Letter to the Editor

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Let's use diverse technologies to assess maternal hemodynamics– both *before* and *during* labor and to both *predict* and *prevent* bad outcomes!

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To the Editor,

I read with great interest the observational study recently published in the Journal of Perinatal Medicine by Daniele Farsetti and his colleagues [1] which demonstrates that antepartum increased maternal systemic vascular resistance identifies women at increased risk of delivering babies with a 5-min Apgar <7, an umbilical artery pH <7.1 and/or a base excess >12 mmol/L, or a NICU admission. This elegant study of antenatal maternal hemodynamics supports the thesis that high maternal systemic vascular resistance and low cardiac output (CO) are predictive markers of both chronic fetal growth restriction and acute hypoxic injury during labor.

I am struck, however, that this study does not mention the possibility that the measurement – or at least the *trending* – of maternal CO could also be used *during labor* to protect the fetus from hypoxic injury! Elsewhere, I have proposed that cardiac output-guided maternal positioning could be used to maximize fetal oxygen delivery during labor, when the fetal oxygen supply is at its most precarious [2]. As yet, no one has undertaken the research required to evaluate this possibility. One possible impediment to this research may be that repeated absolute *measurements* of maternal hemodynamics during labor would be far too labor-intensive to be logistically or economically feasible. The other impediment to repeated "hands-on" hemodynamic measurements is that such frequent physical contact might unacceptably interfere with a woman's need for privacy and "space."

Many maternal hemodynamic studies have used labor-intensive single measurements of maternal hemodynamics obtained with either transthoracic echocardiography (TTE) or the USCOM device. The advantage of these labor-intensive techniques is that they produce usefully accurate absolute values for CO and systemic vascular resistance, but the great disadvantage is that they are prohibitively labor-intensive for widespread use over periods of hours – let alone days or weeks. Transthoracic echocardiography has the additional disadvantage that it almost always needs to be performed with the patient tilted to her left side for ease of cardiac imaging, and is therefore probably unsuitable for the routine study of positional changes in maternal CO.

To avoid both the workload and the intrusiveness of repeated absolute measurement of maternal hemodynamics using either TTE or USCOM, I have proposed that the continuous and hands-free *trending* of maternal hemodynamics be performed with "no-touch" technologies such as impedance cardiography [3]. The disadvantage of this technology is that the absolute CO values probably cannot be relied upon (at least at this stage of technological development), but the countervailing enormous advantage is that CO can be trended continuously and that maternal position can be thereby adjusted in real time to maximize fetoplacental oxygenation.

It is time to investigate the possible value of cardiac output-guided maternal positioning for maximizing fetoplacental oxygenation, both in the short term (during labor) and in the long term (during gestation). To cost-effectively perform the necessary research, however – let alone to perform widespread actual therapy – it will be necessary to welcome reliable CO trending technology such as impedance cardiography into our armamentarium, rather than rejecting it either because it is unfamiliar or because it is "inaccurate" in the sense of giving unreliable absolute values. Investigators and clinicians will therefore need to use multiple complementary technologies to assess maternal hemodynamics. Such flexibility will allow us to use both

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accurate absolute values and meaningful trends – whenever each modality is appropriate. We might then use these values and trends to manage patients both *before* and *during* labor and to both *predict* and *prevent* fetal and maternal injury due to fetoplacental hypoxia.

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Conflict of interest: The author knows and has consulted and corresponded extensively with Markus Osypka, PhD, owner of Osypka Medical, Inc. which manufactures and sells the Electrical Cardiometry system of impedance cardiography, which the author used in his research at UCSD from 2008 until 2015. The author does not have and has never had any business or financial relationship with Dr. Osypka.
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