Automation in clinical data collection in obstetrics - Enabling pooled IPD studies for fetal heart rate and activity monitoring

Cardiotocography is currently the standard surveillance tool during labour. For this reason, there are large cardiotocography datasets available. Several studies gathering additional information of computerized CTG data aiming to improve surveillance during delivery and birth outcome are currently performed. Manual data collection and analysis takes a lot of human resources, is error-prone and study parameters can hardly be adjusted later on. Therefore, a software based approach was chosen to minimize the effort of preparation. The software called “CTG and patient information matcher” (CAPIM) collects relevant CTG signals for a specified patient dataset and under recognition of several parameters. CAPIM was tested with the patient database of Frauenklinik und Poliklinik of Technische Universität München (Munich, Germany). Further hospitals will follow. The cases received from CAPIM will be used to do feasibility studies for two innovative signal processing techniques as „phase-rectified signal averaging“ method on fetal heart rate raw data and „deceleration area“ method to improve prediction of birth outcome.
Automation in clinical data collection in obstetrics

Enabling pooled IPD studies for fetal heart rate and activity monitoring

*These authors contributed equally / Fakultät für Elektrotechnik und Informationstechnik, Technische Universität München, Munich, Germany
**Frauenklinik und Poliklinik, Technische Universität München, Munich, Germany
**Trium Analysis Online GmbH, Munich, Germany / Sylvia Lawry Centre - The Human Motion Institute, Munich, Germany

Background
- Cardiotocography is currently the standard surveillance tool during labour
- Large cardiotocography dataset enables analysis of heart rate monitoring
- Studies for physiological „fetal heart rate” are already available

![Figure 1: Histogram of baseline fetal heart rate values. Red bars show 25th to 75th percentiles, red and green ones 12.5th to 87.5th percentiles, red, green and yellow bars 5th to 95th percentiles and all bars except white ones display 2.5th to 97.5th percentiles. According to the considered 78,892 CTG tracing the normal range of fetal heart rate is between 120 to 160 bpm. Many international guidelines define ranges of 110 to 160 bpm.](image)

![Figure 2: Information flow of “CTG And Fetal Information Matcher” (CAPIM). CAPIM gets information about fetus, all CTGs and additionally the path where the CTG-files are stored. Furthermore, a directory structure with all selected and valid CTG-files and files with relevant information for further processing will be created.](image)

![Figure 3: Representation of relevant selection parameters.](image)

Method
- Selection of relevant cases and collection of relevant data in one step:
  - Umbilical arterial blood pH values > 7.1 (pectile)
  - Only both CTGs are relevant
  - A certain length of CTG signal is required for reliable data analysis
  - Primary caesarean sections are excluded

Implementation
- Software Implementation in C++
- Graphical User Interface designed with the QT-Framework
- Multi-threaded implementation
- Data visualization using QCustomPlot
- System & Unit tests using QTest
- Platform independent
- Static linking for standalone use

Results
- One execution takes less then 4 sec
- 125 - 188 valid cases (parameter depending) out of 477 possible cases between 09/2009 and 12/2015
- Directly applicable in other hospitals

Outlook to the future
- Pooled studies in cooperation with other hospitals and research centers for more resilient data and study results
- Application of innovative signal processing techniques as „phase-restricted signal averaging” method (2) on fetal heart rate raw data and/or „deceleration area” method (3) to improve prediction of birth outcome

References
3. Nesch K (2007). Klassifikation von Dezelerationen. Technical University Munich, Germany & University of Fortaleza, Brazil