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TOWARD PHYSIOLOGIC EXTRACORPOREAL SUPPORT OF THE PREMATURE INFANT: UMBILICAL CORD CANNULATION PROVIDES SUPERIOR OXYGENATOR FLOWS, OXYGEN DELIVERY AND HEMODYNAMIC STABILITY

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Purpose:
ESPI (Extracorporeal Support of the Premature Infant) is a novel system that promotes physiologic development by maintaining the fetus in a sterile fluid medium and providing gas exchange via pumpless arteriovenous ECMO. During the development of ESPI, different cannulation strategies have evolved with the aim to improve circuit flow. This study examined how cannulation strategy affects hemodynamic and oxygen parameters in fetal lambs on ESPI.

Methods:
12 preterm lambs were cannulated at gestational age 105-115 days and supported on ESPI for up to 4 weeks. Experimental groups were distinguished by cannulation strategy: (1) carotid artery outflow and jugular vein inflow (n=4); (2) carotid artery outflow and umbilical vein inflow (n=5); (3) double umbilical artery outflow and umbilical vein inflow (n=3). Circuit flows and pressures were measured continuously, with "flow interruption" defined as circuit flow less than half of mean flow for given hour. Oxygen delivery was calculated as the product of circuit flow and post-oxygenator blood oxygen content.

Results:
Mean length of run was 177±42 hours in Group 1, 477±50 hours in Group 2, and 634±23 hours in Group 3 ($p<0.001$). Mean circuit flows were 67±8 ml/kg*min in Group 1, 92±7 ml/kg*min in Group 2, and 175±11 ml/kg*min in Group 3 ($p<0.001$). Circuit flow to MAP ratio was 6.3±0.7 in Group 1, 8.1±0.9 in Group 2, and 11.3±0.7 in Group 3 ($p=0.01$). Flow interruptions comprised 1.0% of total flow in Group 1, 0.35% in Group 2, and 0.09% in Group 3 ($p=0.04$). Mean total oxygen delivery was 9.0±0.8 ml/kg*min in Group 1, 15.5±1.3 ml/kg*min in Group 2, and 20.7±1.4 ml/kg*min in Group 3 ($p<0.001$).

Conclusions:
We conclude that cannulating two umbilical arteries and one umbilical vein in fetal lambs on ESPI is superior to prior cannulation strategies, optimizing hemodynamic stability and providing circuit flows and oxygen delivery comparable to established *in utero* levels.

Innovation Session (cont.)