Introduction

- The administration of intravenous (IV) medications in a low volume may result in large variability in the quantity of drug entering a patient’s circulation.\(^1\)
- We describe variability in drug delivery when injection volumes of \(\leq 0.5\) mL are administered by attending pediatric anesthesiologists and post-anesthesia care unit (PACU) nurses.

Methods

- 10 attending pediatric anesthesiologists and 10 pediatric PACU nurses performed a series of 10 injections into a simulated patient IV setup (Figure 1).
- Using 1 mL tuberculin syringes, participants injected 5 different volumes in random order (0.025 mL, 0.05 mL, 0.1 mL, 0.25 mL, 0.5 mL). All injections were performed in duplicate. Each volume contained 0.25 millimolar Lucifer Yellow fluorescent dye. Injections were performed into separate three-way stopcocks, which were then flushed into collection vials with 10 mL of 0.9% sodium chloride.
- We used microplate fluorescence wavelength detection (Tecan, Infinite M1000; Manndorf, Switzerland) to determine the concentration of dye in the collected fluid. A standard reference curve was utilized to calculate injection volumes.
- We determined the proportional injection volume variability across the five different injection volumes using the log proportional error \(\log(\text{injected volume}/\text{intended volume})\).

Results

- Substantial under- and over-doses occurred in all injection volume groups (Table 1, Figure 2a).
- Decreasing injection volumes were associated with higher volume administration variability (Figure 2b).
- No variation between PACU nurse or physician injection variability was detected (Wilcoxon Rank Sum)
- Inter-individual injection volume variation is dramatic

Table 1. Injection volume variability

<table>
<thead>
<tr>
<th>Intended Injection Volume, mL</th>
<th>0.025 mL</th>
<th>0.05 mL</th>
<th>0.1 mL</th>
<th>0.25 mL</th>
<th>0.5 mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median ((\text{QQR})), mL</td>
<td>0.036 (0.034-0.038)</td>
<td>0.063 (0.045-0.077)</td>
<td>0.104 (0.07-0.13)</td>
<td>0.224 (0.20-0.26)</td>
<td>0.48 (0.43-0.51)</td>
</tr>
<tr>
<td>Volume, mL</td>
<td>0.111</td>
<td>0.305</td>
<td>0.314</td>
<td>0.28</td>
<td>0.065</td>
</tr>
<tr>
<td>Log (vol/int vol)</td>
<td>0.382</td>
<td>0.272</td>
<td>-0.003</td>
<td>-0.103</td>
<td>-0.002</td>
</tr>
<tr>
<td>Robust SD*</td>
<td>1.223</td>
<td>0.949</td>
<td>0.345</td>
<td>0.151</td>
<td>0.204</td>
</tr>
</tbody>
</table>

*Values from www.ihricharts.com

Conclusions

- Substantial, potentially clinically significant, dose variation exists for injection volumes less than or equal to 0.5 mL.
- Administering low volumes of highly concentrated medications may result in unintended medication administration errors.

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Figure 1

Figure 2a

Figure 2b