Fluid warmer leakage into the bloodstream: A case report

EILEEN M. D'ANGELO, CRNA, CCRN, MS
Quincy, Massachusetts

A patient recently received approximately 750 mL to 1 L of sterile water intravenously because of a defect in the tubing used with a blood warmer, the Level 1 Hotline® HL-90. The patient did not appear to suffer any adverse effects from this either intraoperatively or postoperatively. The leak in the tubing was difficult to detect. The exact source of the leak was determined after infusing a 0.9% saline solution with methylene blue through the warming coil.

Although a literature search did not reveal any similar incidents, there are similarities between this occurrence and previous hemodialyzer membrane leaks the author is personally familiar with. An additional step in preparation of the fluid warmer and tubing is suggested. Both plugs covering the patient connections to the warmer tubing should be removed after the outer lumen is primed with a sterile water bath.

Key words: Blood leak, blood warmer, cross contamination, fluid warmer.

Case summary
The patient was a 62-year-old ASA physical status II male undergoing a radical retropubic prostatectomy under general anesthesia. An epidural catheter was placed preoperatively for postoperative pain management. The patient had a 14-gauge intravenous (IV) catheter and a radial arterial line in addition to the electrocardiograph, noninvasive blood pressure cuff, pulse oximeter, and end-tidal carbon dioxide and temperature monitors.

The fluid warmer, a Hotline® HL-90 and fluid warming set L-70 (Level 1 Technologies, Inc., Rockland, Massachusetts) had been prepared for use following the manufacturer's instructions. The water reservoir was filled with sterile water. A small amount of water had spilled on the floor, and an absorbent sheet was placed on the floor. An L-70 fluid warmer was then plugged into the Hotline and primed once the machine was turned on.

After the intravenous, radial artery, and epidural catheter placements were applied to the patient in the preoperative area, the patient was brought to the operating room. Some water drops were noted on the Hotline tubing at this point and were thought to have resulted from the tubing not being completely inserted into the warmer. The reservoir water level had dropped and there appeared to be some air bubbles in the circulating water bath. The circulating nurse stated that some water spilled from the warmer, and she had wiped it up and then turned the warmer off. The pad on the floor appeared unchanged from the one placed...
there to mop up the original spill from that morning. The reservoir was refilled a second time with sterile water, and the unit was turned on again. The patient's IV was used to prime the patient line portion of the warmer with no apparent leaking. No other air bubbles were noted.

General anesthesia was induced and proceeded uneventfully. About 1½ hours into the procedure, the reservoir was again noted to be low (about one third of the level when full), this time with no apparent water leak onto the floor. The Hotline L-70 warmer was immediately replaced with a new L-70 fluid warmer set and the water reservoir filled a third time with sterile water. Suspecting some absorption of the water bath by the patient, arterial blood gases and electrolytes were sent for analysis. Both came back normal. The second Hotline tubing functioned properly for the remainder of the case, including administration of two units of blood (autologous and cell saver) under about 300 mmHg pressure. We were unable to evaluate the urine for hemolysis due to the type of procedure. The patient’s blood did not appear to be hemolyzed.

The patient was extubated awake at the end of the case and arrived in the intensive care unit hemodynamically stable, alert, and pain-free. The urine did not appear bloody. The night of the surgery, the patient had an elevation in temperature of 101°F. Blood cultures were done and were negative. The patient had received cefazolin preoperatively and continued to receive routine antibiotic coverage in the immediate postoperative period.

In order to discover the source of the leakage of the fluid warmer tubing, after the case, a 150 mL bag of normal saline was injected with 1 mL of methylene blue and run through the Hotline tubing that was suspected of leaking. The inner lumen remained blue, and the outer lumen (water bath) remained clear even while the IV solution was running. The tubing was plugged back into the HL-90 fluid warmer, which was then turned on. Once again, the inner tubing was blue and the outer tubing was still clear. The water in the reservoir was slightly blue, but the source of the leak was still not apparent (Figure 1). The HL-90 machine was turned off again and the tubing unplugged. The ends of the tubing were placed over a bucket to collect the reservoir water which would drip out of the two holes where it attached to the HL-90 machine. When the plug covering the patient end of the tubing was removed, the water from the circulating water bath could be seen coming out of the patient end of the line. The only place the water should be able to come out are the two prongs where the tubing inserts into the reservoir on the HL-90, the “twin-tube connector” (Figure 2). Under very close examination, a small hole was discovered under the blue plastic piece about one inch from where the IV port attaches to the patient’s IV (Figure 3).

Immediately after the end of the case, a sample of the remaining water from the reservoir was sent to the laboratory for analysis and grew out a moderate amount of Pseudomonas pickettii. The manufacturer, hospital risk management, and MedWatch were notified. The lot number was not imprinted anywhere on the tubing itself but was narrowed down to one of three possible lots. The lot number is located either on the cardboard in-
Figure 2
"Twin tube connector" of Level 1 HOTLINE® fluid warming set

Figure 3
Level 1 HOTLINE® L-70 fluid warming set with defect at distal end

Discussion
A literature search for this type of problem did not uncover any similar incidents. In the author's experience with hemodialysis, occasional dialyzer leaks have occurred, resulting in a similar exposure of patient's blood to the water bath, with no apparent adverse effects.

