Sound and Premature Development in Neonates

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When a baby is born prematurely, many problems begin to arise surrounding how the development will continue outside of the mother's womb. Certain noise frequencies can be too much for the baby's delicate, barely developed auditory cortex. These factors can include how often the baby is subjected to these noises and the type of noise. All kinds of factors can have a direct impact of the development of a neonate. Being born premature can lead to various problems immediately, or later on in life, and problematic development of the auditory cortex can lead primarily to auditory or speech problems in life.

A fetus develops the ability to hear at close to 24 weeks of gestation. This process comes about by neurons moving to the auditory cortex to form connections. Scientists believe that since fetuses can only hear low-frequency sounds, such as the mother's heartbeat and the melody and rhythm of her voice, early language acquisition is most likely made possible by this gathering of rhythms and melodies. High-frequency tones made outside of the mother's body are usually drowned out. Recreating this environment with premature babies will contribute to stimulating the auditory cortex and encouraging development.

Almost all experiments to date have not actively simulated a womb-like environment. Upon birth, the premature babies are subject to bright lights, chemical smells, and the loudest environment they've been subjected to at that point in their life. There have been tests conducted where the neonatology units in hospitals have spread out the amount of incubators per unit; they have also conducted experiments where they have given the babies earplugs in order to increase the noise cancellation.

Amir Lahv, a neuroscientist at Harvard University, conducted an experiment testing whether the simulated effects of a mother's heartbeat and reading to the baby would impact the

baby's neural development. They had 40 babies as test subjects, half of the babies were to be subjected to an increased auditory experience, while the other 20 were to receive standard care. The mothers of the half receiving the treatment recorded their heartbeats, read *Goodnight Moon* and sang *Twinkle Twinkle Little Star*. The scientists took these recordings, removed the high frequency sounds and then played the modified recording for the babies multiple time a day. This experiment lasted for 30 days. At the end of the experiment, they conducted ultrasound scans on the babies; the babies who had been subjected to simulated auditory environments had significantly thicker auditory cortices. Although the results don't explicitly give any desired results, "bigger is better" in this region of the brain. Lahv intends to continue following these babies to see if they develop speech or hearing problems later on in life. [1]

It is commonly known that excessively loud noise is damaging to many aspects of neonatal development. That noise alone can disrupt parameters such as blood pressure, breathing, heartbeat and oxygen saturation. [2] All of these criteria are paramount to the survival and development of the neonate and should not be put in jeopardy. The American Academy of Pediatrics recommends that all noise a neonate is subjected to should be 45 dBA or lower. This frequency regulation should decrease any interruptions with the reduce stress on the cardiovascular system, breathing, neurological and endocrine system, thus promoting growth and improving the baby's outcome.

A scientific study conducted by the City Hospital in Nottingham tested whether admission to neonatal units would affect the development of the baby. [3] Half of the preterm infants (21) were subject to the average neonatology setting, whereas the other half (20) were subject to a day-and-night nursery where the light and noise was reduced from 7pm to 7am. The

test was hoping to understand which preterm infants would exhibit the most signs of physical growth over mental growth. The infants with the limited light and noise levels showed an average increase in growth over the babies in the neonatal unit by about 0.5 kg. The study concluded that the regulation of noise and light in a neonatal setting is a predominant guiding factor in the physical growth or preterm neonates.

The average gestation period of the infants was 31.8 weeks, the average birth weight was 1.63kg, and the ages ranged from 1-63 days. The control nursery had 6 cots and no effort was made to change the patterns and routines of any of the staff working there. There was a large window flanked by many smaller ones and there were strips of fluorescent lights on the ceiling. The windows were identical in the experimental nursery and the cot distribution was the same, but the lights were dimmed for a certain time period and there was an effort made to reduce staff noise. The experiment ran from August to December of 1984. There have been few similar experiments conducted since and the subsequent experiments have more existed to test the effects of noise on neurological development.

Although more and more preterm infants are surviving past their early days in the Neonatal Intensive Care Unit (NICU), many of these children will encounter neurodevelopmental problems once they are subjected to a scholastic environment. [4] There is an increasingly common sentiment that these problems stem from unfavorable conditions the infants are subject to in the NICU, especially an excess of high frequency noise. The noise can affect many different bodily functions, even ones that are not directly related to noise. Lahv noticed that the respiratory system showed a decrease in functionality when the intensity of the

noise was increased. As previously addressed, the heart rate and blood pressure of the infant is volatile in terms of intense noise.

The Fesentience womb intends to mimic the mother's heartbeat and also her voice in order to stimulate development of the auditory cortex. The heartbeat sound bite will be played more frequently than the "voice", but will still not be constant. These studies show that if the noise is kept within a certain frequency threshold, and is played at regular intervals, the infant should show long term growth without disrupting many necessities of life. Filters can be applied to the sound files in order to screen what is played, and the frequency can be manipulated by use of audio editing software. The heartbeat will either be played as a sound file, or will be manifested in another manner where it can be both felt and heard.

The sound will also have a filter applied so that it will sound like it was in a womb. The amniotic fluids of the mother's womb filter sound and muffle the sounds naturally. An "underwater" effect could be applied to simulate the sounds that are heard in the womb. A study was conducted by a group of American researchers to understand what sounds could be heard in the womb. [5] They implanted tiny electrodes into a sheep fetus and made recordings of what the fetus was able to hear while in the womb. The low frequencies noises were audible in the womb but the high frequency noises were garbled or completely blocked out. One of the researchers likened the sound to "Lauren Bacall speaking from behind a heavy curtain."

The most important part of the product is that it can't prioritize long term neurological development over immediate coronary, respiratory, circulatory, and nervous functionality. Preterm infants are immensely fragile beings and need to be treated as such, it is the only way to maximize the survival and growth rates. If the sound is maintained within the tolerable frequency

range and is only played at certain time intervals, then the maximal amount of physical and psychological growth can be allowed to come to fruition. Unfortunately, there is more to preterm neonatal care than simply sound management, sound is one of the least immediately important parameters that needs to be met in order to maximize the restorative care for preterm neonates.

References

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