Researchers design more accurate method of determining premature infants' risk of illness

September 8 2010

Stanford University researchers have developed PhysiScore, a revolutionary, non-invasive way of electronically scoring and assessing a baby's well-being and predicting whether future medical treatment might be needed. Pictured in the neonatal intensive care unit at Lucile Packard Children's Hospital are, (left to right), researchers Anand Rajani, Suchi Saria, Anna Penn and Daphne Koller. Credit: Lucile Packard Children's Hospital

Stanford University researchers have developed a revolutionary, non-invasive way of quickly predicting the future health of premature infants, an innovation that could better target specialized medical intervention and reduce health-care costs.

"What the PhysiScore does is open a new frontier," said Anna Penn, MD, PhD, an assistant professor of pediatrics at the School of Medicine

and a neonatologist at Lucile Packard Children's Hospital. "The national push toward electronic medical records helped us create a tool to detect patterns not readily seen by the naked eye or by conventional monitoring. We're now able to identify potential health problems before they become clinically obvious."

Penn is a co-senior author of the research, which will be published Sept. 8 in Science Translational Medicine. The other senior author is Daphne Koller, PhD, professor of computer science in the School of Engineering.

The paper's authors likened their PhysiScore to a more reliable, electronic version of an Apgar score. The Apgar, a simple, repeatable check done shortly after birth, has for more than half a century been the standard method of assessing a baby's physical well-being and predicting whether future medical treatment might be needed.

But by taking into account gestational age and birth weight and using a stream of real-time data routinely collected in neonatal intensive care units - such as heart rate, respiratory rate and oxygen saturation - the Stanford researchers developed a probability scoring system for the health of prematurely born infants that outperformed not only the Apgar but three other systems that require invasive laboratory measurements.

Koller noted that sophisticated computational methods are critical to identifying the subtle patterns in the complex data about these young patients, as well as helping clinicians and researchers accurately discriminate between the different outcomes.

"Our method is similar to fetal heart-rate monitoring, a tool that has profoundly changed management of labor," added Suchi Saria, the graduate student who led the research as part of her doctoral thesis in computer science. "Rather than observing a single physiological variable,

however, we automatically integrate multiple physiological responses to improve accuracy."

"And the beauty is we don't have to stick anybody with a needle or do more expensive tests," said Penn. "Now we have the possibility of using the power of data already available in the intensive care unit to greatly improve care for premature infants."

The researchers relied on data recorded during the first three hours after an infant's birth as part of a computer algorithm that predicted the baby's likelihood of developing serious illnesses with an accuracy of between 91 and 98 percent. By comparison, the success of Apgar score predictions for the same conditions ranged from 69 to 74 percent.

In developing the PhysiScore system, the researchers studied 138 infants cared for in the neonatal intensive care unit of Packard Children's Hospital from March 2008 to March 2009. All the babies were born at 34 or fewer weeks of gestation and weighed less than 2,000 grams, or 4 lbs, 6.5 oz. None had major congenital malformations but all suffered complications that ranged from long-term disorders affecting multiple organ systems to relatively mild problems such as slight respiratory distress.

The PhysiScore proved particularly accurate in predicting the overall risk of life-threatening events in subgroups of infants who had intestinal infections and cardiopulmonary complications, even when these were not diagnosed until days or weeks later. The researchers said that adding lab tests, such as blood-gas measurements required for other scoring methods, was not needed to make PhysiScore highly accurate.

The study authors envision infants' PhysiScores being displayed on bedside monitors along with other vital measurements that would help guide care. "This could be done cheaply," Saria said. "The hardware, the

bedside monitor, already exists. It would just be a matter of layering in new software that would display the PhysiScore."

The study said better neonatal risk assessment could have the practical effect of keeping more premature infants at their local birth centers, avoiding higher costs of specialized care and transportation and "thus potentially reducing the estimated $26 billion per year in U.S. health-care costs resulting from preterm birth."

Penn said many preterm babies have relatively good Apgar scores, even those infants who go on to develop serious health complications. "So now, with a PhysiScore, I could have two 25-week-gestation, 700-gram babies and know that they each have a very different individual risk profile," she said. "This really gives us another tool."

Saria added that although the initial research focused on assessing the health of preterm infants, "the state-of-the-art techniques we used produced a flexible framework that can be optimized for other patient populations. This should make these results of interest to a wide range of physicians and researchers."

The PhysiScore system must still go through additional testing before it could be considered for commercial use. Penn said the researchers hope to validate the new tool on a larger group of preterm babies, and study how it influences medical decision-making. "At the same time, we can try applying our methods to other groups of patients, such as children returning from surgery, to determine if there are similar early signals that can be integrated to predict complications during recovery," she said.

Koller emphasized the broader long-term potential of the new approach. "To achieve truly personalized medicine, we have to integrate an enormous amount of data: clinical symptoms, diagnostic test results,

physiological data streams and, soon, genetic and genomic data," she said. "Computational methods derived from real patient records can deliver on the promise of personalized, evidence-based medicine."

Provided by Stanford University Medical Center