Public summary of PhD-thesis of Lauren Bullens
PhD-defense date: 21 Dec 2018

Maternal hyperoxygenation improves the fetal heart rate pattern during labor

Fetal distress - the lack of adequate fetal amounts of oxygen – is a fairly common complication in labors and births. The administration of supplemental oxygen to pregnant women, or “maternal hyperoxygenation” (MH), has been proposed as a remedy to fetal distress during labor. However, the implementation of MH as common clinical practice is still under debate, since its effectiveness and safety remains unclear. In her PhD project, Lauren Bullens proved - via a mathematical model first and a clinical trial later on - that MH has a positive effect on the fetal heart rate pattern during labor, with no harmful effects for the baby and the mother.

Maternal hyperoxygenation (MH) - the administration of oxygen to pregnant women – is considered as a potential therapy for fetal distress, a condition in which baby's oxygen supply is compromised in the uterus. However, to date, proper studies investigating the beneficial and potentially harmful effects of MH are still lacking. Former studies suggesting a positive effect of MH on fetal heart rate pattern and fetal oxygenation are not supported by well-designed clinical trials. Also, other studies showed that when MH is applied in non-stressed fetus as a preventive measure, risks for the baby might arise due to, for example, the occurring of “oxidative stress”, an imbalance between the production of chemically reactive species containing oxygen and the capability of the human body to remove those, which can cause toxic effects for human cells.

Maternal hyperoxygenation: yes or no?

Given these suboptimal studies and discordant results, the possibility to turn MH into a common clinical practice worldwide remains under discussion. While the American guidelines on fetal resuscitation recommends performing MH, European guidelines advice against this intervention. Yet, according to a national survey conducted by Bullens in this PhD project, approximately 60% of Dutch hospitals use MH in case of fetal distress.

Mathematical model

Bullens hypothesized that MH would lead to an increase in fetal oxygenation and, thus, in an improvement of the fetal heart rate pattern. She first tested this hypothesis using a mathematical model, designed to simulate the fetomaternal blood circulation and oxygenation. Results suggested an increase in fetal oxygenation, and an improvement in fetal heart rate pattern, as initially hypothesized.

Clinical tests

Given the encouraging results of the mathematical simulations, Bullens performed a clinical trial on 117 women with suspected fetal distress in the second stage of term labor. 16.7% of the women subjected to MH showed fetal heart rate improvement against 5.7% of control group (women not treated with MH). Also, in the MH group, deterioration of the fetal heart rate pattern occurred less often when compared to the control groups (13.9% versus 42.9%). In addition, Bullens demonstrated that MH does not increase oxidative stress, in comparison to no MH administration, neither it is associated with risks for the delivery. In the future larger clinical trials should be performed, which include data from admissions of babies to intensive care units and perinatal death.

Title of PhD-thesis: Management of fetal distress during term labor. Supervisors: Prof. Dr. S.G. Oei, (TUe/Máxima Medisch Centrum), Dr. Ir. M.B. van der Hout-van der Jagt (Máxima Medisch Centrum),
Dr. P.J. van Runnard Heimel (Máxima Medisch Centrum). The research described in this thesis was performed within the IMPULS perinatology framework.