Exploring the clinical applications of a multi‑infusion model

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Introduction

Numerous studies show that the administration of drugs is challenging, particularly the intravenous administration of drugs by infusion is often associated with adverse drug events [1,2]. There are many reasons for this, such as the complex pharmacokinetics and pharmacodynamics (PK/PD) of critical drugs. Physiological models incorporating PK/PD-parameters are therefore used to determine the regimen, and in case of intravenous delivery, the infusion dosing rate. However, in recent years, ample evidence has been gathered that the infusion system itself is associated with dosing errors due to ambiguous physical effects, especially in critical care where multiple pumps typically administer drugs through one multiple-in single-out infusion set (multi-infusion) [3]. For this reason we have developed an analytical method to understand the underlying physics of multi-infusion systems. A case can be made that models used to determine intravenous drug delivery approaches in clinical practice should also include physical modeling of the infusion system [4,5]. We therefore aim to explore if our model can be used in clinical practice and how this relates to PK/PD-models already in use for this purpose.

Methods

We developed and validated a multi-infusion model applying basic fluid mechanics and the mechanical properties of infusion hardware to predict the actual drug dosing to the patient. Subsequently, we explored the relevance of using this model in clinical practice.

Results

In order to maximize the applicability of our model, we published the mathematical derivations in an open access journal [6]. The multi-infusion model may be incorporated in existing physiological PK/PD-models used in critical care, e.g. depth of anesthesia predictive control models and target controlled infusion, to improve the actual “administered dose to the patient” parameter, thus providing better results. In general, our model can be used in clinical practice to provide real-time feedback of drug delivery, thereby assisting clinicians in decision-making.

Conclusion

A theoretical multi-infusion model can be used to predict the dosing of drugs to the patient. It is recommended to extend the use of the multi-infusion model towards clinical practice.

References

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