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A SIMULATION STUDY ON THE PERFORMANCE AND SAFETY OF VARIOUS INFUSION DEVICES IN CLINICALLY POSSIBLE VIBRATION SITUATIONS

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Introduction

- Infusion devices are frequently used when transferring critically ill patients using various measures including moving cart, ambulance, or helicopter. However, the performance of various infusion devices has not been explored under these circumstances.

Objective/Aims

- We aimed to evaluate the performance of the infusion devices under clinically possible vibration conditions.

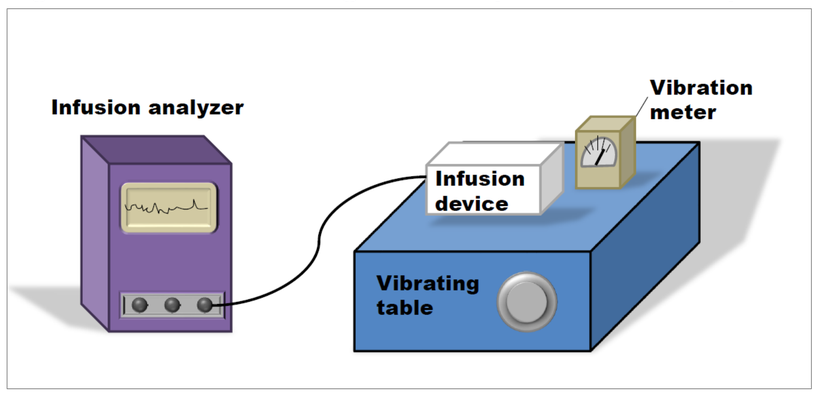
Methods

- ***Study design***

Experiments were conducted using four different types of pumps; two conventional syringe pumps (Injectomat MC Agilia, Fresenius Kabi and TE-331, Terumo) and one conventional infusion pump (Volumed μVP 7000, Arcomed), and a new-generation cylinder pump (H-100, Meinntech) which is a convertible infusion and syringe pump.

Flow rate was measured using the infusion pump analyzer (IDA 4 Plus, Fluke biomedical) on a stable table for 1 hour with flow rate of 1 ml/hr and 5 ml/hr.

- **Figure 1. Schematic diagram of experimental set-up**



- ***Study protocol***

Experiments were repeated in the resting state (0 m/s^2), mild vibration (2 m/s^2, a vibration in a moving cart or an ambulance), and moderate vibration (6 m/s^2, reflecting a vibration in a helicopter). Vibration level of the vibrating table was measured using a vibrating meter (VM-6360). Each experiment was repeated five times.

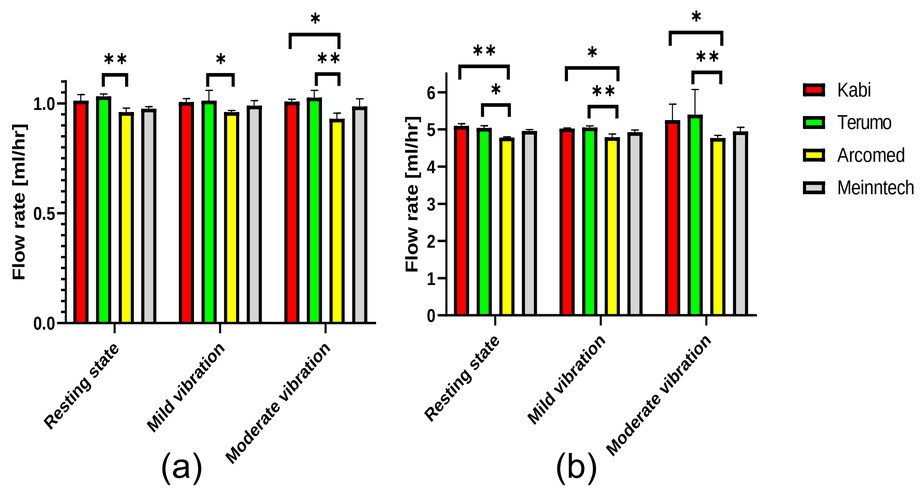
In addition, experiments observing the occurrence of any accidental bolus in an extreme vibrating condition were also performed.

- ***Statistical analysis***

SPSS 25.0 (SPSS Inc. USA) was used for statistical analysis.