Hemodialyzer membranes may be exposed to transmembrane pressures (combined positive and negative pressures) of 500-600 mmHg. The dialysis patients exposed to a small dialyzer leak would not be at risk for fluid overload since the dialysis process itself removes fluid. The patient's own venous pressure (in the range of 110-200 mmHg) applied on one side of the dialyzer membrane is combined with a negative pressure (which can be set up to 300 mmHg) pulling fluid out from the other side of the membrane. This surgical patient would seem to have had greater potential for water intoxication, congestive heart failure, or dilutional anemia than a patient with a dialyzer leak since large amounts of fluids were given intraoperatively; while with hemodialysis, fluid is usually removed in large amounts and volume is replaced sparingly.

In dialysis, chloramine-treated municipal water is typically passed sequentially through a water softener, a carbon filter, a 5-µg sediment filter, a hollow-fiber reverse-osmosis unit, an ion-exchange unit, and then passed by an ultraviolet light source before going to the dialysis machines. Dialysis machines are disinfected daily with sodium hypochlorite (final concentration 2.5%) and weekly with formaldehyde (final concentration 9%) for at least 18 hours. The entire water distribution system may be treated with sodium hypochlorite solution (500 ppm) twice yearly. Ion-exchange tanks may be changed every 3 weeks.

Such water treatment and cleaning of reservoirs has not been recommended and is not practical for use with most fluid warming devices. The Hotline manufacturer recommends filling the reservoir with distilled water; changing the water monthly; and cleaning the inside of the warmer.
monthly with a 30% alcohol solution, followed by rinsing twice with distilled water. There is no suggested method of checking the reservoir for residual alcohol. If a bleach solution were used to clean the inside of the tank, the presence of residual bleach could be picked up by the use of Hemastix®. The manufacturer does not recommend the use of bleach inside the reservoir due to potential for damage to the inner workings of the machine.

Dialysis machines include blood leak detectors, a feature not currently available in fluid warmers for routine use. There are a number of ways these fluid warmers could be tested for possible leaks:

1. Put some methylene blue in the reservoir with the sterile water. A disadvantage here is that one would have to add an IV extension set in order to look at the IV fluid coming out of the tubing to see if it turned blue since the outer layer of water would be blue. If there was a small leak, the change in color of the IV fluid may not be obvious, especially at high flows. This would not work if blood was being infused. It would probably require a large leak of a large amount of methylene blue to be infused to the patient before any change in SaO₂ was noted. We have asked the manufacturer whether methylene blue might damage the internal structure of the HL-90. The manufacturer is unsure if this will cause internal damage and has not advocated the use of methylene blue.

2. Check the reservoir fluid with Hemastix or Dextrostix®, if the fluids administered contain either blood or glucose. If the IV is lactated Ringer’s solution or normal saline, this test will not uncover a leak. Also, for a leak at the distal end of the tubing, such as in this case, a high flow rate of the IV fluid may not cause backflow into the reservoir. Here the opposite happened—the reservoir emptied into the patient port. In this case, the IV fluids were not infused under any pressure through the defective warmer.

3. Prime the circulating bath as usual, and then remove both plugs covering the patient’s IV connections before priming the patient line. A potential disadvantage here is that the patient ports are exposed to possible contamination if the tubing ends and the plugs on each end are not kept sterile during priming. Such contamination of blood tubing has occurred in hemodialysis. Step number 4 of the Hotline L-70 instructions states, “Water path must be fully primed and checked for water leaks before priming IV line and connecting to patient.” The manufacturer has modified its set-up instructions slightly. There are now orange stickers on each machine advising the user to prime the IV fluid path fully and to check the integrity of the tubing before connecting it to the patient. The manufacturer has stated that each unit is pressure-tested up to 300 mmHg and that this incidence of a leak is one in 78,000.

Pseudomonas picketti is an aerobic nonfermentative gram-negative bacillus. It has been implicated as a source of a nosocomial outbreak but was not shown to be a cause of any known specific pathology. Other members of the group include P. Mallei, P. Pseudomallei, P. Malotphila, and P. Cepacia. Individuals most susceptible to this type of bacteria are those at the extremes of age, those undergoing chemotherapy, or those with other debilitating illnesses. Commonly used antimicrobial agents which can inhibit Pseudomonas include ampicillin, cefoxitin, and gentamicin. No other case reports exist regarding this type of leak. Its occurrence was not obvious despite following the manufacturer’s instructions. Hopefully, clinicians will be able to discover this sort of defect before any reservoir water gets a chance to reach a patient.

REFERENCES


AUTHOR

Eileen M. D’Angelo, CRNA, CCRN, MS, received her bachelor of science degree from the University of Massachusetts at Amherst in 1979. She worked for several years in critical care and hemodialysis. She graduated from the New Britain School of Nurse Anesthesia in New Britain, Connecticut, and received her master of science in biology, specialization in anesthesia, from Central Connecticut State University in New Britain, Connecticut, in 1987.

Ms. D’Angelo has been employed as a staff CRNA at Jackson Memorial Hospital in Miami, Florida, and worked several years as a locum tenens CRNA. She is currently employed by South Shore Anesthesia Associates at South Shore Hospital in Weymouth, Massachusetts.