Intravenous Infusion Sets (IV Set) In Anesthesia Practice: A Survey On Their Use And A Look Into The Future
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Citation

Abstract

INTRODUCTION
Establishing reliable intravenous infusion is an essential component of anesthesia practice. Infusion of fluids is used to replenish fluid deficit caused by fasting before the surgery, to replace ongoing losses of fluids and as a vehicle to administer intravenous medications and anesthetics (Figure 1). While the advances in technology have brought number of powered infusion devices (infusion pumps), the gravity–driven intravenous infusion sets (Figure 1) remain most prevalent in majority of applications, including anesthesia practice. Commonly cited reasons for the infrequent use of infusion pumps in anesthesia practice are the expense-related to acquisition, expense-related to their maintenance, and the continuing cost of specialized infusion cartridges of IV sets. In addition, the old fashioned gravity-driven infusion sets are much easier and quicker to set-up and more cost-effective.

METHODS
In an attempt to better understand the use and choice of intravenous infusion sets by anesthesiologists, a survey of anesthesiologists was conducted at the annual American Society of Anesthesiologists (ASA) Meeting in Orlando, FL October 1998. One hundred and twenty anesthesiologists who attended the scientific exhibits were asked to complete a questionnaire on use of IV infusion sets in their practice as well as their choice of anesthesia sets for several typical clinical scenarios. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows), v. 5.02 (Chicago, IL, 1993). Responses were summarized as frequencies and percentages (p-value 0.05 was considered significant).

RESULTS
The majority (44%) of the surveyed anesthesiologists practices on the East Coast. The demographic distribution of the surveyed anesthesiologists is presented in Figure 2.

Figure 1

![Figure 1. Intravenous fluid administration in anesthesia](image)

Legend: Intravenous catheter (1) attached to intravenous infusion set (2) is inserted in the operating-room prior to surgery. A roller clamp (3) and macro-drip chamber (4) are used to regulate and monitor the IV flow, respectively.

Figure 2

![Figure 2. Geographic practice location of the surveyed anesthesiologists](image)

The overwhelming majority (90%) of the surveyed anesthesiologists reported that the practitioners in their departments routinely use gravity-driven IV sets rather than
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power infusion pumps. However, their selection between the MICRO drip IV set or MACRO drip IV set (Figure 3) varied considerably in the presented clinical scenarios, (Figures 4, 5 and 6).

**Figure 3**

![Figure 3](image)

**Figure 4**

![Figure 4](image)

**Figure 5**

![Figure 5](image)

**Figure 6**

![Figure 6](image)

Of note, they also reported that they occasionally use both MICRO drip and MACRO drip in the same patient, (Figure 7). The majority of respondents felt that an alternative IV set design (Dual-Drip IV set, Figure 8) with both the MACRO-drip and MICRO-drip chambers combined together in a single IV set, would prove advantageous (Figures 9,10 and 11). The perceived advantages over a Dual-Drip IV set are summarized in Figure 12.
Figure 7. Have you had a need for both the MICRO drip (60 drop/ml) and the MACRO drip (15 drop/ml) for the same patient?

- Yes: 81.0%
- No: 5.0%
- Undecided: 10.0%
- Missing: 4.0%

Figure 8. Dual-Drip IV Set Design with Micro and Micro drips combined.

Figure 10. Would a Dual-Drip infusion system offer any advantages over either the MICRO or MACRO drips in a 70 year old man with DM and history of CHF, who is undergoing metastatic amputation under spinal anesthesia?

- Yes: 85.9%
- No: 3.0%
- Undecided: 10.1%
- Missing: 1.0%

Figure 11. Would a Dual-Drip infusion system offer any advantages over either the MICRO or MACRO drips in a 50 year old man with chronic renal failure undergoing AV graft implantation?

- Yes: 79.0%
- No: 10.0%
- Undecided: 11.0%

Figure 12. The Dual-Drip infusion system has the following advantages over the MICRO or MACRO drip infusion sets:

DISCUSSION

The results of this survey suggest that the old-fashioned
gravity-driven infusion IV sets continue to be the most widely used IV sets by anesthesiologists. However, there is a divergence of preferences when it comes to the choice between the MACRO-drip and MICRO-drip sets. While the majority of anesthesiologists use both sets, their choice of one over the other in the presented clinical circumstances varied. This is so because the MACRO-drip and MICRO-drip sets have inherent advantages and disadvantages over one another, (Figure 13).

