PERSPECTIVES

BIOMEDICINE

Improving care of critically ill newborns

Wireless monitoring of neonates can decrease skin injuries and allow natural mobility

By **Ruth Guinsburg**

The risk factors that can result in the death of newborn infants depend greatly on whether they are born into the developed or the developing world. In the developed world, the infants at greatest risk either have complex malformations or inborn metabolic errors or are extremely preterm infants, at less than 24 weeks of gestation (barely half the normal period). They require a highly technological care environment with complex diagnostic and therapeutic measures (*1*, *2*). In the developing world, infants who are not so premature or critically ill die daily because basic maternal and neonatal care is not available. These infants face problems such as mild prematurity, birthing difficulties, and infections already overcome in structured health systems that fail to be implemented in poor or less developed countries or regions (*3*). The challenge in these areas is to translate what has already been achieved in the developed world in a meaningful and economically viable way. Monitoring of vital signs is essential to support the life of babies who are sick or preterm (or both) as soon as they are born. On page 947 of this issue, the study by Chung *et al.* (*4*) on developing a wireless system to monitor babies in a less invasive manner. This technology is part of a frontier in which physics,

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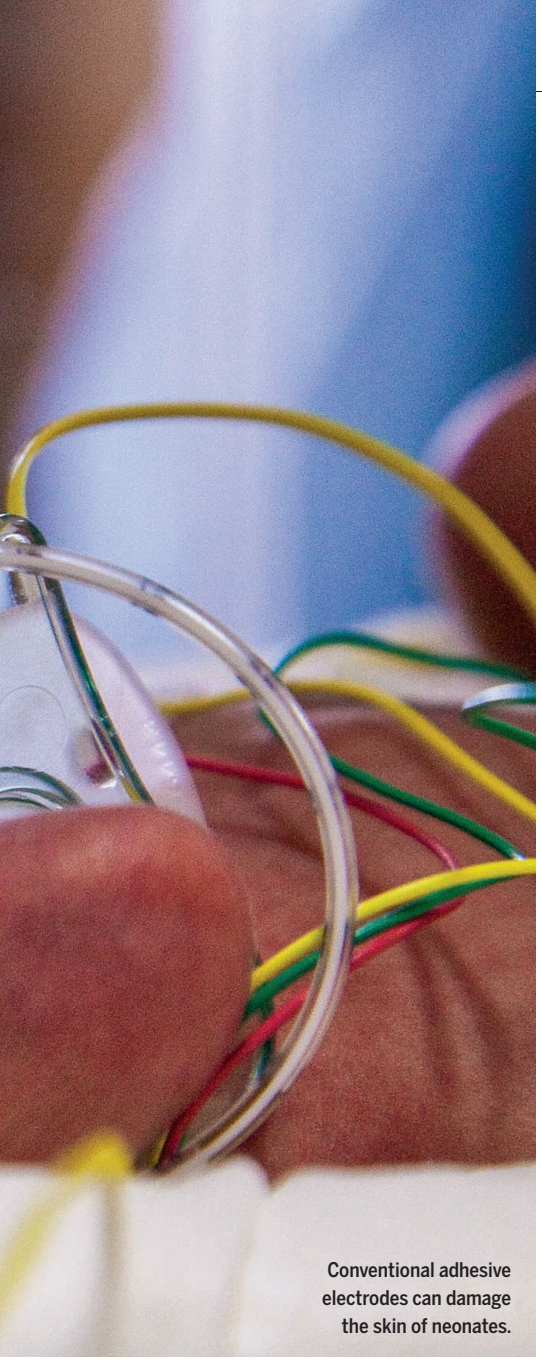


Conventional adhesive electrodes can damage the skin of neonates.

GRAPHIC: V. ALTOUNIAN/*SCIENCE*

chemistry, and engineering bring new options to clinical care.

