Earthquakes prove to be an unexpected help in interpreting the brain activity of very premature babies

May 25 2015

Researchers have found that certain episodes, brainstorms of a kind, occur in the brains of very premature babies and are critical for the maturation of the baby's brain. Credit: University of Helsinki

University of Helsinki researchers have partnered with Swedish and Australian researchers to create a "brainstorm barometer", which allows

computers to calculate the brain functions of very premature babies during their first hours of life. The new research method is based on the hypothesis that the brainstorms generated by the billions of neurons inside a baby's head are governed by the same rules as other massive natural phenomena, such as earthquakes, forest fires or snow avalanches.

Giant strides have been taken in the early care of very premature infants in postnatal intensive care units during the past two decades. Doctors can now support the function of especially the lungs, heart and the circulatory system so as to guarantee the survival of most of even extremely premature infants. Despite a good start, many of these may still have lifelong problems with brain function, such as attention deficit disorders or difficulty with visual function. For this reason, the primary focus of developing care for premature infants has been on securing brain development.

The biggest risks in the development of a very premature baby are concentrated on the first days of life, when intensive care seeks to find the care balance suitable for each individual child.

"At this stage it would be vitally important to be able to track the child's brain function and to identify the babies whose brains are at particular risk," says Sampsa Vanhatalo, PhD, who leads the University of Helsinki's Baby Brain Activity (BABA) research group based at the HUS Children's Hospital.

The brains of very premature babies being treated in intensive care have been tracked with continuous electroencephalography (EEG) monitoring, but evaluating the EEG results has proven to be a challenge:

"The brain function of very premature babies is completely different from that of older children or adults, meaning that the currently used methods of EEG interpretation are poorly suited for use on premature

babies," Vanhatalo explains.

Storms help the brain mature

Researchers have found that certain episodes, brainstorms of a kind, occur in the brains of very premature babies and are critical for the maturation of the baby's brain. Together with Swedish and Australian researchers, Vanhatalo has now developed a completely new way of evaluating such brainstorms in newborn very premature infants.

"Our research was published in the journal *Brain*, and it is the result of exceptionally broad-based international cooperation. It involved specialists of different medical fields, physicists, mathematicians and engineers," Vanhatalo says.

The patient material for the research came from Dr. Lena Hellström-Westas' research on premature babies in Sweden. Hellström-Westas is a professor in neonatology at Uppsala University. Vanhatalo contributed the neurophysiological expertise of his research group. Finally, Professor Michael Breakspear's computational neuroscience research group in Australia developed a new kind of analysis method for the EEG signal.

The laws of nature hold true in the brain

Breakspear's research group began to develop mathematical methods used in geology and basic physics research after it was found that the brainstorms in very premature babies were astonishingly similar to the "crackling noise" that occurs on small scales in weakly magnetised metals and large-scales during earthquakes.

Ultimately, the research groups worked together to generate a clear instrument, a brainstorm barometer if you will, which can be used by a

computer to calculate the state of a very premature baby's brain during the first hours of life. Of greatest clinical interest was the observation that the results from this barometer correlated significantly with the child's cognitive development at age two.

"In terms of science, this has already revolutionised the idea of what we can observe of the brain function in very premature babies. This method is the first source of objective data on the messages the brain of a very premature baby may be sending to the doctors taking care of the child during the first hours of life," Vanhatalo describes. "It's still too early to say how the brainstorm measurements we have discovered will impact the care given to each premature baby. Our discovery helps doctors identify which children are in need of special attention, and which ones have brains that are fine on their own. This is crucial information that opens the door for new targeted care studies."

The EEG instrument created in the study is a collection of sophisticated mathematical functions, combined ingeniously to create a software component for analysing the EEG signal. This component can be added to the software of existing brain monitors. In terms of technology, the adoption of the method is no more difficult than downloading new apps onto our smartphones.

"The interest of EEG monitor manufacturers to engage in product development will be the bottleneck. Luckily the market is very competitive, and new manufacturers need to introduce innovations that are necessary for hospital work," Vanhatalo points out.

More information: "Cortical burst dynamics predict clinical outcome early in extremely preterm infants." DOI: dx.doi.org/10.1093/brain/awv129