Empowering the disempowered: Remote pregnancy monitoring for hard-to-reach populations

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Tobias R. Kollmann, Professor at Dalhousie University, and Nima Aghaeepour, Professor at Stanford University, examine remote pregnancy monitoring for hard-to-reach populations

Preventing adverse pregnancy outcomes requires knowing which pregnancies are at risk. Remote monitoring offers a transformative solution.

Crisis: Adverse pregnancy and birth outcomes are the longest-standing, deadliest medical disaster of human history [(1)]. Specifically, the leading cause of death in childhood is preterm birth (PTB; < 37 weeks of gestational age (GA)). Currently, one baby is born prematurely every 2 seconds, resulting in 15 million preterm babies in the world every year; 1 million of them die around birth from preterm birth-related complications [(2)].

Preterm birth is also the most significant risk factor for newborn death from infection [(2)]. Globally, over 3 million newborns are diagnosed with severe systemic infections each year, and 800,000 of them die; of those who survive, 1.3 million preterm newborns every year suffer major long-term disabilities such as breathing difficulties, blindness, and cerebral palsy, making preterm birth the leading cause of childhood disability [(3)]. This profound negative impact of preterm birth on health outcomes remains detectable for life as a significantly increased risk of dying compared to term-born age-matched peers [(4)].

In addition, another 2 million babies die before or during birth, i.e., are stillborn [(2)]. Finally, nearly 300,000 mothers die every year due to complications of pregnancy [(2)]. Beyond the tremendous toll this takes on women, children, families, and communities, adverse pregnancy outcomes also cost billions of dollars every single year in healthcare [(5)].

Opportunity: Each adverse pregnancy outcome prevented represents a decades-long opportunity to improve lifelong health and well-being – for both mother and child. Yet, maternal-child health research – particularly focused on pregnancy outcomes – has historically received very little investment across the human lifespan. This gap is not just a challenge; it is a powerful opportunity to lead a transformation in care. Investing in early-stage pregnancy research, particularly in underserved and hard-to-reach communities, will unlock the potential for meaningful interventions that improve outcomes for mothers and babies alike [(1)].

By expanding resources and innovation to these areas, we can ensure that all families benefit from the latest scientific advances, regardless of geography or access to traditional care.

Insight: To transform the current approach from management to primary prevention of adverse pregnancy outcomes, insight into which pregnancies might be at risk is needed early in pregnancy (approximately the first trimester) to provide timely interventions [(1)]. The tools to generate this insight are available. Based on our previous work analyzing the molecular trajectory of more than 100,000 pregnancies, followed by the artificial intelligence (AI)-based extraction of biomarkers from biological samples, we can predict who is at higher risk for adverse pregnancy outcomes. For example, quantification of immune proteins such as the 'Programmed Death Ligand 1' can, during the 1st trimester, predict risk for PTB with 70% accuracy [(6)]. While this early risk stratification represents an advance in insight, it does not (yet) empower the disempowered (hard-to-reach populations), given blood-based biomarker assessment requires invasive blood sampling in medical facilities, followed by costly sample processing (i.e., this is not feasible in remote or resource-constrained settings).

Transformation: To overcome this feasibility hurdle, a recent study in the U.S. demonstrated the feasibility of non-invasive, remote pregnancy monitoring. Specifically, wearable actigraphy devices (~smartwatches) capture deviations from a normal 'clock' of physical activity and sleep changes during pregnancy that signal an increased likelihood of preterm birth early during gestation already, thereby allowing time for possible interventions [(7)]. However, to translate wearable data into actionable insights, the analytical algorithms that produce this insight must be trained using data generated from the target population. This is necessary to avoid erroneous results that introduce bias, which would further compound rather than ameliorate existing inequities. Dalhousie University in Canada and Stanford University in the U.S. have partnered with the Born Strong Initiative to finally generate this data from hard-to-reach populations. The results of this effort are likely to catalyse the transformation of pregnancy care from management to prevention and empower the disempowered.

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