The goal in caring for these infants is not just to ensure their survival but also to give them a future free of major impairments that would compromise their quality of life. However, even the best clinical care available must be afforded with sensitivity to families who now have a baby with immediate health problems and longer-term challenges of motor, cognitive, and sensory impairments and other clinical problems throughout their lives. Health professionals must appreciate the fears of families and bring them closer to their babies in order to create the healthiest possible bonding (*5*, *6*).

In the developed world, a key aspect of this care is continuous electronic monitoring of heart rate and continuous evaluation of oxygen saturation, as these data guide resuscitation decisions after birth. In the longer term, the clinician manages the care of critically ill infants on the basis of additional monitored data, including neonatal and environmental temperature, content of carbon dioxide in expired breath, the respiratory parameters of the ventilator that breathes for the infant, and electric brain waves. All this equipment needs electricity or batteries, and it is connected to fragile infants by wires connected to sensors placed on different parts of their bodies (*7*).

All of this information comes with costs in addition to the obvious financial ones for equipment and operation. The information displays are spread around so many places outside the incubator or the crib that clinicians incur a logistical cost integrating the information. There is a care cost, in that the patients have several attached sensors that may bruise their very immature skin, and they are connected to multiple wires that limit their mobility. There is also a family cost. Because of the limited mobility and extreme fragility of the patients, sometimes it can take days until a mother, father, or other family member can actually hold their child and provide essential human contact.

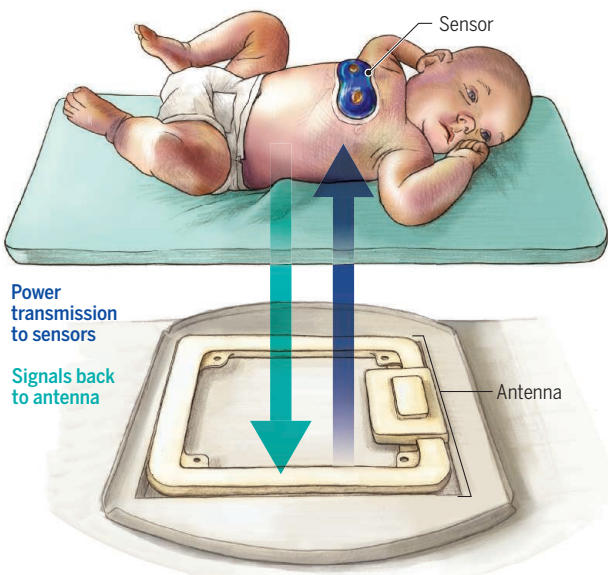
The study of Chung *et al.* offers an innovative approach to overcoming some of these difficulties. Ultrathin skin-like electronic sensors whose coordinated operation bypasses the limitations of existing technologies. The sensors are powered and transmit data through embedded radio-frequency (RF) coils, both in the wearable sensors and under the crib bed that is designed to allow RF transmission (see the figure). This wireless, battery-free operation provides time-synchronized continuous data streaming of several vital signs. The soft mechanics and light adhesive interfaces to the skin are also compatible with advanced medical imaging techniques.

This technology may improve the care of very preterm infants in developed-world settings, but also has great potential impact on monitoring practices all over the world and may give many neonates a more equitable opportunity to survive. In general, neonatology needs new inputs of hard sciences in order to find creative solutions to maintain life and preserve proper development. However, these developments must be considered in the context of millions of infants in the developing world, or in areas of poverty in the developed world, who live for less than 1 month not because of impairment or prematurity, but because of their families' poor economic and health conditions (*3*, *8*). ■

Wireless sensing

The system designed by Chung *et al*. uses soft skin-like sensors that are powered with an antenna, placed under an infant's bedding, that also receives data from the sensors.

Easier on the child
Neonates are more likely to have fewer skin lesions and fewer constraints on movement.



Comparable to wired sensors
Accurate monitoring of heart rate, respiratory rate, oxygen saturation, and skin temperature can be achieved without increasing costs.

Division of Neonatal Medicine, Escola Paulista de Medicina–Universidade Federal de São Paulo, São Paulo, SP 01410-020, Brazil. Email: ruth.guinsburg@unifesp.br

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