Aseptic Violations with Push-Pull and Disconnect-Reconnect Fluid Infusion Techniques

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Introduction

Fluid resuscitation is frequently used in the treatment of pediatric septic shock. The American College of Critical Care Medicine (ACCM) guidelines recommend early and rapid delivery of 20 ml/kg fluid boluses targeted at the reversal of shock.[1] Adhering to these fluid delivery guidelines has been shown to reduce mortality, organ dysfunction, length of hospital stay, and is a main component of sepsis bundles.[2-4] Unfortunately, the recommended guidelines are often not met due to the technical barriers of fluid delivery, including slow infusion rates and complex or inefficient methods.[2,5,6]

The disconnect-reconnect technique (DRT) and push-pull technique (PPT) are commonly used to deliver fluid boluses to pediatric patients with septic shock.[10] Maintaining aseptic technique while using these methods is challenging as both methods include many steps in which syringes, stopcocks, and tubing can become contaminated. Repeated use of the sterile disposable syringes in both techniques increases the possibility of exposure to pathogens from the provider's hands and the environment. Numerous studies have demonstrated that pathogens are easily transferred from contaminated gloves into the fluid being infused. [7-9] These contamination risks are directly related to the number of syringe plunger strokes.[7] This contamination potentially increases the risk for hospital-acquired infection. The objective of this study was to evaluate the average number of aseptic violations that occur during the use of both DRT and PPT.

Methods and Materials

Aseptic Technique Violations

Four pediatric critical care nurses were asked to deliver 500 mL of saline to a simulated 25 kg patient through a 22G IV catheter using both the PPT and DRT techniques. Aseptic violations were recorded by an independent observer.

Procedure:

- Clinicians were informed that they will be observed infusing 500 mL as quickly as possible, and that their infusion times would be recorded.
- Clinicians were specifically asked to use aseptic technique during infusion and provided gloves and alcohol wipes, but were not specifically informed that aseptic technique was being observed.
- Clinicians were given their choice of setup (i.e. syringe size, IV tubing, and stopcock) for both PPT and DRT.
- Clinicians were video-recorded while pulling fluid from the bag and delivering fluid to the simulated patient during the use of both techniques.

Benchtop Demonstration of Syringe Contamination

Fluorescein dye was applied to the rib of the 20 mL syringe plunger and cycled to simulate a 500 mL bolus (Figure 1a-c). Photographs were taken under ultraviolet light.

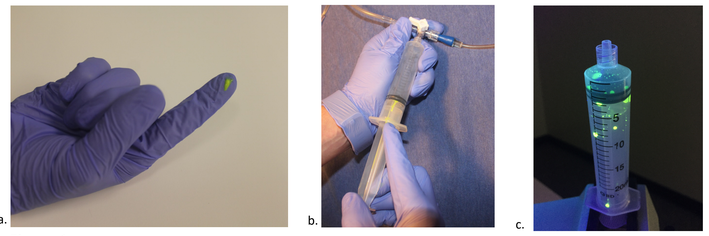


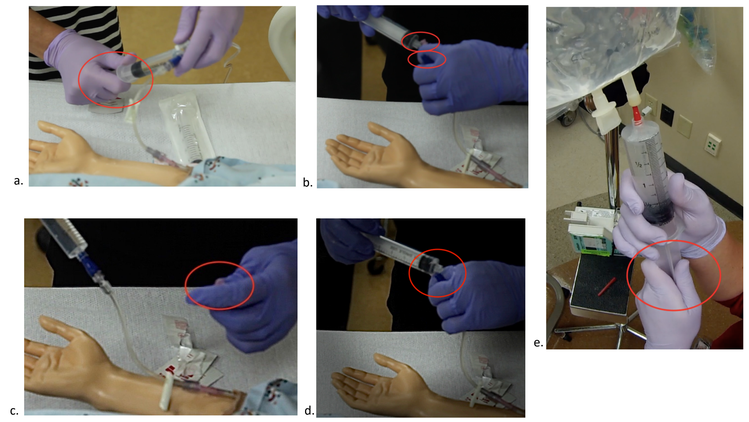
Figure 1.

Results

An average of 31 (SD=28) and 20 (SD=10.5) aseptic violations per study participant (n=4) were observed during the 500 mL bolus administration using both DRT and PPT respectively. The majority of observed violations occurred due to hand contact with the sterile portion of the plunger. The other common violation was missing the connection when attaching a reused syringe to a patient's IV needleless connector, therefore potentially contaminating tip of the syringe and subsequently the patient's IV tubing. Photographs showed fluorescein present inside the syringe (Figure 1a-d), which demonstrates how contaminants can travel through the syringe when aseptic technique is violated.

Figure 2.

The images in Figure 2 highlight the numerous aseptic violations a clinician could make during both PPT and DRT. Images a and e are examples of syringe plunger violations in both techniques, image b and d are examples of a clinician missing their fill needle connector and patient's needleless connector when attempting to reconnect the syringe. Image c is an example of a clinician contaminating their fill needle connector.



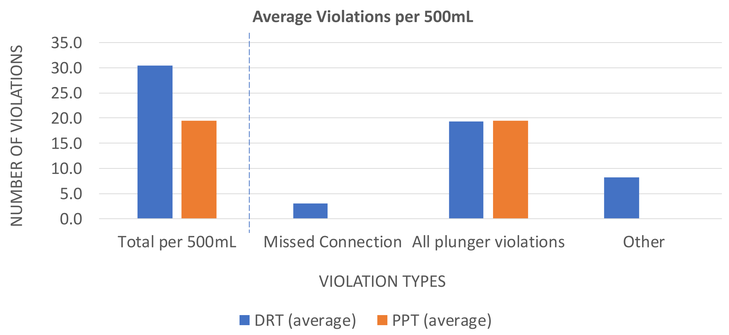


Figure 3.

