

## Undetected Venous Line Needle Dislodgment during Hemodialysis

**Hazard [Health Devices Nov 1998;27(11):404-6]**

### **Problem**

ECRI recently received two reports of hemodialysis machine venous line needles dislodging from patients during treatment without triggering a venous pressure alarm. In both cases, it was determined that the back pressure created by the narrow-bore needles that were being used had prevented the machine's venous pressure monitors from sensing the loss of pressure created by the dislodgment.

Midcourse dislodgment of a venous line needle during hemodialysis treatment can cause the loss of a significant quantity of blood. In some cases that ECRI has investigated, patients have died before clinicians have become aware of the situation. This problem is not unique to any specific brand or model of hemodialysis machines or tubing sets.

### **Discussion**

Because hemodialysis blood lines are often partially covered by the patient's blanket during treatment, a dislodgment or other type of disconnection within the venous line can occur without being visually detected. In many instances, the hemodialysis machine's venous pressure alarm will alert the dialysis staff to a loss of venous pressure. However, in the specific case of venous line needle dislodgments, venous pressure alarms cannot be relied on to detect a problem.

### ***Operation of Hemodialysis Units***

Hemodialysis units are used to cleanse metabolic wastes from the blood and to remove excess fluid from patients lacking kidney function. During hemodialysis treatment, the hemodialysis machine continually draws blood from the patient via the arterial line, pumps it through a dialyzer where fluid is removed and waste is exchanged, and then returns it to the patient's venous system through the venous line. Blood can be pumped through the hemodialysis circuit at rates as high as 450 to 500 mL/min, although flows of 300 to 400 mL/min are more common.

Pressures in both the arterial and venous lines are monitored at the hemodialysis machine to detect changes that may indicate an obstruction or disconnection and to ensure that appropriate transmembrane dialyzer pressures are maintained. At the onset of a treatment session, the alarm limits for the monitors are adjusted above and below the existing arterial and venous pressures. (On older machines the technician manually sets the limits, while on many newer machines the limits are automatically set to default values once steady blood flow rates are achieved.) Typically, the limits are set at  $\pm 50$  mm Hg around the existing venous line pressures.

### ***Problems Leading to Undetected Needle Dislodgment***

Chronic hemodialysis can be long (2.5 to 5 hours, three times a week) and painful (because of the frequent needlesticks required). To accelerate the treatment, newer high-permeability dialyzers have been developed that allow increased blood flow rates through the extracorporeal circuit (the increased rates also benefit the patient through more effective electrolyte clearance). And to help reduce the pain associated with needle insertions and to reduce scarring, smaller-bore (e.g., 16- or 17-gauge) needles are often used.

But while these changes may ameliorate one set of problems, they can create another problem by adversely affecting the venous pressure monitor's ability to detect dislodgment of the venous line needle. Smaller-bore needles create significant flow resistance, particularly at higher blood flows, producing back pressures that greatly exceed patient venous pressure. Consequently, even if the needle is fully or partially dislodged from the patient, the venous pressure monitor is likely to continue sensing the pressure created by the needle's flow resistance and thereby miss the smaller drop in pressure associated with the disconnection.

The problem is exacerbated by the fact that users may sometimes increase alarm limits to minimize nuisance alarms. (With wider alarm limits, venous line needle dislodgments become even more difficult to detect.) Nuisance alarms can occur because the higher venous line pressure associated with higher flows and smaller-bore needles can increase roller pump-generated oscillations in pressure. And these oscillations can be great enough to exceed even the customary  $\pm 50$  mm Hg venous pressure monitor limits.

When the venous pressure alarm problem is discussed with manufacturers of hemodialysis machines, their response is usually to warn users to be more vigilant (e.g., visually monitor the patient's lines more frequently). They stress that this is the key to safety and the only reliable way to detect events such as needle dislodgments.

### **Conclusions**

ECRI believes that the venous pressure monitor is not a reliable means of detecting needle dislodgments and agrees with manufacturers that visually monitoring the status of blood lines appears to be the only sure way to spot these problems. Although the monitor may reliably detect the large pressure change associated with a disconnection between the venous line and the venous line needle, the high needle flow resistance paradoxically makes it unlikely for the monitor to detect a needle dislodgment.

### **Recommendations**

1. Inform dialysis staff that secure needle placement is crucial to avoiding dislodgments. This involves taking the time to securely tape the needle to the patient's skin, arm, or access device.
2. Alert dialysis staff to the dangers associated with relying on the venous pressure alarm to detect a venous line needle dislodgment. Advise them to continually examine hemodialysis blood lines during treatment if this is not already routine.
3. Instruct users to keep the entire venous line from being covered by anything that might prevent good visualization of the needle insertion so that it can be easily monitored.
4. Encourage users to continue to use the venous pressure monitor. While the monitor may not be able to detect a dislodged needle, it is

useful for detecting obstructions or disconnections that occur elsewhere in the venous line. Instruct users to ensure that the monitor's alarm limits are set to clinically appropriate levels.

**UMDNS Terms**

- Dialyzers, Hemodialysis [11-232]
- Hemodialysis Needle Sets [18-245]
- Hemodialysis Tubing Sets [11-225]
- Hemodialysis Units [11-218]
- Needles, Dialysis [12-741]

**Cause of Device-Related Incident**

Device Factor: Device interaction

User Errors: Inappropriate reliance on an automated feature; Incorrect clinical use; Incorrect control settings

**Mechanism of Injury or Death**

Exsanguination

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