Reality or singular pipe dream?

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Zhou and colleagues,¹ in a prototype proof-of-concept study, have introduced a transapical dual-lumen cannula with inflow below and outflow above the aortic valve for the purpose of providing a “better” option of neonatal left ventricular assist device support.¹ By using 6 neonatal lambs and a paracorporeal centrifugal pump, they demonstrated good support and no complications. Duration of support was 6 hours. I am respectful of this group and their work, and I thank them for their present effort focused on neonates.

In part, this concept has been demonstrated with devices currently being used for adults, the latter albeit without the transapical approach.²⁻⁴ Assuming the approach works well, one can debate the merits of a single-cannula paracorporeal system versus other neonatal support options (eg, extracorporeal membrane oxygenation, other dual cannulation, paracorporeal nonextracorporeal membrane oxygenation strategies). I will not focus on the many viewpoints that may exist on this issue.

My primary concern with this cannula is the transition from the latitude afforded by a proof-of-concept context to its actual application and validity in a human neonate. The body of the cannula housing the inflow is 6 mm (cross-sectional area of 28.3 mm²), and the diameter of the infusion cannula is 4.3 mm (area of 14.5 mm²). The aortic annular diameter of the neonatal lambs in this study was approximately 14 mm, which also approximates the distance in diastole between the anterior mitral leaflet and the outflow septum (wherein the inflow portion of cannula resides). The corresponding figure for a typical 3.5-kg human neonate is approximately 7 mm. This translates to a 4-fold increase in the fractional cross-sectional area occupied by the pump within the outflow tract, valve, or aorta: 18% for the lamb and 73% for a human neonate. No doubt, the authors recognize the risk this poses of (1) inadequate drainage because of size constraints; (2) injury to the mitral valve or subvalve apparatus; or (3) injury to the aortic valve or aortic insufficiency. Can the catheter be downsized 4-fold or to a degree to allow it to function safely and effectively?

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Central Message

Although theoretically appealing, a neonatal single-cannula left ventricular assist device strategy is anatomically constrained. Further data are required using a more appropriately sized animal model and duration of support.

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If so, how will the catheter perform over a longer duration of support?

Another potential issue, particularly given the laxity of neonatal soft tissue, is the lever-arm effect. Compared with standard left ventricular assist device apical inflow cannulas, the dual-lumen cannula has more length inside the heart/aorta. Therefore, any motion of the externalized portion will translate to greater motion at the distal (aortic) end of the cannula. This could affect both inflow and outflow performance and the mitral and aortic valves. I trust Zhou and colleagues¹ will consider these issues as their work progresses.

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