Discussion

All clinicians in this study frequently violated aseptic technique. The most common aseptic violation, regardless of fluid delivery technique, was repeatedly touching the sterile portion of the syringe plunger. Within this sample of clinicians, there was no difference between DRT and PPT, which had averages of 31 and 20 (P=0.9) aseptic violations per participant respectively. As seen in Figure 2a-e, there are a variety of techniques utilized for pulling and pushing the plunger when performing PPT and DRT. The manner in which DRT is performed provides clinicians with many opportunities to violate aseptic technique. While PPT offers fewer distinct opportunities for aseptic violations, the same violations are repeated frequently. Figure 3 Demonstrates the total number of violations by infusion technique as well as the total average violations for both PPT and DRT. Previous research has shown that the repeated contact of the syringe plunger with a gloved hand causes bacteria to travel into the fluid which is then infused into the patient. [7-9]

The other common violation was missing the connection, "bouncing", when attaching a syringe to a patient's IV needleless connector, therefore potentially contaminating the tip of the syringe and subsequently the patient's IV tubing. Clinicians were also observed contaminating their fill needle (Figure 2c) while not in use, and exposing the tip of the syringe to potential contamination. Participants in this simulation were told that they were being timed, however in a true emergent scenario a clinician might be much more hurried which could decrease their ability to precisely and sterilely attach the syringe to the patient's needleless connector.

In this simulated scenario, each clinician was given their choice of DRT setup. Three of four clinicians chose to connect to the bag with an 18G sharp, or filtered, fill needle to pull fluid from the IV bags. The fourth clinician chose to spike the bag with an IV line and used that to fill their syringe. It is recognized that each hospital might have a protocolized setup for DRT, but the reuse of syringes and needles is still being widely used in clinical practice. There are other methods for fluid delivery that eliminate the reuse of syringes and needles. Some examples are: prefilled or factory filled syringes, or LifeFlow. The LifeFlow syringe is enclosed beneath a clear canopy, preventing inadvertent contamination.

Limitations and Next Steps

Limitations

- Small sample size of n=4
- Simulation was not a true representation of a clinical emergency

Next Steps

- Increase number of clinician participation
- Increase emergent nature of the simulation

Conclusions

Unintentional violations of aseptic technique are common during rapid fluid resuscitation with DRT and PPT, two frequently used techniques, potentially increasing the risk of nosocomial infection when using these methods. This highlights the need for an alternate technique for the rapid and measured delivery of fluid boluses for children with septic shock. Preventing contact with the syringe plunger, and minimizing the number of times a syringe is connected to an IV tubing without cleaning the connector would reduce the risk of contamination when rapidly infusing fluids.

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References

1. Davis AL, Carcillo JA, Aneja RK, et al. American College of Critical Care Medicine Clinical Practice Parameters for Hemodynamic Support of Pediatric and Neonatal Septic Shock. *Crit Care Med.* 2017;45(6):1061-1093.
2. Paul R, Neuman MI, Monuteaux MC, Melendez E. Adherence to PALS Sepsis Guidelines and Hospital Length of Stay. *Pediatrics*. 2012;130(2):e273-e280.
3. Balamuth F, Weiss SL, Fitzgerald JC, et al. Protocolized treatment Is Associated With Decreased Organ Dysfunction in Pediatric Severe Sepsis. *Pediatr Crit Care Med.* 2016;17(9):817-822.
4. Lane RD, Funai T, Reeder R, Larsen GY. High Reliability Pediatric Septic Shock Quality Improvement Initiative and Decreasing Mortality. *Pediatrics*. 2016;138(4):e20154153.
5. Davison D, Basu RK, Goldstein SL, Chawla LS. Fluid management in adults and children: core curriculum 2014. *Am J Kidney Dis*. 2014;63(4):700-712.
6. Stoner MJ, Goodman DG, Cohen DM, Fernandez SA, Hall MW. Rapid fluid resuscitation in pediatrics: testing the American College of Critical Care Medicine Guideline. *Ann Emerg Med*. 2007;50(5):601-607.
7. Oliver LC, Kendorf D, Wolfhard U, Nast-Kolb D, Nazif Yazici M, Esche H. Modified syringe design prevents plunger-related contamination—results of contamination and flow-rate tests. *J Hosp Infect*. 2003;53(2):140-143.
8. Blogg CE, Ramas MA, Jarvis JD. Infection hazard from syringes. *Br J Anaesth*. 1974;46(4):260-262.
9. Chatrath M, Veneracion M, Alby K, Ager E, Gilligan P, Valley R. Intraoperative contamination of fluids by anesthesia providers. Paper presented at: International Assembly for Pediatric Anesthesia 2012; Society of Pediatric Anesthesia. http://www2.pedsanesthesia.org/meetings/2012winter/posters/uploads/136--SO1-109.pdf. Accessed August 6, 2018.
10. Cole ET, Harvey G, Urbanski S, Foster G, Thabane L, Parker MJ. Rapid paediatric fluid resuscitation: a randomised controlled trial comparing the efficiency of two provider-endorsed manual paediatric fluid resuscitation techniques. *BMJ Open* 2014; 4(7):e005028.