The Rapid Infusion System: User Error in Tubing Connection Mimicking Severe Hemorrhage

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THE Rapid Infusion System (RIS) (Haemonetics, Braintree, MA) is a device used to infuse blood or other fluids at body temperature at rates up to 1.5 l/min.1 The RIS infuses fluid via Y output tubing into two separate, large-bore intravenous cannulae to minimize resistance to flow and displays cumulative infusion output during use via a digital step-motor driving a roller pump. The knowledge of transfused fluid volumes may facilitate resuscitation by influencing the choice of subsequent blood component replacement during severe hemorrhage in anticipation of transfusion-related coagulation disorders. We present a case in which the use of a mechanically intact RIS during trauma resuscitation led to a gross overestimation of blood transfusion and estimated loss as a result of simple and unreported user error.

Case Report

A 64-yr-old man fell 7.6 m from a tree and had a left open forearm fracture with vascular compromise, a pelvic fracture, and serial rib fractures in the left side of the chest with flail chest and a widened mediastinum. He became hypotensive in the emergency room and received crystalloid resuscitation via two intravenous catheters. At arrival in the operating room, fluids were administered intravenously via a single limb of the RIS output into the existing femoral “trauma” catheter. The second limb of the RIS was not connected to the patient. Repeated acute fluid challenges and, finally, continuous infusion of 100-300 ml/min via the RIS were administered. The cumulative intraoperative fluid administration was 2,500 ml via a 16-gauge peripheral catheter, whereas the RIS indicated a cumulative 224 transfusion of packed cells and crystalloid mixture after 90 min. Thoracic exploration was performed, which disclosed only moderate bleeding from a lacerated intercostal artery. This led to scrutiny of the extent of all visual-measurable hemorrhage, now suspected to be in gross discrepancy with the registered 264 transfusion via the RIS output display. An RIS malfunction was excluded after the review of transfusion records indicated that only 7 l fluid was placed into the RIS. Closer examination revealed that, because only one of the two output infusion tubings was connected to the patient’s intravenous catheters, the second output tubing had remained connected to the reservoir and unclamped after priming of the machine and tubing. This allowed the correctly measured RIS output via the Y tubing to predominantly recirculate into the reservoir as the path of least resistance.

Discussion

The RIS can rapidly replace blood loss with fluids at body temperature, typically using two sites to minimize resistance to flow.2,3 Only one limb of the RIS output was connected to the largest intravenous catheter, and this singular connection resulted in the registered output error via recirculation in the second limb as a deviation from routine application of the RIS during an urgent situation (fig. 1). Such single-limb use occurs possibly once or twice a year in our tertiary trauma center, which uses the RIS on a daily basis. The use of the RIS in trauma may benefit patients by minimizing lactate levels, coagu-
Fig. 1. Numbered include: (1) reservoir fill-line; (2) Rapid Infusion System (RIS) reservoir; (3) digital step-motor-driven roller pump; (4) stopcocks and disconnection site for Y-administration tubing from priming lines; and (5) "to-patient" output. The solid black tubings depict the situation described with the lower recirculation stopcock of the Y-delivery tubing open at 4. The upper, broken-line tubing open to 5 suggests the typical configuration with both Y-administration tubings to the patient.

Therapy, and hypothermia, while optimizing hemoglobin levels. However, some evidence suggests that, especially in blunt trauma patients who have undergone massive transfusion, the use of the RIS is associated with excessive mortality in this group. Appropriate use and preparation becomes particularly important in these most critical emergency patients, as shown here: After priming of RIS tubings with infusate, it is imperative to clamp the unused limb whenever a single limb is connected for infusion. This will allow accurate measurement of infused volumes and afford maximal flow to the patient, without loss of driving pressure via recirculation through the unclamped limb. Other user errors can impair accuracy of RIS readout measurements, including improper positioning of recirculation lines, as recently reported. Accurate and timely recording of transfusion volume added to the reservoir was essential in the detection of our user error and can be recommended as fundamental to safe RIS use. Running tabulation of the volume "infused" next to the total volume (p.s. packed red blood cell units) "added to the reservoir" by the technicians on the transfusion datasheet could have facilitated earlier recognition of this type of event by indicating a widening gap between these parameters. Such early recognition can prevent patient exposure to unnecessary blood component administration and, for this reason, should be considered for routine application when using the RIS.

References

5. Lustik SJ, Chhibber AK: Unintentional recirculation with the rapid infusion system. Anesth Analg 1999; 89:1069