Supporting preterm cardiovascular function

B.E. Lingwood, Perinatal Research Centre and UQ Centre for Clinical Research, Faculty of Medicine, The University of Queensland, Royal Brisbane and Women's Hospital, QLD 4029, Australia..

Preterm infants are at high risk of adverse neurodevelopmental outcome. Inadequate cerebral oxygen delivery resulting from poor cardiovascular function is likely to be a significant contributor to preterm brain injury. In this context, improved support of cardiovascular function is integral to improving preterm outcomes. Many of the treatments used to support preterm cardiovascular function are based on adult physiology and may not be appropriate for the unique physiology of the preterm infant.

The preterm heart is structurally immature. Myocytes contain less contractile material than at term and that material is poorly organized. As a result, contractility is reduced and cardiac output is low. In an adult poor contractility would be treated with inotropes. Inotropic support with dopamine and/or dobutamine is a common treatment in preterm babies but there is limited evidence that it is effective. Perhaps the reduced amount of contractile protein present limits the response to inotropes. In addition the sympathetic nervous system has not reached maturity and the expression of beta-adrenoceptors is low, limiting the responses to adrenergic agents.

The expression of the renin-angiotensin system (RAS) in the preterm piglet heart is similar to the term heart. Elements of the RAS are inotropic, pressor and may also help to mature the heart structure more rapidly. This system deserves more attention as a possible target for treatments to support preterm cardiovascular function.

Hypovolemia may contribute to poor preterm cardiovascular function. There is evidence that capillary leakage results in a considerable loss of plasma from the circulation of newborn preterm babies. In addition, the fetus does not need to use vasoconstriction to protect itself against hypothermia as this function is provided by the mother. It is possible that the vasoconstrictor response to acute stimuli does not develop until quite late in gestation and is limited in the preterm infant. This may lead to inappropriate vasodilatation in preterm babies adding a functional component to hypovolemia. We have shown that the preterm piglet has limited ability to compensate for reduced blood volume.

The first line treatment for hypotension in preterm infants is often volume expansion with crystalloid solutions. Even in the adult this has limited efficacy but in a preterm infant with leaky capillaries it is likely to be less effective. We have found that volume expansion with saline does not provide a sustained increase in mean arterial pressure in preterm piglets and may be associated with detrimental effects including edema, acidosis and neuroinflammation. In the presence of hypovolemia, inotropic treatment is less likely to lead to normal function than inotropic treatment in the presence of normovolemia. More effective methods of volume expansion are required.

Effective support of preterm cardiovascular function requires better understanding of preterm cardiovascular physiology so that treatments can target mechanisms that are sufficiently mature to respond.