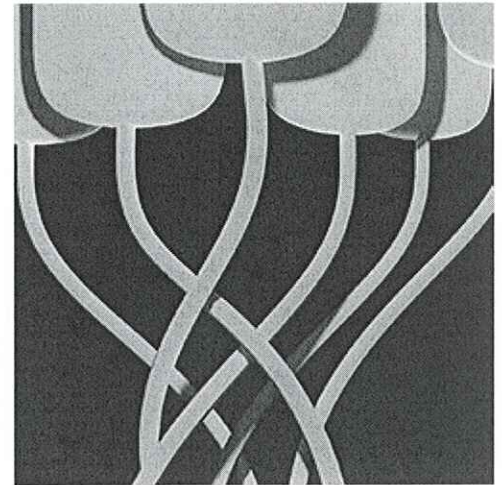


3. Mix-Up of IV Lines Leading to Misadministration of Drugs and Solutions



Member Resources

In addition to the specific resources listed below, members of various ECRI Institute programs can also access product specification charts for ambulatory, large-volume, patient-controlled analgesic, and syringe infusion pumps, as well as for enteral feeding pumps, through our *Healthcare Product Comparison System* (available through www.ecri.org).

Health Devices.

- Evaluation: choosing a syringe infusion pump. 2014 Jul 16. Available from: <https://members2.ecri.org/Components/HDJournal/Pages/Choosing-a-Syringe-Infusion-Pump.aspx>.
- Infusion pump integration: why is it needed and what are the challenges? [guidance article]. 2013 Jul;42(7):210-21. Available from: <https://members2.ecri.org/Components/HDJournal/Articles/ecri-hd201307-guid.pdf>.
- Infusion pump medication errors [hazard no. 2]. In: Top 10 health technology hazards for 2014: key safety threats to manage in the coming year [guidance article]. 2013 Nov;42(11):354-80. Available from: <https://members2.ecri.org/Components/HDJournal/Articles/ecri-hd201311-guid.pdf>.
- Patient-controlled analgesic infusion pumps: making a painless purchase [evaluation]. 2011 Feb;40(2):42-58. Available from: <https://members2.ecri.org/Components/HDJournal/Articles/ecri-hd201102-p042-eval.pdf>.
- Which smart pumps are smartest? Ratings for six large-volume infusion pumps [evaluation]. 2012 Dec;41(12):378-91. Available from: <https://members2.ecri.org/Components/HDJournal/Articles/ecri-hd201212-eval1.pdf>.

In previous Top 10 Health Technology Hazard lists, we've addressed the role that infusion pump programming errors play in infusion-related adverse events, most notably medication errors. This year, we focus not on the pump, but on the tangle of tubing that exists when multiple IV infusions need to be administered to a single patient—a common occurrence in healthcare.

If a medication or IV solution is delivered to the wrong infusion site, or at the wrong rate, the consequences can be severe. There are several ways this can happen—for example:

- ▷ The infusion line could be connected to the wrong fluid container. This will lead to the wrong fluid being delivered to the patient or to the fluid being delivered at the wrong rate or via the wrong administration route.
- ▷ The infusion line could be installed in the wrong infusion pump or pump channel. This could result in a medication or solution being delivered at a higher or lower flow rate than was intended.
- ▷ The patient end of the infusion line could be connected to the wrong administration route. In one reported incident, for example, liquid intended for IV delivery was instead delivered into an epidural catheter.

Not surprisingly, the opportunity for error is compounded when there are multiple lines and fluid containers. One study found that the likelihood of an adverse drug event increased by 3% for each additional IV medication being administered (Kane-Gill et al. 2012).

Factors that contribute to infusion-line confusion include the following:

- ▷ The number of infusion lines present. Intensive care patients and patients undergoing surgical procedures can have 12 or more infusion lines at once. Also, for “piggyback” infusions, two infusion lines (primary and secondary) and two fluid containers are associated with a single large-volume pump or pump channel.
- ▷ The variety of administration routes. Although pumps are primarily used to deliver fluids and medications intravenously, they are also used for epidural, subcutaneous, and arterial infusions. Thus, the potential exists for an infusion intended for one route to be mistakenly delivered through another.
- ▷ Difficulties in visually discerning one line from another. The tangle of infusion lines can make it difficult to visually trace a line from the fluid container to the patient. This issue is exacerbated when the tubing is obscured by the patient's gown or bed covers.
- ▷ Infusion pumps' inability to tell one line from another. That is, no automated method exists for associating an infusion pump or pump channel with the correct fluid container and route of delivery.

RECOMMENDATIONS

Several researchers and organizations have issued recommendations to reduce the risks associated with IV infusion-line confusion. The bracketed letters below refer to the source(s) for each recommendation, as listed in the inset on page below.

For all instances in which multiple IV infusions need to be administered to a single patient:

- ▷ Physically trace each infusion from the fluid container, and verify that the patient connector is attached to the correct administration site. [A], [B]
- ▷ Label each infusion line with the name of the drug or solution being infused. [C], [D], [E/F—Phase 2b]
- ▷ Make connections without forcing or adapting. If a connection is difficult to make—that is, if it requires a lot of effort—chances are you shouldn't make it. [A]

When purchasing supplies and equipment:

- ▷ As various products conforming to the ANSI/AAMI/ISO 80369-1 standard become available, purchase only those products. Do not purchase adapters that permit misconnections.