Results

- **Figure 2. Average flow rate for various infusion devices with (a) 1ml/hr, (b) 5ml/hr**



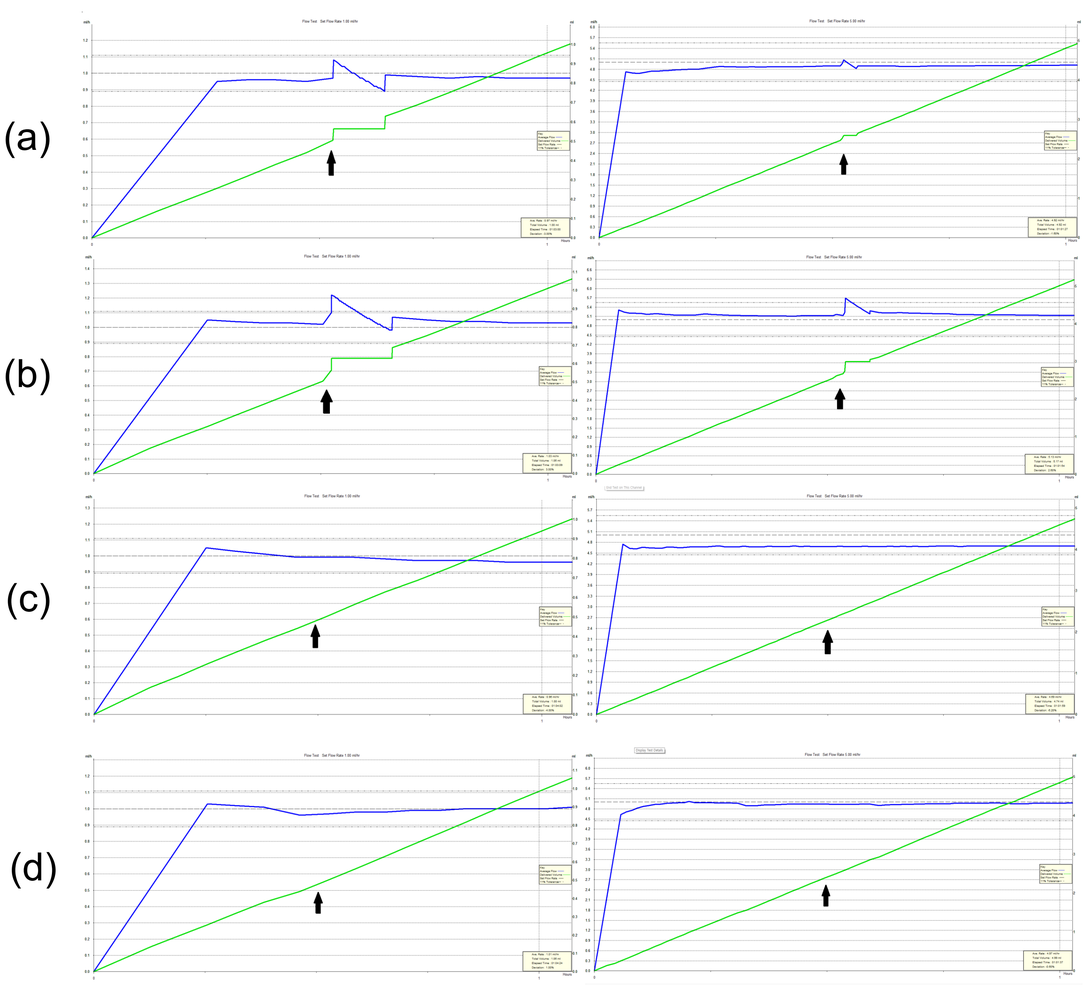
- **Table 1. Performance of various infusion devices.**

	Manufacturer	Vibration state			P-value
		Resting	Mild	Moderate	
1ml/hr	Kabi	1.01±0.03	1.01±0.02	1.01±0.01	0.88
	Terumo	1.03±0.01	1.01±0.05	1.03±0.03	0.66
	Arcomed	0.96±0.02	0.96±0.01	0.93±0.03	0.33
	Meinntech	0.98±0.01	0.99±0.02	0.99±0.03	0.63
5ml/hr	Kabi	5.10±0.06	5.03±0.01	5.25±0.43	0.38
	Terumo	5.04±0.06	5.05±0.04	5.40±0.68	0.31
	Arcomed	4.78±0.02	4.79±0.09	4.77±0.07	0.89
	Meinntech	4.96±0.04	4.92±0.06	4.95±0.11	0.76

The data are expressed as mean ± SD

In the resting state without vibration and the mild vibration condition, all pumps showed comparable results within clinically acceptable error-range. However, in the moderate vibration, an inadvertent bolus dose was injected accidentally in both conventional syringe pumps. In the case of the infusion pump, overall less amount was infused than an intended amount. The new generation cylinder pump showed relatively stable pump performance without an accidental bolus occurrence or under-infusion tendency under vibrations.

- **Figure 3. Hydrograph of inadvertent bolus infusion with flow rate of 1ml/hr (left) and 5ml/hr (right) under extreme vibration situation (Arrow). (a) Kabi, (b) Terumo, (c) Acromed, (d) Meinntech**



Conclusion

Under mild-to-moderate simulated clinical vibration situations, most of the infusion devices worked well. However, there was a slight under-infusion tendency with the conventional infusion pump, and unintentional bolus infusion occurred when the conventional syringe pump was used in a strong vibration, which require a careful attention.

Conflicts of interest: This study was funded by Korea Health Industry Development Institute(KHIDI). No other potential conflict of interest relevant to this article was reported.