The amounts of fluid delivered from the primary, from the secondary outcomes were the flow rates from primary and secondary containers over time.

The primary outcome measure was the total volume of fluid delivered from the primary bag in relation to the pump was per the user manual (24 inches) head-height differentials and secondary flow rates.

For all testing, the height differential of the secondary bag in relation to the pump was per the user manual (24 inches) head-height differentials and secondary flow rates.

In all head-height differentials, the secondary infusion was infused at 100, 200, 300, 400, or 500 mL/hr.

For all testing, the height differential of the secondary bag in relation to the pump was per the user manual (24 inches) head-height differentials and secondary flow rates.

At each head-height differential, the secondary infusion was infused at 100, 200, 300, 400, or 500 mL/hr.

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The secondary outcomes were the flow rates from primary and secondary containers over time.

The amounts of fluid delivered from the primary, from the secondary, and to the outlet beaker were each recorded continuously per gravimetric methods in IEC-60601-2-24.

### Methods

- **Two identical, commercially available infusion pumps utilizing administration sets with back-check valves were selected**
- The pumps were programmed to deliver secondary infusions at head-height differentials of 0, 4, 8, 16, or 20 inches
- At each head-height differential, the secondary infusion was infused at 100, 200, 300, 400, or 500 mL/hr.
- For all testing, the height differential of the secondary bag in relation to the pump was per the user manual (24 inches)
- The primary outcome measure was the total volume of fluid delivered from the primary bag in relation to the pump was per the user manual (24 inches) head-height differentials and secondary flow rates.
- The secondary outcomes were the flow rates from primary and secondary containers over time.
- The amounts of fluid delivered from the primary, from the secondary, and to the outlet beaker were each recorded continuously per gravimetric methods in IEC-60601-2-24.

### Purpose

- **To evaluate whether back-check valve failure and unintended primary flow occurs at clinically relevant combinations of head-height differentials and secondary flow rates**

### Results

- **Test configuration**
- **Sympathetic flow as a % of total delivered fluid**
- **Programmed secondary infusion rate 500 mL/hr**
- **Head-height differential 8 inches**

### Conclusions

- During a programmed secondary infusion via a peristaltic pump, sympathetic flow from the primary bag was observed with decreasing head-height differentials and increasing programmed secondary flow rates.
- Unintended sympathetic flow occurred with both pumps consistently when flow rates increased and head-heights decreased.
- High flow rates lead to sympathetic flow even when head-height differential aligned to manufacturer recommendations.
- In clinical circumstances when bag position options may be constrained, lower head-height differentials may lead to incomplete closure of the back-check valve and significant sympathetic flow.
- The potential patient impacts from sympathetic flow are delayed secondary medication administration, delivery of the primary fluid at the programmed secondary rate, and clinician confusion on remaining secondary fluid after a “completed” programmed piggyback infusion.
- Further studies are required to confirm and evaluate the clinical significance of these results.

### Directions for further study

- Obtain data from an increased number of pumps and administration sets with the studied infusion platform.
- Expansion of testing to other peristaltic pumps and administration sets.
- Evaluation of results with consideration of pumping mechanism, back-check valve manufacturer, secondary connector.
- Expansion of research to clinical observations of secondary head-heights and programmed secondary rates.

### References

1. Cassano-Piché A, Fan M, Sabovitch S, Masino C, Easty AC, Health Technology Safety Research Team, Clinical Effectiveness & Safety. "Completed" programmed piggyback infusion. "sympathetic flow" from the primary container was delayed secondary medication administration, delivery of the primary fluid at the programmed secondary rate, and clinician confusion on remaining secondary fluid after a “completed” programmed piggyback infusion. Further studies are required to confirm and evaluate the clinical significance of these results.

- Evaluation of results with consideration of pumping mechanism, back-check valve manufacturer, secondary connector.

- Expansion of research to clinical observations of secondary head-heights and programmed secondary rates.

**REFERENCES**

1. Cassano-Piché A, Fan M, Sabovitch S, Masino C, Easty AC, Health Technology Safety Research Team, Clinical Effectiveness & Safety. "Completed" programmed piggyback infusion. "sympathetic flow" from the primary container was delayed secondary medication administration, delivery of the primary fluid at the programmed secondary rate, and clinician confusion on remaining secondary fluid after a “completed” programmed piggyback infusion. Further studies are required to confirm and evaluate the clinical significance of these results.

- Evaluation of results with consideration of pumping mechanism, back-check valve manufacturer, secondary connector.

- Expansion of research to clinical observations of secondary head-heights and programmed secondary rates.

**CONFIRMED**

- Evaluation of results with consideration of pumping mechanism, back-check valve manufacturer, secondary connector.

- Expansion of research to clinical observations of secondary head-heights and programmed secondary rates.

**DIRECTOR**

- Evaluation of results with consideration of pumping mechanism, back-check valve manufacturer, secondary connector.

- Expansion of research to clinical observations of secondary head-heights and programmed secondary rates.