removal of additional liquid. In fact, half of the liquid in the horizontally positioned PCA syringe could be removed by air displacement, until the air–saline meniscus reached the syringe outlet.

In an attempt to block such aspiration of opioid, an additional one-way valve (Bard Microbore Anti-Reflux Y-Set, C. R. Bard) was placed between the PCA syringe and the aspirating syringe (fig. 2). Only 4 ml liquid could then be aspirated. No air could be injected in retrograde fashion, because of the additional one-way valve. The extra tubing could be enclosed entirely within the locked plastic cover of the machine, preventing unauthorized access.

DISCUSSION

Presence of a large amount of air in the syringe in a PCA machine may be explained in several ways. The syringe may have been filled incorrectly. A partially filled syringe may have been taken out of the machine, opened to air, filled with air, and replaced in the machine. A cracked syringe may have allowed its contents to drain out as they were displaced by air.[1] Finally, if a tamper-proof luer lock fitting is not used on the syringe, the intravenous tubing can be removed and a needle and syringe used to aspirate liquid directly from the PCA syringe while it is still locked in the machine.

In our patient, none of these appears to explain the findings. The presence of both air and blood in the PCA syringe indicates that retrograde filling of the syringe took place from the patient's intravenous tubing, with inter-

* Assistant Professor of Anesthesiology; Associate Director, Acute Pain Management Service.

† Assistant Professor of Anesthesiology.

‡ Resident in Anesthesiology.

§ Chief Resident in Anesthesiology.

Received from the Department of Anesthesiology, University of Massachusetts Medical Center, Worcester, Massachusetts. Accepted for publication June 8, 1991.

Key words: Analgesia: patient-controlled. Analgesics: opioid.

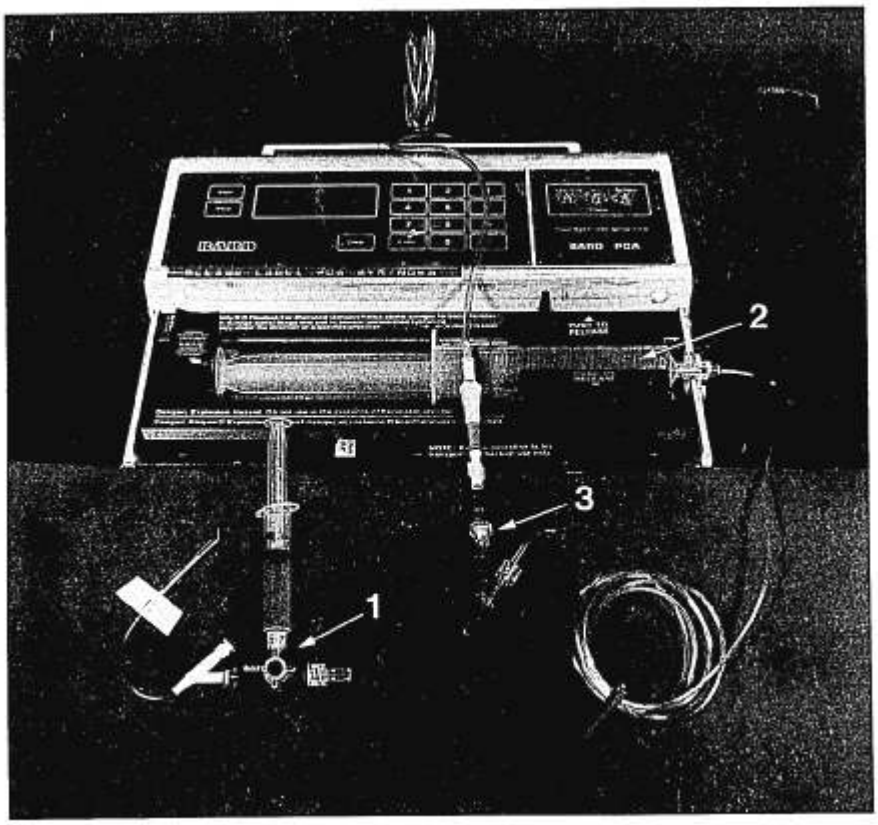

FIG. 1. Patient-controlled analgesia (PCA) machine, assembled as described (and opened for display). A syringe and stopcock (1) are used to aspirate liquid from the PCA syringe (2) and to inject air back into the PCA syringe. A one-way valve (3) prevents flow back into the intravenous maintenance line.

