The EEG of the Neonatal Brain – Classification of Background Activity

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Abstract: The brain requires a continuous supply of oxygen and nutrients, and even a short period of reduced oxygen supply can cause severe and lifelong consequences for the affected individual. The unborn baby is fairly robust, but there are of course limits also for these individuals. The most sensitive and most important organ is the brain. When the brain is deprived of oxygen, a process can start that ultimately may lead to the death of brain cells and irreparable brain damage. This process has two phases; one more or less immediate and one delayed. There is a window of time of up to 24 hours where action can be taken to prevent the delayed secondary damage. One recently clinically available technique is to reduce the metabolism and thereby stop the secondary damage in the brain by cooling the baby.

It is important to be able to quickly diagnose hypoxic injuries and to follow the development of the processes in the brain. For this, the electroencephalogram (EEG) is an important tool. The EEG is a voltage signal that originates within the brain and that can be recorded easily and non-invasively at bedside. The signals are, however, highly complex and require special competence to interpret, a competence that typically is not available at the intensive care unit, and particularly not continuously day and night. This thesis addresses the problem of automatic classification of neonatal EEG and proposes methods that would be possible to use in bedside monitoring equipment for neonatal intensive care units.

The thesis is a compilation of six papers. The first four deal with the segmentation of pathological signals (burst suppression) from post-asphyctic full term newborn babies. These studies investigate the use of various classification techniques, using both supervised and unsupervised learning. In paper V the scope is widened to include both classification of pathological activity versus activity found in healthy babies as well as application of the segmentation methods on the parts of the EEG signal that are found to be of the pathological type. The use of genetic algorithms for feature selection is also investigated. In paper VI the segmentation methods are applied on signals from pre-term babies to investigate the impact of a certain medication on the brain.

The results of this thesis demonstrate ways to improve the monitoring of the brain during intensive care of newborn babies. Hopefully it will someday be implemented in monitoring equipment and help to prevent permanent brain damage in post asphyctic babies.

Keywords: EEG, segmentation, classification, asphyxia, hypoxia, newborn, neonatal, cerebral