

# SYRINGE DESIGN INFLUENCES INFUSION ERRORS DUE TO CHANGES IN PUMP HEIGHT

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**Introduction:** At low flow rates, syringe pumps exhibit some undesirable characteristics such as slow start-up to deliver at the set rate, prolonged time to alarm on line occlusion, release of bolus volume on removal of line occlusion and transient flow error on change in pump height.<sup>1-3</sup> These phenomena are due to the compliance of the fluid circuit. To assess the influence of the compliant syringe plunger component on infusion rates, infusion delivery using a standard syringe was compared with an identical system where the rubber plunger was replaced by a plunger constructed using non-compliant plastic.

**Method:** An infusion system was tested using a TOP-5100 syringe pump, 60ml BD Plastipak® disposable syringe and an Alaris® 1.5m extension line with internal diameter 1.5mm (CareFusion, San Diego, CA). The syringe was primed with water at 20°C, connected to a primed extension line and inserted into the pump. The pump was set to infuse at 3ml/h. The rate of flow was measured using precision digital weighing.<sup>4</sup> The time from starting the infusion at 3ml/h to actually achieving that infusion rate was measured as the start-up time (A). The pump was then lowered by 24" (B) and the time until flow returned to the set rate was measured (C). The pump was then returned to its original height (D) and again the time until flow returned to the set rate was measured (E). The measured times were compared for an infusion set with a rubber plunger and an identical set with a non-compliant plunger. For both systems the time to alarm on line occlusion was measured along with the bolus volume produced by removing the occlusion.

**Results:** Data are shown for both the rubber (light color) and non-compliant (dark color) plungers. Start-up time for the rigid plunger system was 60s compared to 470s for the rubber plunger system. On lifting the pump back to reference height, the rigid plunger system produced a fluid bolus of 0.05ml compared to ca. 0.1ml for the rubber plunger system. The time-to-alarm on occlusion for the rubber plunger system was 18 minutes 20 seconds with a bolus of 0.63ml released when occlusion stopped, compared with 9 minutes 55 seconds and 0.25ml for the non-compliant plunger.

**Conclusion:** Infusion rates observed were closer to the desired rate for all conditions tested when the noncompliant plastic plunger was used. Observed errors even with the non-compliant syringe suggest that other factors also influence compliance and infusion performance. These variations in infusion rate can have undesirable consequences especially for concentrated potent vasoactive infusions given to small patients. Further investigation to optimize infusion pump design is indicated.

## References

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