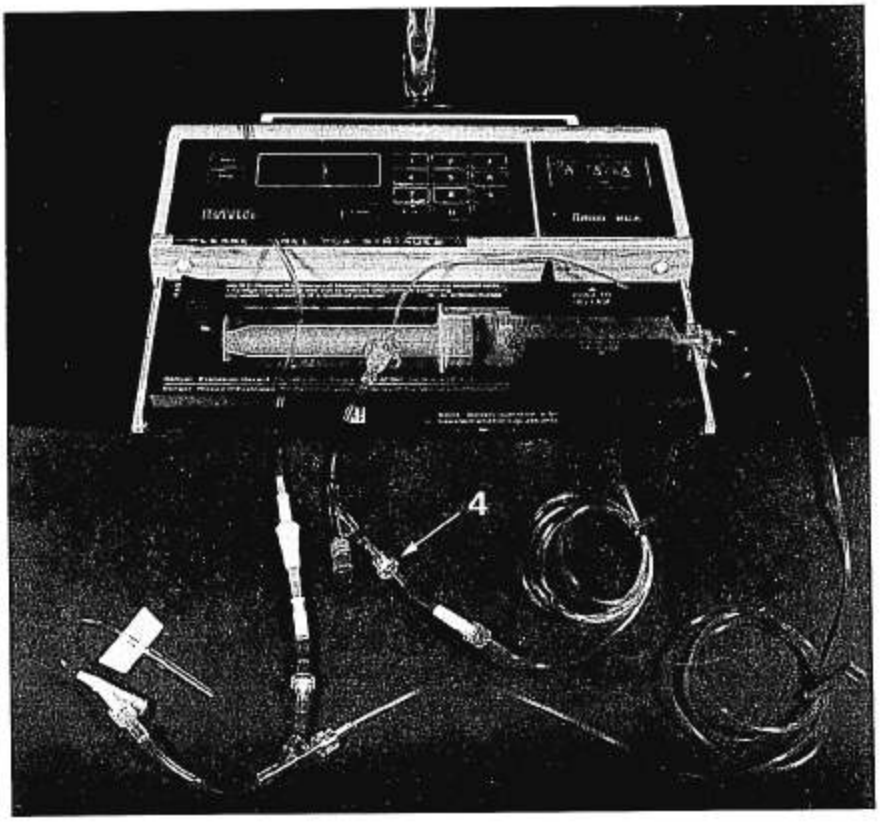

FIG. 2. Patient-controlled analgesia machine, assembled to prevent retrograde air injection (and opened for display). An additional one-way valve (4) prevents retrograde injection into the PCA syringe.

mittent injection of air and aspiration of fluid. The blood would have been drawn into the intravenous tubing from the patient by the application of negative pressure and would have been injected into the PCA syringe during retrograde injection of air.

Our findings indicate that medication can be aspirated from a PCA syringe *in situ* in a PCA machine simply by the use of negative pressure. Access can be from an injection port, with a needle and syringe used for negative pressure and also for positive pressure to fill the PCA syringe with air in retrograde fashion. Therefore, routine PCA set-up as commonly done may *not* be as secure from violation as was previously believed.

Unauthorized access to PCA opioids, such as we describe, requires the use of a syringe for aspiration of fluid and for retrograde injection of air. According to the clinical signs described above, we suspect that our patient was responsible. Since the meperidine concentration used was 10 mg/ml, and a maximum of 30 ml (300 mg) was replaced by air, if our patient did self-administer the missing meperidine, his 8-h use would have been 390 mg. This amount is close to the 400 mg that he used by PCA during each 8 h of the preceding day.

However, such tampering also could be done by *any* individual with a syringe and needle, including any physician, nurse, relative, or other visitor. Acquisition of syringes and needles by unauthorized personnel should be prevented by routine hospital policies but still may occur. Authorized medical personnel also must have access to syringes and needles and therefore would be able to obtain opioids from a PCA machine in this fashion. Therefore, even if certain patients who may be likely to tamper with PCA machines (such as those with a history of drug-seeking behavior) are excluded from PCA use, it is recommended that methods still be used to minimize PCA machine tampering by other individuals.

Our findings indicate that placement of a one-way valve between the PCA syringe and the first intravenous access port will prevent the type of unauthorized access that we have described. As long as air cannot enter the PCA syringe, no more than 4 ml of opioid-containing liquid can be obtained. This one-way valve should also be inside the locked portion of the PCA, so that it cannot be bypassed. Since this incident occurred, we have learned that C. R. Bard also manufactures an extension set with a one-way valve immediately next to the PCA syringe swivel connection (Bard Anti-Siphon Extension Set, C. R. Bard) Use of this type of extension set will prevent retrograde injection into the PCA syringe.

In an alternative solution without an additional valve, the PCA syringe would be mounted with its outlet upward, so that if air is introduced in the manner described, it would not displace liquid. One risk with doing so is that if such tampering does occur, air injection into the patient could result.

In conclusion, it appears that additional safeguards may be required in current PCA equipment to prevent unauthorized access to the opioid in the PCA syringe. Use of an additional one-way valve or of an upward-facing PCA syringe to prevent retrograde filling of the syringe with air may help to accomplish this.

REFERENCE

1. Thomas DW, Owen H: Patient-controlled analgesia - the need for caution. Anaesthesia 43:770–772, 1988

Anesthesiology
75:699–701, 1991

Malignant Hyperthermia during Sevoflurane Anesthesia in a Child with Central Core Disease

HIROSHI OTSUKA, M.D.,* YOSHIHIRO KOMURA, M.D.,† TAKAHISA MAYUMI, M.D., PH.D.,‡
TAKEYASU YAMAMURA, M.D., PH.D.,§ OSAMU KEMMOTSU, M.D., PH.D., F.C.C.M.,¶
KEIKO MUKAIDA, M.D., PH.D.**

Malignant hyperthermia (MH) is a catastrophic, hypermetabolic syndrome that arises in susceptible individuals when they are exposed to certain inhalational anes-

* Instructor of Anesthesiology, Hokkaido University School of Medicine.

† Instructor of Anesthesiology, Hokkaido University School of Medicine.

‡ Assistant Professor of Anesthesiology, Hokkaido University School of Medicine.

§ Associate Professor of Anesthesiology, Hokkaido University School of Medicine.

¶ Professor and Chairman of Anesthesiology, Hokkaido University School of Medicine.

** Instructor of Anesthesiology, Hiroshima University School of Medicine.

Received from the Department of Anesthesiology, Hokkaido University School of Medicine, Sapporo, Japan, and the Hiroshima University School of Medicine, Hiroshima, Japan. Accepted for publication June 24, 1991.

Address reprint requests to Dr. Otsuka: Department of Anesthesiology, Hokkaido University School of Medicine, N15 W7, Sapporo, 060 Japan.

Key words: Anesthetics, volatile: sevoflurane. Complications: malignant hyperthermia. Hyperthermia: malignant.