Letters

Identifying occlusions in paediatric intravenous infusion therapy and evaluating impact on systolic blood pressure

Intravenous infusions for neonates often involve fast-acting medication with a short half life. The narrow therapeutic margins require a stable but low infusion flow rate, typically 0.5 mL/hour, which syringe pumps struggle to deliver reliably.1 Infusion alarms are reported2 but the rate of undetected line occlusions and the overall impact remains unclear. Here, we estimate the rate of line occlusions in a paediatric intensive care unit (PICU) and the physiological consequences thereof.

We conducted a prospective service evaluation in the cardiac PICU of Freeman Hospital, Newcastle upon Tyne, from March to September 2021. Our aim was to quantify the frequency and impact of line occlusions on our PICU. For infants treated with intravenous epinephrine by syringe pump, we recorded the infusion line pressure (ILP) from the syringe pump and simultaneous invasive systolic blood pressure (SBP) where available from the patient monitor. Given that this work was conceived as a service evaluation, data were collected anonymously and without corroborating demographic or clinical details.

Occlusions are characterised by a progressive increase in line pressure. Four specialist raters were trained on these characteristics using known occlusions in a bench model. Each ILP record was then assessed independently and in a random order to mark candidate occlusion events. Events marked by consensus of all four raters are reported.

We recorded 929 hours of data from 36 sessions in 13 infants. There were 167 candidate occlusions, of which 48 were by consensus. Despite a mean duration of 13 min and one lasting over an hour, only three occlusions raised a syringe pump alarm.

For 29 of the 48 consensus occlusions, simultaneous SBP measurements were available. To assess physiological consequences we measured mean SBP for three 2.5 min epochs (figure 1A, bottom): a baseline immediately before the occlusion started (green), immediately before occlusion release (red) and immediately after occlusion release (blue). We measured SBP changes from green to red due to the occluded epinephrine delivery, and from red to blue on release of the occlusion.

In practice, there are many disturbances to SBP: waking, feeding, crying, etc; nonetheless, a physiologically important effect on SBP ought to stand out against the background variability from the entire session. We defined background variability by repeating the calculation described above for the entire SBP record. Conceptually, we slid the green, red and blue epochs together from beginning to end of the data set, repeating the calculations at each point. Figure 1B, C provide examples.

In vitro models offer detailed assessment of technical issues such as start-up delay and erratic delivery,1 but spontaneous line occlusions can only be assessed in clinical practice. Here we report 48 occlusion events in 929 hours of data, 1 per 19 hours of syringe pump use.

Since the half life of epinephrine in vivo is only 2.5 min, even short-term disruptions to delivery may be detrimental. Yet, statistically abnormal variability was apparent in just four of the 29 pertinent occlusions. Here the effect was most pronounced on release of the occlusion, where the raised line pressure may deliver the ‘missing’ epinephrine as a bolus (figure 1C).

Finally, we note that only three of 48 unambiguous events were detected by built-in infusion alarms. We suggest that there is scope for improvement, technically and/or clinically. In the mean time, our data shed light on a source of unexplained haemodynamic instability in the PICU which should be the subject of further investigation.

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Figure 1  A pressure rise showing an unequivocal line occlusion lasting 7 min with corresponding systolic blood pressure (SBP) (A). The SBP decreases after occlusion starts (t=91 min) then rapidly rises as occlusion is released (t=98 min). Change in SBP due to the occlusion (A—green to red), in the context of background variability, is illustrated in B. A fall of 27 mm Hg (B—orange line) is presented against SBP variability for the entire infusion session (blue histogram). C displays the change in SBP immediately after the release (A—red to blue). A 37 mm Hg rise (C—purple line) was calculated and is presented against the session background variability provided by the alike calculation (blue histogram).
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