In the three typical clinical scenarios presented, there is a disadvantage of fluid over-administration, yet a potential for an emergent need for fluid resuscitation. For instance, in a 70 year old man with DM and history of congestive heart failure (CHF), who is undergoing a minor surgery under spinal anesthesia, over administration of fluids can be hazardous and it may precipitate CHF, thus a MICRO-drip would seem to be better suited in this case as it carries less risk of accidental fluid overload. However, the hypotension which commonly occurs after spinal anesthesia may require treatment with fluid boluses, a scenario in which a MACRO-drip would be required as the fluid delivery through a MICRO-drip is inadequate for fast fluid administration (Figure 4). Similarly, intracranial or lung surgery both require fluid restriction to prevent brain edema or “wet lungs” postoperatively, making a MICRO-drip appealing in these patients. However, at the same time these surgeries may result in an unexpected, sudden and substantial blood loss requiring larger boluses of fluids to replenish the intravascular volume, a scenario in which a MACRO drip would be necessary. Furthermore, central venous catheterization for the purpose of monitoring the fluid status or vascular access (CVP, pulmonary artery catheters, VAS-caths, etc) are a common place in anesthesia practice. These ports routinely require a continuous IV flow to prevent clotting where a MICRO-drip IV set would be suitable. When the need for treatment with fluid boluses or higher infusion rates arise, MICRO-drip proves inadequate and MACRO-drip is a necessity. However, when larger volumes of fluid are not required, the presence of a MACRO-drip IV set connected to a large bore IV port, such as a CVP or pulmonary artery catheter, carries a risk of accidental fluid overload. In the presented Dual-Drip design where both the MICRO-drip and MACRO-drip are incorporated in a single IV set (Figure 8), the inherent limitations and strengths of both the MACRO-drip and MICRO-drip IV sets combine into a convenient and flexible IV fluid administration set (Figure 12). For instance, when fluid restriction is required, the MACRO-drip is clamped off and only the MICRO-drip is used. The infusion rate is regulated by a roller clamp in the MICRO-drip path, identically to that in a conventional MICRO-drip IV sets. On the other hand, when the higher infusion rates or fluid boluses are required, the MACRO-drip is unclamped and the infusion rate is regulated by a roller clamp. Once the need for higher fluid rates ceases, the infusion through the MACRO-drip is stopped again and the infusion through the MICRO-drip spontaneously resumes at the set rate (\(1\)).

CONCLUSIONS

Reliable and convenient intravenous infusion systems are among the most important aspects of anesthesia care. Anesthesiologists spend considerable time and effort staring IV infusion, regulating infusion rate, administering fluid boluses, monitoring infusion rate and making sure that the medications injected through the ports in the IV sets get reliably “flushed” into the patient’s circulation. With estimated 25 million surgeries per year, 50 million office base intravenous infusions, 40 million emergency room admissions and some 45 million hospital admissions (\(2\)), it is almost certain that the use of more flexible IV sets would result in an increased safety with their use and a reduction in labor-intensity related to their use and monitoring. Additionally, in addition to more comfort with their use, more flexible sets could also result in substantial cost savings by saving space and stocking costs through reduction in the need to stock several different IV sets (Figure 14). Additionally, their use would also eliminate the need to switch between sets (e.g., substituting MICRO for MACRO drips and vice versa), as well as eliminate the costs of wasted sets and the need to purchase costly specialty kits.
In summary, the gravity-driven IV infusion sets remain the most commonly used IV sets in anesthesia practice. Our survey clearly indicates that the present design of gravity IV infusion sets have inherent limitations and that anesthesiologists combine various sets even in a single patient in order to meet their infusion needs. Although the power infusion systems could potentially resolve some of the limitations of the currently used MACRO and MICRO drip sets, their use is uncommon, more expensive and labor intensive in anesthesia practice. A new and more flexible design is suggested whose use has a potential to significantly increase the safety and comfort, as suggested by the results in this survey. Dual-Drip IV set design appears to be perceived as a very practical improvement over the existing IV set (Figure 15). The indications for its use are best exemplified in clinical situations in which administration of IV fluids is undesirable or contraindicated, but where the ability to fluid-resuscitate must be immediately available. However, the Dual-Drip design should offer advantages over the existing sets beyond the operating room, such as emergency rooms, cardiac catheterization and pulmonary laboratories, GI endoscopy suites, EMS (ambulances), military (field), MRI suites and CT scans to name a few.

References
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