Innovation in neonatology

Authors' reply

In the *Lancet Child & Adolescent Health* Commission on the future of neonatology, Daniele De Luca and colleagues call for innovation to close evidence gaps and reduce preventable neonatal deaths.[1] However, one crucial dimension of safety remains overlooked: the precision of intravenous infusion therapy.

For millions of sick and preterm neonates, life-sustaining therapy depends on continuous infusions, often under 5 mL/h, where prescribed, programmed, and delivered doses can diverge substantially. Start-up delays could exceed 60 min, multi-infusion setups risk retrograde flow or inadvertent boluses, and partial or complete occlusions might remain undetected for hours.[2,3] Even with advanced pumps, up to 30% of the intended drug might not reach the neonate during the early phase of infusion, undermining stabilisation and increasing risk of harm.[2]

At these ultra-low flow rates, small disruptions in delivering vasoactive drugs, sedatives, insulin, prostaglandins, or antibiotics can destabilise perfusion, worsen ventilatory desynchrony, impair metabolism, and increase the risk of cerebral haemorrhage.[4] Today's pumps infer flow rather than measure it, effectively leaving a crucial information gap at the point where therapy reaches the patient..[1]

The Commission warns against generalising context-specific interventions, such as antenatal steroids or hypothermia.[1] In contrast, the risks of infusion variability are universal: whether in low-resource neonatal intensive care units without advanced pumps or in high-income neonatal intensive care units using state-of-the-art technology, neonates face identical, hidden threats to therapy precision. Reducing the risk of infusion variability represents a context-neutral safety improvement across all settings.

Advances in non-invasive sensor technology now enable direct, bedside verification of intravenous infusion using external flow sensors clipped onto standard tubing. Preclinical studies demonstrate an accuracy within 2% at flow rates as low as 0·1 mL/h, outperforming syringe pumps.[5] At bedside, these sensors reveal startup delays, hidden occlusions, kinks, and retrograde flow, while providing continuous exportable data that improve titration, reduce manual checks, and support safety and quality initiatives.

The Commission urges innovation through research and collaboration. Real-time infusion monitoring embodies this call to action: we must quantify infusion variability, establish alarm taxonomies, and embed monitoring into training and guidelines. Multidisciplinary partnerships are essential to make neonatal drug delivery visible and safe.

Integrating real-time monitoring with smart pumps opens the door to closed-loop infusion systems, where delivery dynamically responds to physiological changes. Such systems would enable individualised, data-driven dosing, predictive modelling, and improved outcomes—directly aligning with the Commission's call for innovation and precision.[1,4]

Neonatology cannot claim precision medicine while remaining blind to what reaches the infant. Real-time flow monitoring transforms an invisible risk, enabling timely intervention, empowering nurses, reassuring families, and improving equity of care, in line with the Commission's vision.

We declare no competing interests.

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4 Zhang L, Yang Y, Bertos GA, Liu C, Hu H. Bio-inspired micromachined volumetric flow sensor with a big dynamic range for intravenous systems. *Sensors* 2022; **23:** 234.
5 Sherwin CM, Medlicott NJ, Reith DM, Broadbent RS. Intravenous drug delivery in neonates: lessons learnt. *Arch Dis Child* 2014; **99:** 590–94.