Abstract

Due to the high complexity and low incidences of emergencies during labor and delivery, gynaecologists often cannot rely on previous experiences during a crisis. Simulation training can provide both experience and skills in a safe environment, such that complications due to emergencies can be reduced as much as possible.

Several simulators are available that support a safe learning environment for obstetric emergency training. However, none provides a realistic and physiology-based (simulation of) the cardiotocogram (CTG), which is a continuous and synchronous registration of uterine contractions and fetal heart rate. However, at the labor and delivery ward, the CTG is widely used as main indicator for fetal welfare. The CTG provides information on the fetal stress reaction to uterine contractions, based on oxygen levels in the fetal blood. Since the CTG is widely available and the only non-invasive method for fetal monitoring, medical decisions are often based on deviations in the CTG. The CTG is therefore an essential part of the clinical environment in medical simulation training.

In a one-year clinical project as part of a qualified medical engineer training, a start is made with the development of a CTG simulator. The three main deviations in the CTG were studied: early, late and variable decelerations in fetal heart rate, caused by uterine contractions and complications in labor. The mechanism of these three deceleration types was studied, and each step was quantified for early and late decelerations. In this project, early decelerations were implemented in a mathematical model, based on the underlying physiological principles. In future, implementation of late and variable decelerations are planned within a PhD-project.

A validation study was performed for the modeled CTG, where a comparison was made between real and computer-generated CTG tracings from our model, based on experts' opinion. The first results show no significant differences between real and computer-generated CTG tracings. However, the number of clinical experts was low, and a larger study has to be performed to confirm these results.

Coupling of the modeled CTG to a simulator interface is planned in future. The model can be implemented in different types of simulators: in a screen-based simulator (individual in-depth training to improve insight into and interpretation of the CTG), as part of a full-body delivery simulator, and as part of a serious game (in these two cases the CTG is part of the clinical environment). Future plans include implementation in a screen-based simulator and a full-body delivery simulator.

Key-words: Simulation, Mathematical model, Cardiotocogram, Decelerations, Labor, Delivery

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