SOURCES OF RECOMMENDATIONS

As noted in the main text, various recommendations in this article were proposed by the following researchers and organizations (see the Member and Additional Resources for complete citation information):

- [A] ECRI Institute (see: Poster on page 12)
- [B] Cassano-Piché et al. (see: Ontario Health Technology Assessment Series, Phase 1b)
- [C] Pennsylvania Patient Safety Authority (see: Wollitz and Grissinger)
- [D] The Joint Commission
- [E] HumanEra (formerly the Health Technology Safety Research Team; see: Ontario Health Technology Assessment Series)
- [F] Institute for Safe Medication Practices Canada (ISMP Canada; see: Ontario Health Technology Assessment Series)
- [G] Institute for Safe Medication Practices (ISMP)

Additional Resources

American National Standards Institute (ANSI), Association for the Advancement of Medical Instrumentation (AAMI), International Organization for Standardization (ISO).

- Small-bore connectors for liquids and gases in healthcare applications—part 1: general requirements. ANSI/AAMI/ISO 80369-1:2010. Arlington (VA): AAMI; 2011.

Institute for Safe Medication Practices (ISMP).

- IV potassium given epidurally: getting to the "route" of the problem. *Med Saf Alert* 2006 Apr 6;11(7):1-2.

Joint Commission.

- Lines crossed: errors involving multiple IVs. *The Source* 2014 May;12(5):8-11. Available from: www.ingentaconnect.com/content/jcaho/jcts/2014/00000012/00000005/art00004.

Kane-Gill SL, Kirisci L, Verrico MM, et al.

- Analysis of risk factors for adverse drug events in critically ill patients. *Crit Care Med* 2012 Mar;40(3):823-8.

Ontario Health Technology Assessment Series on multiple intravenous infusions—a collaboration between University Health Network's HumanEra (formerly the Health Technology Safety Research Team) and the Institute for Safe Medication Practices Canada (ISMP Canada); for information about this series, see www.hqontario.ca/evidence/publications-and-ohnac-recommendations/ontario-health-technology-assessment-series/MIVI-phase2b.

- Phase 1b: Cassano-Piché A, Fan M, Sabovitch S, et al. Multiple intravenous infusions phase 1b: practice and training scan. 2012 May;12(16):1-132. Available from: www.hqontario.ca/en/eds/tech/pdfs/2012/multipleinfusions1b_May.pdf.
- Mitigating the risks associated with multiple IV infusions: recommendations based on a field study of twelve Ontario hospitals [online]. 2012 Jun [cited 2014 Sep 2]. Available from: http://ehealthinnovation.org/wp-content/uploads/MultipleIVInfusions_Phase1bSummary_Recommendations-and-Rationale_June-20121.pdf.

- ▷ Consider supplying patient gowns with snaps, ties, or Velcro on the shoulders and sleeves to facilitate line tracing and gown changes. (Nonmetallic closures are required for compatibility with magnetic resonance imaging.) [E/F—Phase 1b, Phases 2a and 2b recommendations]

For epidural infusions in particular, also consider the following approaches:

- ▷ Using yellow-lined tubing without injection ports. [G]
- ▷ Placing the pump for an epidural infusion on the opposite side of the patient from pumps used for IV medications/solutions. [G]
- ▷ Using a different model pump for epidural infusions than that used for IV infusions. [G]

Additional Resources (continued)

- Phase 2a: Fan M, Koczmara C, Masino C, et al. Multiple intravenous infusions phase 2a: Ontario survey. 2014 May;14(4):1-141. Available from: www.hqontario.ca/Portals/0/Documents/eds/ohtas/full-report-phase2a-mivi-140505-en.pdf.
- Phase 2b: Pinkney S, Fan M, Chan K, et al. Multiple intravenous infusions phase 2b: laboratory study. 2014 May;14(5):1-163. Available from: www.hqontario.ca/Portals/0/Documents/eds/ohtas/full-report-phase2b-mivi-140505-en.pdf.
- Phases 2a and 2b recommendations: Ontario Health Technology Advisory Committee (OHTAC). Multiple intravenous infusions phases 2a and 2b: OHTAC recommendation. Toronto: Queen's Printer for Ontario; 2014 May. Available from: www.hqontario.ca/Portals/0/Documents/eds/ohtas/recommendation-mivi-140505-en.pdf.

Wollitz, A, Grissinger, M.

- Aligning the lines: an analysis of IV line errors. *Pa Patient Saf Advis* 2014 Mar;11(1):1-7. Available from: [http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2014/Mar;11\(1\)/Pages/01.aspx](http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2014/Mar;11(1)/Pages/01.aspx).

NEW CONNECTOR STANDARDS ARE NOT A PANACEA

New connector standards are being developed to reduce the risk that tubing from one delivery system would be misconnected to a system that is intended for a different purpose (e.g., an enteral feeding pump being misconnected to an IV line)—a hazard facilitated by the use of Luer connectors for multiple applications. The new standards—the ANSI/AAMI/ISO 80369 series—define unique connector designs for several specific applications to prevent the cross-compatibility of connectors for those applications. For example, an enteral feeding connector designed according to the new standard would not be physically compatible with the Luer connector on an IV line. (Enteral connectors that conform to the standard will be the first of the new connector designs on the market. For more information, see the Stay Connected website of the Global Enteral Device Supplier Association [GEDSA]: www.stayconnected2014.org/index.html. Also see “Fixing Bad Links to Prevent Tubing Misconnections” in the November 2014 PSO Navigator, produced by ECRI Institute PSO.)

However, even once all the connector standards have been implemented, it will still be possible to connect an IV infusion line to the wrong fluid container, to install it in the wrong infusion pump or pump channel, or to connect it to the wrong (Luer-based) administration route.



Trace existing lines from source to site

Read existing line labels

Affix labels when/where required

Connect compatible lines without forcing or adapting

Examine the new connection

Retrace and confirm source to site

Be a **T.R.A.C.E.R.**TM
not a **RACER!**