USING ARTIFICIAL INTELLIGENCE TO EVALUATE NEWBORN HEALTH

The minutes and hours immediately after childbirth are critical for the health of both the baby and the mother. Rapid evaluation of the placenta can provide valuable information about the health of the child and mother, but placentas are not commonly examined. Researchers at Penn State are working to develop and distribute software that could evaluate a placenta using only a picture taken with a smartphone.

Alison Gernand, associate professor of nutritional sciences at Penn State, studies micronutrients and their impact on the placenta and pregnancy outcomes. Her collaborator James Wang, distinguished professor of information sciences and technology, studies how to interpret and use large, complex, visual data. Together, they are developing software that medical practitioners and researchers can use to evaluate placentas in near real-time following births.

The algorithm that powers their software was innovative enough to be granted a patent in the United States, and the software could help improve health outcomes for mothers and newborns around the world.

Evaluating placentas

The placenta develops inside the uterus during pregnancy to provide oxygen and nutrients to a growing baby. It also protects the baby from infection and sends hormone signals to the mother and the baby. After a newborn is delivered, the placenta typically follows in the next five to 30 minutes.

Once a placenta is delivered, it is evaluated by a pathologist in only about 20 percent of births in the United States. In nations with developing economies where there are fewer pathologists per capita, evaluation of the placenta is usually less common and often completely unavailable. Furthermore, even when a placenta is evaluated, results may not be available for days, missing a critical window for potential intervention on health problems.

"By understanding placentas, we can understand a lot about health—both on the mom's side and the baby's side," said Gernand. "But placentas are hard to assess, and this work currently requires a pathologist. We are not trying to replace pathologists, but we do want to create something easy to use that can provide good information about any placenta, anywhere."

To evaluate a placenta with Wang and Gernand's software, the user only needs to blot the excessive blood with a paper towel and then photograph the placenta with a smartphone. The software evaluates the basic characteristics of the placenta—including size, color, shape, and circumference—to identify potential pathologies. Health care providers can then use this information to help them assess the health of the newborn and mother.

The software also checks for signs of infection that could necessitate treatment. For example, the researchers have demonstrated that their software can identify chorioamnionitis, an infection of the placenta that can mean the newborn may also have an infection. Use of the software could provide opportunities for early intervention.

"The work would not have been possible without the close interdisciplinary collaboration between the clinical and artificial intelligence research teams," Wang said. "Penn State has created an environment that encourages tackling large challenges through such collaborations. As artificial intelligence researchers, my doctoral students and I are excited to be able to contribute to a research problem that is highly challenging and has a high potential societal impact."

Dr. Jeffery Goldstein, director of perinatal pathology at Northwestern Memorial Hospital, and Kelly Gallagher, assistant research professor in Penn State's College of Nursing and certified nurse midwife, also provide key contributions to this research.

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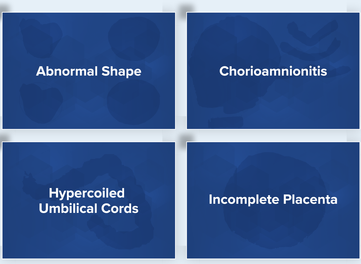
NOTE: This section contains images of human placentas. Each image depicts a different medical condition that the software detects. In some cases, the area of detection is indicated on the image.



Next steps

Currently, the software can evaluate 12 attributes of the placenta that provide information about potential health problems. Future development is expected to allow it to evaluate additional problems—including abnormalities of blood vessels—and to identify specific health risks.

"We have developed and evaluated the software primarily using a large and comprehensive dataset collected over the years by our research partners at the Northwestern Memorial Hospital," Wang said. "We are currently extending the capacity of the software so that it can reliably handle the diverse imaging infrastructure and lighting conditions in various hospitals and delivery settings. Optimizing the algorithms will allow a phone or tablet to carry out the needed computation. We are also interested in expanding the software's classification power so more pathologies can be identified."

Developing and refining the software is the greatest scientific hurdle that Gernand and Wang face. Additionally, the researchers plan to develop user-friendly apps that will allow the software to work on any smartphone or tablet. Other development could include integration of data from the software into electronic medical records in the United States. Infant and maternal mortality rates are higher in the United States than in other wealthy nations, and rapid placental evaluation could help save lives.

Acquiring support to make the software available

In order to expand the software's functionality and distribute it to people who need it, the researchers have pursued and are pursuing a broad array of potential funding sources.

- Bill & Melinda Gates Foundation
- Penn State
- National Institutes of Health (NIH)
- Crowdfunding
- Private development

"We believe in this work and are willing to step outside of our comfort zones to bring it to life. Commercialization is not our world, though. Our world is making the science work. We will do what it takes, but we will need other partners to implement and bring to scale. Our goal is to provide the software free of cost to low- and middle-income countries. The support of Penn State and the Penn State community has been central to our work and will hopefully make it possible for us to complete and disseminate this tool."

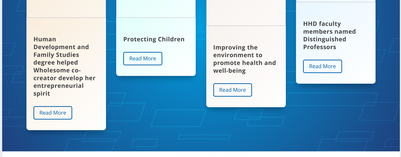
– Alison Gernand

Beyond healthcare

As useful as the software can be in medical practice, it could also serve as a tool for researchers studying pregnancy. Processing physical samples can be expensive and time consuming, depending on the laboratory where samples are being processed. This software will enable researchers to collect data instantly on placentas in any delivery setting at very low cost.

"We have completed the proof of concept and have shown that this will work. We really just need funding to put this all together," said Gernand. "Whether we use traditional funding or find a new path, we are determined to bring this research to the people who need it. It could save a lot of lives."

Photos Credits



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